SPECIAL STUDY No. 5

Price Stability and High Employment:

The Options for Canadian Economic Policy

An Econometric Study

by

Ronald G. Bodkin
Elizabeth P. Bond
Grant L. Reuber
T. Russell Robinson

prepared for the
Economic Council of Canada

PRICE STABILITY AND HIGH EMPLOYMENT: THE OPTIONS FOR CANADIAN ECONOMIC POLICY

An Econometric Study

Prepared for the
Economic Council of Canada

by

Ronald G. Bodkin
Elizabeth P. Bond
Grant L. Reuber
T. Russell Robinson

SEPTEMBER 1966

This is one of a series of technical studies prepared as background papers for the Economic Council of Canada. Although these studies are published under the auspices of the Council, the views expressed in each case are those of the authors themselves. Other Council publications are listed at the end of this study and are available from the Queen's Printer, Ottawa.

Available by mail from the Queen's Printer, Ottawa,
and at the following Canadian Government bookshops:

OTTAWA
Daly Building, Corner Mackenzie and Rideau

TORONTO
221 Yonge Street

MONTREAL
Æterna-Vie Building, 1182 St. Catherine St. West

WINNIPEG
Mall Center Bldg., 499 Portage Avenue

VANCOUVER
657 Granville Street

or through your bookseller

A deposit copy of this publication is also available
for reference in public libraries across Canada

Price $3.25　　　Catalogue No. EC 22-2/5

Price subject to change without notice

ROGER DUHAMEL, F.R.S.C.
Queen's Printer and Controller of Stationery
Ottawa, Canada
1967

PREFACE

This study constitutes one part of the research programme undertaken by the Economic Council of Canada in response to the Government's request to the Council to prepare a comprehensive review on Canadian prices, costs, and incomes. Specifically the Council was asked:

1) To study factors affecting price determination and the interrelation between movements in prices and costs, and levels of productivity and incomes.

2) To report on their relationship to sustained economic growth and to the achievement of high levels of employment and trade and rising standards of living.

3) To review the policies and experiences of other countries in this field and their relevance for Canada.

The analysis presented in this study has a direct bearing on each part of the Council's terms of reference.

It is a pleasure to acknowledge the assistance which we have received in the course of our work from various persons. Our greatest obligation is to the staff of the Economic Council of Canada, particularly to Dr. J.J. Deutsch, Dr. A.J.R. Smith, and Dr. D.L. McQueen. Dr. Deutsch, in his unique way, has been a fertile source of ideas as well as of staunch encouragement and support. Dr. Smith has also made important contributions to this study. Dr. McQueen, who has been immediately responsible for organizing and co-ordinating the research undertaken by the Council on prices, has established himself in our minds as a model to be emulated in performing this delicate and sometimes difficult task.

We should also like to acknowledge the help with statistical data which was provided by Mr. E.C. West of the Council's staff. Mr. West was especially helpful in providing us with the data on which Chapter 8 is based and should be given most of the credit for the Appendix to Chapter 8.

Apart from the Council's staff, our greatest obligation is to Professor S.F. Kaliski who read a first draft of the study and commented on it in detail. We cannot be sure that we have met all Professor Kaliski's criticisms to his satisfaction, but we are certain that the study is very much better because of the very high standards which he challenged us to meet. In addition to Professor Kaliski, we also wish to acknowledge the helpful comments we received from Professor T.I. Matuszewski.

Finally, we wish to acknowledge the conscientious and devoted help of our research assistants: Mr. W. Trusty, Miss E. Richardson, and Mrs. J. Wilensky. We also wish to acknowledge the patient and long-suffering help provided by our typists: Mrs. M. Gower, Mrs. F. Scott, Mrs. C. Winbow, and Miss S. Brown.

University of Western Ontario,
London, Canada.
September 1966.

Ronald G. Bodkin
Elizabeth P. Bond
Grant L. Reuber
T. Russell Robinson

TABLE OF CONTENTS

PART I
BACKGROUND DISCUSSION

PART II
NEW EVIDENCE FOR POST-WAR CANADA

PART III
CANADIAN HISTORICAL EVIDENCE, INTERNATIONAL COMPARISONS, AND CONCLUSIONS

LIST OF TABLES

LIST OF FIGURES

PART I

BACKGROUND DISCUSSION

CHAPTER 1

INTRODUCTION

1. The Concept of a "Trade-Off"

In everyday life, individuals frequently face the difficulty of choosing among several goals, all of which are highly desirable in themselves but each of which is inconsistent with some of the others to some degree, thus making it impossible fully to achieve all of them. Among the many examples which could be cited are the following: the desire for income (requiring effort) vs. the desire for leisure; the desire for speed in transportation vs. the desire for safety; the desire to consume current income vs. the desire to accumulate assets. Few, if any, individuals opt for all work or all leisure, maximum speed without any concessions to safety, or starvation in order to save all of their income. Most individuals elect a compromise between these extremes: some income and some leisure; a "safe" speed; some consumption and some saving. In this sense we can say that individuals are willing to "trade off" income against leisure, speed against safety, and consumption against saving.

Nations frequently face similar difficulties in choosing among the objectives of economic policy. In the modern world, policy-makers in most, if not all, countries aspire to a wide range of economic objectives: full employment, a stable price level, rapid and sustained economic growth, balance-of-payments equilibrium, wide regional dispersion of economic development, and greater equality (of income, wealth, and opportunity) is an illustrative list. If it were merely a matter of compiling a list of desirable goals, questions of economic policy would be comparatively simple. However, if the various goals considered important by society conflict with each other to some extent, the compilation of such a list is merely the beginning, not the end, of the process of formulating satisfactory economic policies. If all goals cannot be attained simultaneously, a hard choice must then be made as to how far to pursue one objective at the expense of the others. Under these circumstances, most societies, analogously to most individuals, can be expected to elect a compromise, trading off some portion of one objective in order not to fall further short on some other. It is true that the decision may not be a conscious one: the policy-makers may not view the matter in these terms or even if they take such a view, the "objective" trade-offs may differ from those considered most probable by the decision-makers. Consequently, past actions by the policy-makers may be an imperfect guide to their preferences, given the uncertainties pervading most "real world" policy actions. Nevertheless, if a conflict between goals is present, some form of compromise is usually reached in practice; in this sense at least, the policy-makers may be said to have traded off one goal against one or more other goals.

How much of one objective must be traded off in order to gain a particular amount of another depends, of course, on the degree to which the objectives are in conflict. Conceivably, objective A might not conflict at all with objective B: in this case, A can be fully attained without impairing in any way the country's ability to achieve B as well and hence no choice between A and B is required. At the other extreme, it is conceivable that A and B are mutually exclusive. Here the choice is between all of A and none of B, or none of A and all of B--one can choose either A or B, but no combination of the two. It is, however, the view of the writers of the present study that many objectives of public policy (including the two on which this study focuses, high employment and price level stability) are neither completely independent of other objectives nor mutually exclusive of these other objectives, but lie between these two limits.[1] Under these circumstances, a decision must inevitably be made, implicitly or explicitly, as to how far to pursue each objective. (In this context, an objective may be defined as the ideal that would be sought in the absence of conflicts.) Hence, in order to evaluate public policies a key question to be considered is how much of one objective must be foregone in order to move a step closer towards some other objective. In other words, what are the quantitative terms of the "trade-off" between goals A and B?

2. Trade-Offs between Price Level Stability and High Employment

In this study, we attempt to examine, primarily in the Canadian context, the issues of whether a conflict exists between the objectives of price level stability and high employment and if so, what are the trade-offs, at various levels of unemployment, between these goals. The approach underlying this investigation can be made explicit with the aid of the "trade-off" curve[2] of Figure 1.1. In this Figure, the level of unemployment as a percentage of the labour force is measured along the horizontal axis with the hypothetical zero rate of unemployment corresponding to the origin. The annual percentage rate of change of the Consumer Price Index is measured along the vertical axis, with (as is customary) points above the origin representing price level increases and points below it, price decreases.

---

[1]It is of course conceivable that two goals, considered as an isolated pair, may be mutually reinforcing or complementary, rather than conflicting or of the nature of substitutes. For example, the goal of rapid economic growth and that of a high level of employment may be such a pair, as one of us (R.G. Bodkin) has argued in a previous publication. See "An Analysis of the Trade-Offs Between Full Employment, Price Stability, and Other Goals," pp. 47–77 of S.F. Kaliski, ed., *Canadian Economic Policy Since the War* (no city given: Canadian Trade Committee, 1966).

[2]This trade-off curve is a derived relationship with "other things remaining equal," much like the partial equilibrium demand curve of economic theory. The theoretical relationships underlying this trade-off curve are discussed in Chapter 2 below; this theoretical discussion enables one to sort out some of the variables which may induce a shift in the trade-off curve, generally in a longer-term context. The nontechnical reader should be forewarned that there are a number of statistical (or econometric) problems connected with the estimation of the underlying relationships from empirical data. One of the most important qualifications relates to the probabilistic nature of the trade-off curve: points on the curve are of the nature of expected values or arithmetic averages, rather than iron-clad values of a mathematical function from which there is no escape. Thus, with "good luck", it is possible to end up below the curve (closer to the origin), while, with bad fortune, the economy will experience more than the expected amount of inflation for a given rate of unemployment (and a given environment). For simplicity of exposition, these qualifications are not mentioned explicitly again in this section.

As the trade-off curve AA' is drawn, when the unemployment rate is 3 per cent, the rate of increase in the Canadian consumer price level which can be expected is 1¾ per cent per year; if the rate of unemployment were raised to 4 per cent, the consumer price level could be expected to increase by three quarters of a per cent annually. Hence, between these two positions, one can "trade off" a one percentage point decrease in the rate of domestic inflation for a one percentage point increase in the unemployment rate. Similar trade-offs can likewise be derived for other pairs of points along this curve.

Before considering the factors determining the shape and position of this curve, it is useful to consider the significance of points such as W and Z, which lie on either side of the trade-off curve. Points to the right of AA', such as Z, are unsatisfactory in the sense that they can be improved upon in terms of both objectives by moving towards the curve AA'. On the other hand, points to the left of AA', such as W, are preferable to points along AA' in that they are closer to the ideal situation for one of the objectives at a given value of the other; unfortunately, however, the structure of the economy, the instruments of policy, and other aspects of the economic environment make it impossible to achieve such combinations in the absence of unexpected good luck. Thus, given the nature of the economy, it is unrealistic for policy-makers to aim at combinations such as W, nor can they be condemned for failing to reach such positions. In other words, the trade-off curve AA' defines the locus of *consistent* and *attainable* combinations of inflation and unemployment, each point measuring the *minimum* extent by which it is necessary to fall short of one policy objective in order to avoid falling further short of the other. Hence the curve may be viewed as showing the best performance society can achieve for one goal, for a given fulfilment of the other goal.

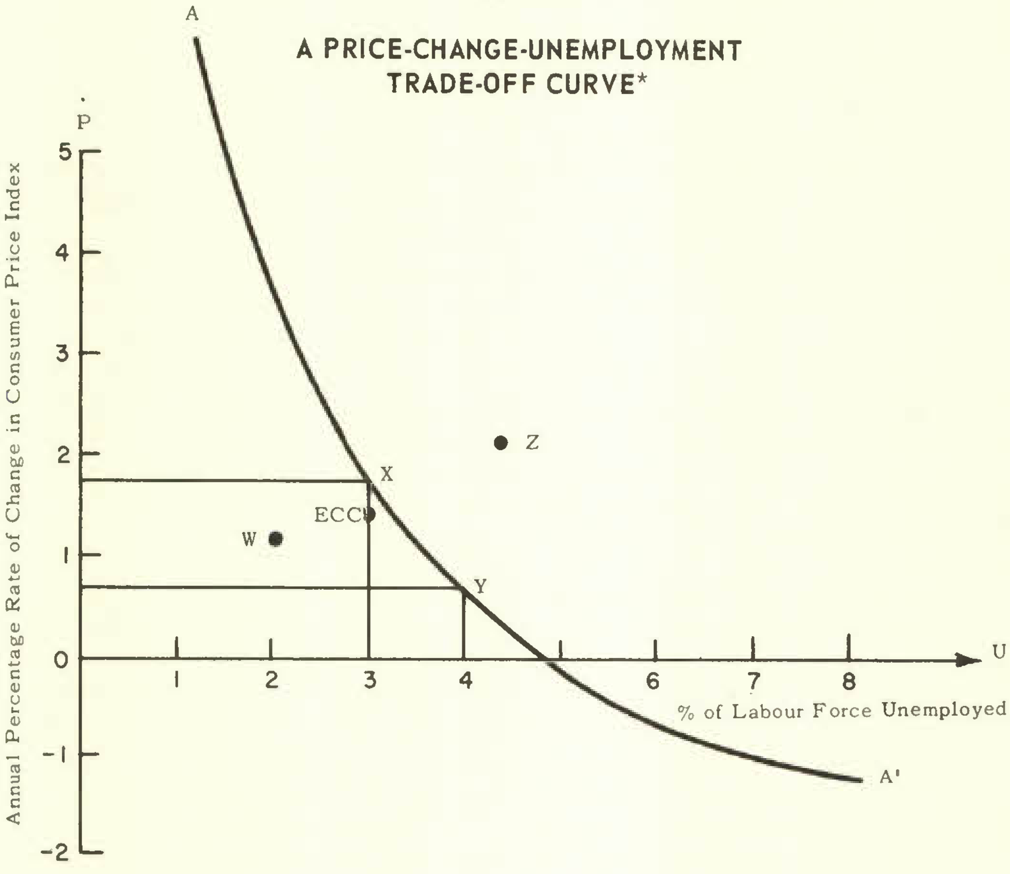
In order to illustrate the importance of knowing the empirical relationship from which trade-offs between inflation and unemployment may be derived, the price and unemployment combination stated as desirable by the Economic Council of Canada in its *First Annual Review* is plotted in Figure 1.1 as the point marked ECC, which shows a combination of a 3 per cent unemployment rate and a 1.4 per cent annual increase in the Consumer Price Index. It will be observed that this point is slightly below AA' and consequently might be deemed unrealistic *if* indeed AA' accurately reflects the empirical relationship between the rate of change of the consumer price level and the unemployment rate.[1] This illustration is included not in order to evaluate the Council's target, but rather to emphasize

[1]This point is reinforced when it is emphasized that AA' is constructed on the assumption of a zero rate of change in the price level of imports. By contrast, the Economic Council appeared to incorporate an estimate of the probable rate of foreign inflation equal to 1 per cent annually. The effect of any positive rate of foreign inflation is to shift the trade-off curve upwards and to the right, as discussed in Chapter 2 below. The estimated relationship from Reuber's earlier study, on which Figure 1.1 is based, implies that, with the assumption of a 1 per cent per year rate of foreign inflation, a 3 per cent unemployment rate might then be expected to be associated with a 2.4 per cent annual increase in the Consumer Price Index. This, in turn, is a full percentage point greater than the target rate of change of the consumer price level suggested by the Economic Council. As pointed out in Chapter 2, the Council based its implicit estimate of the combination of unemployment and price stability which might be regarded as an appropriate policy goal for 1970 on the assumption that a comprehensive manpower policy would be in operation.

that it is impossible either to set or to evaluate satisfactorily any target combination of rates of inflation and unemployment unless one estimates, in some fashion, the "real world" trade-off relationship between these two policy objectives. Failure to do so means that one is assuming some sort of trade-off relationship in any event but doing so implicitly on the basis of intuition rather than analysis.

Figure 1.1

A PRICE-CHANGE-UNEMPLOYMENT TRADE-OFF CURVE*



*The points plotted are based on G.L. Reuber, "The Objectives of Canadian Monetary Policy, 1949–61: Empirical Trade-Offs and the Reaction Function of the Authorities," *Journal of Political Economy*, Vol. LXXII, No. 2 (April 1964), pp. 109–132. The trade-off curve is drawn on the assumptions that foreign prices remain constant and that the effects of the estimated lags have been fully worked out.

The general shape of the trade-off curve is that of being convex to the origin: the relationship is asymptotic to the price change axis and flattens out along the unemployment axis. This means that the expected rate of inflation rises increasingly rapidly as the rate of unemployment is reduced; the expected trade-off (slope of the AA' curve) is not constant over the usual range of unemployment. This is what one might expect from the nature of the economy; as unemployment is reduced due to an increasing demand for labour, it will gradually approach a frictional minimum level, at which wage increases will accelerate rapidly. Moreover, other stresses may be encountered in a high-pressure, low-unemployment economy; some industries will reach full capacity before others and attempts to expand output still further will induce rapid rises in prices, at least in the short run in which it is very difficult to alleviate such bottlenecks. On the other hand, as unemployment is increased and the pressure of demand is reduced still further in an already slack economy, the gain in further price level stability might be expected to be rather small. Some of the unemployed labour force might be expected to lose touch with the labour market and so to exert very little downward influence on money wages (and hence on product prices); moreover, considerable excess capacity may have only a minor impact on the rate of change of final prices. For a variety of institutional reasons, prices and wages might be expected to move in a downward direction less readily than upwards, which is reflected graphically in the curve's flattening out at higher rates of unemployment. These rough and ready assertions about the nature of the economy's labour and product markets have been presented without rigorous proof or documentation, but it seems likely that many of them would be widely accepted by professional economists.

Factors which determine the slope and position of the trade-off curve include the underlying structural elements of the economy—e.g., its resource base, its rate of technical change, the attitudes and short-term expectations of the public, its institutional arrangements (particularly its labour markets and its price-setting mechanisms), and its international relationships. Such structural elements may themselves change, and, if they do, the curve will shift. Thus it is quite possible for an economy to generate spontaneous shifts in its trade-off relationship. It seems likely, though not necessarily inevitable, that such shifts will take place only during some comparatively long period of time. In a closed economy, only the structural features of the domestic economy are relevant. In an open economy such as the Canadian, the structural features of other economies (particularly the U.S. economy, in the Canadian case) enter the picture as well. In particular, the linkages (trade, investment, and direct pricing and wage spillover effects) of the various participants in the international economy may give rise to price and demand linkages of several types. In addition, balance-of-payments considerations can be regarded as a constraint conditioning the attainability of policy goals, making only a certain portion of the hypothetical trade-off curve relevant to the policy decision.

The shape and position of the trade-off curve may also reflect the number of policy instruments available for use, their impact on the economic structure, and the interrelations among the various instruments of policy. One idealized case is that in which all instruments are independent of each other and all objectives are similarly independent of each other. Here, Professor Tinbergen has shown that it is possible to attain each objective fully, thus avoiding conflicts among objectives, provided one uses as many instruments as there are objectives.[1] However,

---

[1]Jan Tinbergen, *Economic Policy: Principles and Design* (Amsterdam: North Holland Publishing Company, 1956).

the realism of this case may be questioned; if the above argument is valid, objectives are generally not independent of each other but may conflict to some degree. The principal lesson to be learned from Tinbergen's discussion is, however, that the conflict among objectives is influenced by the number of instruments. Since it is widely accepted that the number of instruments generally falls far short of the number of objectives that society wishes to pursue, this suggests that complete achievement of all goals may not be feasible, even with "perfect" management of economic policy.[1]

Finally, some mention should be made of policies designed to shift the trade-off curve. Wartime price controls would be a striking illustration of such a policy; they attempt to suppress the price pressures associated with a very high level of utilization of the economy's resources during such an abnormal period. More recently, many governments in the Western democracies have instituted policies that have come to be termed "incomes policies"; while the stated purposes underlying such policies have varied somewhat, a common strand has been the attempt to reduce the conflict between the goals of high employment and stable prices or, in other words, to shift the trade-off curve in towards the axes (closer to the origin). Since the theory and practice of such policies is the subject of a companion study,[2] the details of this type of policy will not be explored here. It may be observed, however, that an incomes policy attempts to reduce the amount of spontaneous wage and/or profit push to which an economy would otherwise be subject, at any level of unemployment below the "full employment" value.

3. Outline of the Study

This study has been divided into three parts. Part I, comprising Chapters 1–3, is designed to provide a broad introduction to the empirical analysis of the second and third parts. The purpose of the present Chapter is to furnish a non-technical overview of the entire project. In Chapter 2, the trade-off equation (presented as a curve in this Chapter) is derived from a wage adjustment equation, a price level equation, and an assumption about the development of labour productivity. Armed with this theoretical underpinning, we are in a position to examine the factors which might induce shifts in the trade-off curve. The theoretical discussion of Chapter 2 is then rounded out by an examination of how the trade-off approach fits into the controversy between demand-pull and cost-push theories of inflation, by a discussion of the theory of the optimum policy combination (under this approach), and by a review of the comparability of economic statistics internationally, particularly those on unemployment rates. Chapter 3 is a selective review of the literature in this area, with the focus on wage adjustment relationships. The wage adjustment relationships which have been estimated by other investigators for a variety of developed economies, along with estimates for Canada, are compared in that Chapter.

---

[1] Of course, to the extent that a given policy is capable of "killing more than one bird with one stone," the conflict between objectives is further reduced. Thus, labour market policy may conceivably reduce (structural) unemployment, promote the efficiency of resource allocation in a static sense, enhance the growth of labour productivity, and lessen the conflict between high employment and price level stability, all at the same time.

[2] David C. Smith, *Incomes Policies: Some Foreign Experiences and Their Relevance for Canada*, Economic Council of Canada, Special Study No. 4 (Ottawa: Queen's Printer, 1966).

Part II, which comprises the middle three chapters, is the core of this study. In Chapter 4, we re-examine three earlier studies of the Canadian wage adjustment relationship, in order to gauge how well these studies forecast wage (and, in one case, price) changes beyond the period to which they were fitted. In Chapter 5, the wage adjustment, price change, and productivity relationships are refitted to quarterly Canadian data ending in 1965. In this refitting process, we were able to take into account recent developments in the literature and to experiment with various modifications of the basic relationships. Also in Chapter 5, the stability of the final wage and price equations, between two parts of the entire sample period, is examined by means of several statistical techniques. In Chapter 6, "steady state" variants of the wage and price change equations are derived; these steady state equations eliminate, in principle, the lagged effects built into the relationships estimated directly from the statistical data. The steady state relationships are then employed to derive trade-off equations, analogous to the theoretical derivation of the trade-off equation presented in Chapter 2. Finally, some qualifications on this type of analysis are given at the end of both Chapters 5 and 6.

Part III, which also contains three chapters, is designed to put the post-war Canadian quarterly relationships in perspective, by means of both temporal and international comparisons. Chapter 7 is an examination of a similar set of relationships for Canada, based on annual historical data going back to the 1920's. The examination of the historical data yields some further information on the stability (or lack of stability) of the underlying relationships from which the trade-off relationship is derived. In addition, some limited tests regarding asymmetry or irreversibility in the wage and price change relationships are made on the basis of the historical data. Chapter 8 presents a tentative analysis of similar types of relationships for five foreign countries: Britain, France, Germany (Federal Republic), Sweden, and the United States. This discussion, together with the review of the literature in Chapter 3, serves to place the results of the present study in an international context. Finally, Chapter 9 concludes by re-examining the broad issue of the optimum policy combination, for an open economy like the Canadian. The detailed conclusions of particular parts of the study are generally to be found at the end of the relevant chapters.

CHAPTER 2

A THEORY OF THE WAGE-PRICE MECHANISM AND THE DERIVED TRADE-OFF EQUATION

1. Foreword

In Chapter 1, a trade-off curve relating unemployment rates and expected rates of change of consumer prices, for a particular economy, was postulated. Since the essential purpose of the previous Chapter was to provide an overview, the details of the theoretical justification of such a relationship were given only scanty attention. The purpose of the present Chapter is to furnish a theoretical explanation of this asserted relationship.[1] Armed with this theoretical underpinning, one can then return to the trade-off curve and examine what must be held constant in order to present this relationship as a two-dimensional curve. At the same time, the analysis suggests a number of factors which might be expected to shift the relationship from an existing position. In the penultimate section of this Chapter, we attempt to relate this approach to inflation to the more familiar controversies between the adherents of demand-pull and cost-push theories. The Chapter closes with a brief introduction to the theory of "the optimum policy combination" under this view of the subject.

2. The Wage Adjustment Relationship

The heart of our approach to the conflict between the objectives of high employment and price level stability is the wage adjustment relationship. Basically, the wage adjustment relationship is an application to the labour market of the familiar idea that prices rise in response to excess demand and fall in response to excess supply. Thus, in the labour market the money wage is the basic price which may be expected to rise with excess demand (unemployment rates below "normal" or at frictional levels) and to fall with excess supply (high unemployment rates). In the post-war world of generally increasing money wages, the influence of heavy unemployment may be limited to retarding the rate of rise of money wages, rather than inducing an actual decrease in wages. Nevertheless, the effects can still be rather pronounced: the price level implications of a 10 per cent annual rate of change of money wages compared to a 2 per cent rate may be quite different.

---

[1] A similar, but not identical, theory of inflation has recently been published by Otto Eckstein in "A Theory of the Wage-Price Process in Modern Industry," *Review of Economic Studies*, Vol. XXXI (4) (Oct. 1964), pp. 267–286. A rigorous discussion of this subject, in nontechnical language, is developed in great detail in William G. Bowen's excellent book, *The Wage-Price Issue* (Princeton, N.J.: Princeton University Press, 1960). Both the Eckstein and the Bowen treatments focus primarily on the closed economy case.

In addition, money wage changes may be conditioned by the current or immediate past rates of change of consumer prices. In a neoclassical world, one might expect money wages to be adjusted proportionately to changes in the consumer price level, as workers and managers are assumed to be free from any "money illusion". While the existence of escalator clauses testifies to worker awareness of changing price levels, there appear to be enough lags, inertia, and other "imperfections" in the system to prevent full adjustment of money wages to consumer prices, at least in the short period.[1] But changes in consumer prices are at least a significant factor conditioning money wage changes demanded (and obtained) in the unorganized labour markets of the economy and over the collective bargaining tables.

While early investigators confined their attention principally to these two determinants of wage changes, several others have been suggested in recent years. It has been suggested that money wages will rise more rapidly the greater is the power of the trade unions (or the more they choose to exercise this power), the higher is the level of corporate profits, or the faster is the growth of labour productivity. At the level of the individual labour market, wages may be expected to rise more rapidly if the wages of a "comparable group" of workers have also risen (or are expected to rise) by a substantial amount. Some writers have asserted that the rate of change of the unemployment rate is also a relevant determinant of the rate of change of money wages: the usual argument is that the rate of change of unemployment is an additional indicator of current labour demand, or, alternatively, serves to gauge anticipated labour demand in the near future.[2]

We may draw these determinants of wage changes together in the form of an equation. Let w be the level of money wages and let $\dot{w}$ be the (percentage) rate of change of money wages. We denote unemployment as a percentage of the labour force by the symbol U, and the level of consumer prices by the symbol P_c. (Hence the percentage rate of change of consumer prices is represented by $\dot{P}_c$.) Finally, let Z represent any (or conceivably, all) of the other variables systematically influencing the determination of money wage changes. The wage adjustment relationship can then be written, at a broad level of abstraction, in the following form:

$$\dot{w} = f(U, \dot{P}_c, Z)\,, \tag{2.1}$$

where the symbol f denotes a general mathematical function. For statistical work, this is too general; some further amount of specification of the functional form is necessary.[3] It is generally thought that the rate of change of wages is a nonlinear

---

[1]The results of earlier studies and the present work suggest this conclusion. In general, supporting footnotes have not been presented in this section, because most of the propositions presented are "common knowledge". In a sense, most of Chapter 3 may be regarded as documentation of the propositions developed in this section.

[2]Richard G. Lipsey has argued, however, that the importance of the unemployment change variable arises in the aggregation of the relationships for individual labour submarkets to that of a relationship for the economy as a whole. (The reference to Lipsey's article is given in Chapter 3 below.)

[3]Another specification which must be made is that of the lag structure of the relationship. This issue is discussed briefly in the empirical chapters of Part II below.

function of the unemployment rate: when the unemployment rate is near the frictional level, small variations in the unemployment rate might be expected to have a big impact on the resulting wage change; on the other hand, if the rate of unemployment is already large, a small variation in this rate might be expected to have little impact on the rate of change of money wages. This influence is often represented by making the wage change variable a linear function of the reciprocal of the unemployment rate. Since there is no obvious argument as to why the other determinants of wage changes should exert their influence in a nonlinear fashion, we may specify the wage adjustment relationship to take the following form:

$$\dot{W} = \alpha_0 + \alpha_1(\frac{1}{U}) + \alpha_2\dot{P}_c + \alpha_3 Z \, , \qquad (2.2)$$

where the α's represent the parameters of the equation. Equation (2.2) will be employed in Section 4 below in our theoretical derivation of a trade-off relationship. It should also be emphasized that this wage adjustment relationship is one of the two focal equations of this entire study.

3. The Relationship between Prices and Costs

In this section, we wish to derive a theoretical relationship between the rate of change of money wages and that of prices, enabling us (in the following section) to obtain a trade-off function connecting the rate of inflation with the percentage of the labour force unemployed, in addition to other factors. The link between wage changes and price changes which we develop is through the cost aspects of price determination. This is not to deny that payments to the factors of production also constitute the incomes of the owners of these factors, which, in the aggregate, will have an influence on the price level of final output from the side of demand as well. But our principal focus in this section is on the cost side; some justification of this emphasis will emerge from the following discussion. Our theorizing will initially deal with the closed economy case; the later paragraphs will extend the argument to an open economy.

i. Labour costs and productivity

In traditional economic theory, the firm is regarded as attempting to earn maximum profits. In a simple static model of firm behaviour, this means that the firm will equate marginal cost to marginal revenue; in turn, marginal revenue can be linked to the price of the product through the elasticity of the demand curve. (The perfectly competitive firm is a special case, in this view, being one which faces an infinitely elastic demand curve.) Thus marginal costs, which depend upon the prices of the productive factors and upon a number of other considerations that can be summarized as the productivity of the factors, are one part of the explanation of the price charged by the noncompetitive firm or determined in the competitive product market. In particular, if marginal costs rise due to a higher price of a particular factor, the product price might be expected to rise. Thus, even in the traditional framework, the prices of the inputs play a role in the explanation of the prices of the final output produced by these inputs.

The argument can be formalized for an idealized case. Let us assume a firm that uses only one variable factor of production, labour, and let the quantity of labour inputs employed be N. Let the price of the single product of the firm be P, with the quantity of output being denoted by Q. Finally, let w denote the wage of a unit of labour, MC the marginal cost of a unit of output, and η the numerical value of the price elasticity of demand. If the firm is maximizing its profits, the condition:

$$MC = MR \tag{2.3}$$

must hold.[1] But since MC is equal, in this simple case, to the money wage divided by the marginal physical product (MPP) of labour, equation (2.3) can be rewritten in the following form:

$$\frac{w}{MPP} = P\,(1 - 1/\eta). \tag{2.3a}$$

With a log-linear (or Cobb-Douglas) production function, the marginal physical product of labour is always a constant proportion (denoted here by k_1) of the average product (Q/N). Under this further assumption, equation (2.3a) becomes:

$$\frac{w}{k_1 Q/N} = P\,(1 - 1/\eta). \tag{2.3b}$$

Finally, we may write:

$$P = k\,\frac{w}{Q/N}, \qquad \text{where } k = \frac{\eta}{\eta - 1} \cdot \frac{1}{k_1}\,. \tag{2.4}$$

Under the additional simplifying assumption that the price elasticity of demand is constant, the price of the final output is directly proportional to the money wage and inversely proportional to the productivity of labour. If we expand our focus to a closed economy regarded as a whole, we would have a direct relationship between the price level of final output and the level of labour costs. (In a closed economy, labour might be expected to be the principal variable factor.) The traditional theory, then, provides us with one possible explanation of the link between money wages and the price level of final output.

Many writers have criticized the above approach, claiming that firms do not in fact calculate the profit-maximizing levels of price and output in this manner. Instead, firms are said to use a system of mark-up pricing, in which prices are set at a certain margin above the level of average costs.[2] Thus, in the situation in which labour is the only variable factor, if wage costs rise, the price may be expected to increase proportionately. Demand is held to play only a secondary role, exerting an influence on what firms think is a reasonable or "realistic" mark-up, but not entering explicitly into the pricing decision. This approach is a somewhat less complicated one and implies a direct relationship between costs and prices.

---

[1]Provided the second order conditions hold and provided it pays to produce any output at all.

[2]Detailed references to the literature may be found in Bowen, *The Wage Price Issue*. Eckstein, *op. cit.*, argues that mark-up pricing may be viewed as an attempt to price so as to achieve a target rate of return, a practice said to be favoured by a number of large firms.

In *The Wage-Price Issue,* Bowen surveys both the mark-up and the "traditional" theories, examining the former in considerable detail. Basically, he establishes the relationship between labour costs and total costs and then makes the link between wage costs and prices. He concludes that, in an uncertain world in which the firm is in business for a long time and must take explicit account of the reaction of its rivals, prices are much more sensitive to cost changes than to demand changes, which corroborates the mark-up view. As wages are the major element in total costs, there is a derivable close relationship between the price level of final output and money wages.

It is interesting to observe that the average cost (mark-up) and the marginal cost theories need not be inconsistent with each other, at least as applied to the global aggregates of a closed economy. Thus we shall see that it is possible to derive the same price level equation, beginning with either view. For example, Sidney Weintraub adopted the mark-up view for the economy as a whole, postulating a constant ratio between total sales proceeds in money terms (S) and total labour compensation (W).[1] Let k denote the mark-up factor, and decompose total money sales proceeds into real output (Q) and the price level (P); total labour compensation is similarly factored into the product of the money wage (w) and total manhours (N). Hence, Weintraub's "mark-up" equation may be written:

$$(2.5) \qquad k = \frac{S}{W} = \frac{PQ}{wN},$$

from which it easily follows that:

$$(2.4) \qquad P = k\,\frac{w}{Q/N}.$$

Since this is the same equation as derived above under the traditional theory, the claim that the two theories yield equivalent results (under these circumstances) is substantiated.

Over a period of some years, one might expect that production will become more capital-intensive (capital per head of the labour force will rise) and also that organizational changes and technical advances will occur. These improvements will raise the average output per unit of labour input, and so wages can rise without necessitating increases in prices in order to keep the distribution of income unchanged between labour and property shares. Equation (2.4) implies a relationship between the percentage rates of change in the variables of this equation, which it is useful to make explicit.

If the mark-up factor is approximately constant, differentiation and further manipulation of equation (2.4) yields:

$$(2.6) \qquad \dot{P} = \dot{w} - \dot{A},$$

where the "dot" symbol over a variable represents the percentage rate of change of that variable and the A variable represents the average productivity of labour,

[1]Sidney Weintraub, *A General Theory of the Price Level, Output, Income Distribution, and Economic Growth* (Philadelphia: Chilton Company, 1959), p. 59.

namely the Q/N ratio.[1] In words, equation (2.6) states that the percentage change in the price level is equal to the difference between the percentage change in the money wage and the percentage change in labour productivity. There is some evidence that the theory can be corroborated in this form. For example, J.M. Clark noted that, for individual U.S. industries over the period 1955–59, there was a close relationship between the percentage increases in prices and the percentage increase in wages *less* percentage productivity gains.[2]

Relationship (2.6) also has important implications for the long-term development of the price level in a closed economy. If we assume a continuous growth in productivity over time, then we can envisage a range of possibilities: (1) if money wages do not change, the price level can go down; (2) if the growth of wages matches that of productivity, prices will remain constant; (3) if wages rise more rapidly than productivity, the price level will rise. (A constant distribution of the total product between wage and nonwage incomes is still assumed, of course, as this assumption underlies equation (2.6).)

At the same time, equation (2.6) suggests an explanation of the findings of some investigators of the relative unimportance of productivity changes in explaining price level changes. If productivity grows at a constant or a nearly constant (percentage) rate, then equation (2.6) indicates that the percentage change in the price level is merely equal to the percentage change in the wage level less a (nearly) constant damping factor. In other words, the influence of the productivity change variable would be difficult or impossible to detect by standard statistical methods, as this variable does not go through a wide enough range of variation.[3]

ii. Import costs

The preceding discussion has implicitly assumed a closed economy, that is, one that is self-contained and which does not engage in international trade. It is high time to extend this analysis to an open economy in order to take account of the important role that international relationships play in the Canadian economy. In an open economy, some of the materials and intermediate products fabricated by domestic producers will be imported, and so the prices of these imports will enter

---

[1]This equation is most easily derived by taking natural logarithms of both sides of equation (2.4) and then differentiating.

[2]J.M. Clark, *The Wage-Price Problem* (city not indicated: Committee for Economic Growth without Inflation, the American Bankers Association, 1960), Chapter III, especially pp. 40 and 41.

[3]It is possible to explain the nonsignificance of the productivity or productivity change variable on price levels or changes in price levels in alternative ways. Thus, in a mark-up view, one might argue that prices are marked up solely over wage rates rather than wage costs, thus allowing no scope for the mitigating effects of productivity gains. A related argument would be the view that short-term (e.g., quarter-to-quarter) variations in labour productivity are unimportant in affecting firms' pricing decisions and that the productivity variable which is relevant in the pricing decisions is the expected or "normal" level of productivity, at the time at which prices are set. Some recent econometric work tends to corroborate this view; see, e.g., R.R. Neild, *Pricing and Employment in the Trade Cycle* (Cambridge: Cambridge University Press [for the National Institute of Economic and Social Research], 1963), Chapter 2.

the cost structure of domestic production. In addition, the prices of finished imports may have a direct influence on the consumer price level; moreover, both the price level of imports and that of a country's exports can have indirect effects on domestic price levels, through the economic substitution relationships. However, these latter complications are ignored or assumed to be subsumed under the effects of the price level of imported materials. Let P'_m denote the price level of materials imports, and let M represent the quantity (in real terms) of these imported materials. Then, by a simple extension of the mark-up formula to allow for the influence of imported materials costs, one can write:

$$P = k_2 \frac{w}{A} + k_3 \frac{P'm\ M}{Q}, \tag{2.7}$$

where all other symbols retain their previous meanings and k_2 and k_3 are parameters. In words, equation (2.7) states that, in an open economy, the price level of final output will vary directly, in a linear fashion, with both domestic labour costs and the costs of imported materials.

Equation (2.7) can also be employed to derive an expression for the percentage change in the price level. By mathematical manipulation, one can derive the following approximate relationship:

$$\dot{P} = \beta\dot{w} - \beta\dot{A} + (1-\beta)\,\dot{P}'_m - (1-\beta)\left(\dot{\frac{Q}{M}}\right), \tag{2.8}$$

where the "dot" symbol again represents the percentage rate of change in a variable and β denotes the proportion of the price level of final output attributable directly and indirectly to wage costs.[1] (Hence, $(1-\beta)$ represents the proportion of final product price attributable, directly and indirectly, to import costs.) Often the last term is dropped, as it is thought that imported inputs of materials per unit of output are either largely unchanged over time or else change at a fairly constant (percentage) rate over time. In addition, we shall generally work with the price level of all imports, P_m, rather than just the price level of imported materials (P'_m). In this case, there need not be a rigid link between the coefficient of this variable and that of wages. Moreover, we might argue that the coefficient of the rate of change of labour productivity need not be equal in absolute value (but opposite in sign) to the coefficient of the rate of change of money wages, for reasons outlined in footnote 3 on page 16 above. Hence the price change equation becomes:

$$\dot{P} = \beta_0 + \beta_1\dot{w} - \beta_2\dot{A} + \beta_3\dot{P}_m\ , \tag{2.9}$$

where the β's are parameters, the last three of which are positive. (The constant term, β_0, is intended to subsume the influence of omitted variables, like the rate of change of the ratio of imported materials to output or like those discussed in the final paragraph of this section.) We are left with a relationship in which the percentage change in the price level is a linear function of the percentage changes

---

[1]Symbolically, $\beta = k_2 \dfrac{w/A}{P}$ and so $1 - \beta = k_3 \dfrac{P'_m M/Q}{P}$

In the spirit of the analysis of the closed economy, β is taken to be approximately constant.

in wages, labour productivity, and the price level of all imports. The wage changes and import price changes are positively related to the changes in the domestic price level while, as in the case of a closed economy, labour productivity growth exerts a dampening effect on the rise in domestic prices.

There is some empirical evidence supporting this view of aggregate price formation in an open economy. Klein and Shinkai, in an econometric model of the Japanese economy, obtained good results when they fitted an equation similar to (2.7) to Japanese data for the combined subperiods 1930–36 and 1951–58.[1] The fit was a very tight one, and each explanatory variable exerted a significant influence in the expected direction on the dependent price level variable. Similarly, L.A. Dicks-Mireaux, employing British data for the period 1946–59, fitted a relationship of same form as equation (2.9).[2] Dicks-Mireaux also obtained results which corroborate the theory outlined in this section: the fit was good, and the percentage changes in money wages, labour productivity, and import prices each contributed significantly to the explanation of percentage changes in the domestic price level, the direction of influence being that which would be predicted by the underlying theory.

iii. Demand for final products

Our final variant of a price change equation is a further modification of equation (2.9). The argument used in the preceding section regarding prices being adjusted to excess demand (or excess supply) can, of course, be applied to the final product markets, for which the argument was originally stated. Let D be an indicator of excess demand in the product market; according to standard economic theory, the D variable should be positively related to the rate of change of final prices.[3] Alternatively, on a theoretical plane, one is free to interpret D as some other factor directly conditioning the rate of change of the price level, such as a change in public attitudes or a change in the short-term expectations of the public regarding the future course of the price level. The final price level change relationship is:

$$(2.10) \qquad \dot{P} = \beta_0 + \beta_1\dot{w} - \beta_2\dot{A} + \beta_3\dot{P}_m + \beta_4 D ,$$

where the parameter β_4 is positive, if the D variable is interpreted as the level of excess demand for the final output of the economy.

---

[1] L.R. Klein and Y. Shinkai, "An Econometric Model of Japan, 1930–59," *International Economic Review*. Volume IV, No. 1 (January 1963), pp. 1–28.

[2] L.A. Dicks-Mireaux, "The Interrelationship between Cost and Price Changes 1946–59: A Study of Inflation in Postwar Britain," *Oxford Economic Papers*, Volume XIII, No. 3 (October 1961), pp. 267–292.

[3] In general, most studies of the pricing of final output, either for industry groups or for larger output aggregates, have found that the state of demand is a secondary variable and many have found this type of variable to be insignificant, over the range of the data examined. As pointed out above, this is not unexpected, according to Bowen, when one considers the "real world" context (including uncertainty and oligopolistic interdependence) within which firms operate. This view, however, need not necessarily imply that, for the economy as a whole, demand for final output is not an important determinant of the rate of change of the price level. Strong demand may be transmitted back to the labour market (or the market for imported materials), inducing large increases in the relevant factor prices. The large increases in these factor prices may then, on a return trip, be an important explanation of the observed rise in the price level of final output.

4. The Derived Trade-Off Relationship

The trade-off relationship, on which the trade-off curve of Chapter 1 is based, may now be derived. Substituting equation (2.2) into equation (2.10), we obtain:

$$(2.11)\quad \dot{P} = \beta_0 + \beta_1 (\alpha_0 + \alpha_1 \frac{1}{U} + \alpha_2 \dot{P}_c + \alpha_3 Z) - \beta_2 \dot{A} + \beta_3 \dot{P}_m + \beta_4 D \cdot$$

Now assume that the price level of all final output changes at the same (percentage) rate as the price level of consumer goods and services; then we may set $\dot{P}_c$ equal to $\dot{P}$. In this case, equation (2.11) becomes:

$$(2.12)\quad \dot{P}(1 - \beta_1\alpha_2) = \beta_0 + \beta_1\alpha_0 + \alpha_1\beta_1 \frac{1}{U} + \beta_1\alpha_3 Z - \beta_2 \dot{A} + \beta_3 \dot{P}_m + \beta_4 D \cdot$$

The derived trade-off relationship is thus:

$$(2.13)\quad \dot{P} = \frac{\beta_0 + \beta_1\alpha_0}{1 - \beta_1\alpha_2} + \frac{\alpha_1\beta_1}{1-\beta_1\alpha_2}\frac{1}{U} + \frac{\beta_1\alpha_3}{1-\beta_1\alpha_2} Z - \frac{\beta_2}{1-\beta_1\alpha_2} \dot{A} + \frac{\beta_3}{1-\beta_1\alpha_2} \dot{P}_m + \frac{\beta_4}{1-\beta_1\alpha_2} D \cdot$$

We may briefly comment on the signs of the parameters of equation (2.13). The coefficient of the wage change variable in the price change equation, β_1 , will be between zero and unity; in general, for an open economy one would expect this parameter to be less than its upper limit. The coefficient of the consumer price change variable in the wage adjustment relationship, α_2 , will also be between zero and unity; in virtually all the empirical wage adjustment relationships estimated, this parameter is less than unity. Consequently, the divisor $(1 - \beta_1\alpha_2)$ is strictly positive; thus, implicitly holding the other variables constant, we see that, in equation (2.13), $\dot{P}$ is positively related to the reciprocal of the unemployment variable (and hence negatively related to the unemployment rate itself), positively related to the rate of change of import prices, and negatively related to the rate of growth of productivity. Moreover, $\dot{P}$ is related to the Z variable (or variables) in the same sense as money wage changes are related to this variable (these variables) in the wage adjustment relationship; also, $\dot{P}$ is related to the D variable (or variables) in the same sense as it is related to this variable (these variables) in the price change relationship (2.10).

In a formal sense, the task of showing how the trade-off function is obtained and how the expected rate of inflation is related to the numerical values of several other macroeconomic variables is completed. However, it will be helpful to discuss this relationship in somewhat more detail. A trade-off curve, like the one illustrated in Figure 1.1 of the preceding Chapter, is obtained by specifying (in principle) values of the rate of growth of labour productivity, the rate of change of import prices, the Z variable (or variables), and possibly the D variable (or variables).[1] Thus the

---

[1]If the D variable represents excess demand in the economy's product markets, then presumably one would not wish to hold this variable constant as the level of unemployment varied. Even though excess demand in the product market is not the same thing as demand in the labour market, for the economy as a whole there is generally a close relationship between the rate of unemployment and most measures of excess demand for final goods and services, such as pressures on capacity. Thus, in principle, one might wish to consider the D variable as a simple function of the U variable in constructing a (theoretical) trade-off curve. In such a construction, the rate of unemployment serves as a proxy for the influence of demand pressures both in the labour market and directly in the markets for final output. Because the D variable is negatively related to the rate of unemployment, the two types of pressure will serve to reinforce each other, as one would expect. Of course, if the direct influence of demand on the rate of change of prices in the final output markets is negligible or insignificant, the construction of trade-off curve will not necessitate the consideration of these fine points.

trade-off curve is based on assumed values for all of the other variables in the trade-off relationship (2.13); by making these specifications, one can display the two-dimensional curve relating the rate of unemployment and the expected rate of change of the price level as the familiar inverse relationship. But the trade-off curve, like the trade-off equation (2.13), is premised on a given institutional background so that one may consider the parameters of this relationship as reasonably stable constants. Among the institutional factors that might be expected to affect the parameters of this relationship are those connected with the functioning of the economy's labour markets, the attitudes and short-term expectations of the public, and the strategy and effectiveness with which economic policy is pursued.

As noted above, the coefficient of the $\dot{P}_m$ variable is positive. This means that, other things remaining unchanged, a rise in the rate of foreign inflation will induce a larger value for the rate of change of the domestic price level, while a decrease in the rate of change of import prices will exert, by itself, a mitigating effect on the rate of change of the domestic price level. In common-sense terms, such an influence is easily explicable. It is generally acknowledged that the Canadian economy is highly vulnerable to international price changes – especially those originating in the United States – and that a large proportion of any change in Canada's export and import prices will be reflected in domestic Canadian price movements. This influence may arise either because of price changes in foreign countries or because of movements of the exchange rate (or possibly because of both developments); in turn, these changes will be translated into internal Canadian price levels directly through export and import prices and indirectly through the response of domestic product and factor prices to changes in export and import prices.[1]

In terms of the price-change-unemployment curve, a change in the value of the $\dot{P}_m$ variable will be one factor capable of shifting the two-dimensional trade-off curve. In particular, the trade-off curve will shift upward if the rate of change of import prices rises and downward if the rate of change of import prices decreases. These points are illustrated by the trade-off curves of Figure 2.1, which are also based on Reuber's earlier study.[2] In this diagram, the curve AA' is reproduced from Figure 1.1 of the preceding Chapter; the assumption underlying this curve is that there is no change in the level of import prices (a zero rate of change of this variable). The curve BB' is drawn on the assumption that foreign prices increase at 1 per cent per year. It lies above AA' because, at every value of the unemployment rate, prices in Canada will increase by a greater amount if foreign prices are rising than if they are constant. In other words, a faster pace of foreign inflation intensifies the conflict between the objectives of high employment and price level stability for the domestic economy, rendering the old trade-off curve no longer relevant.

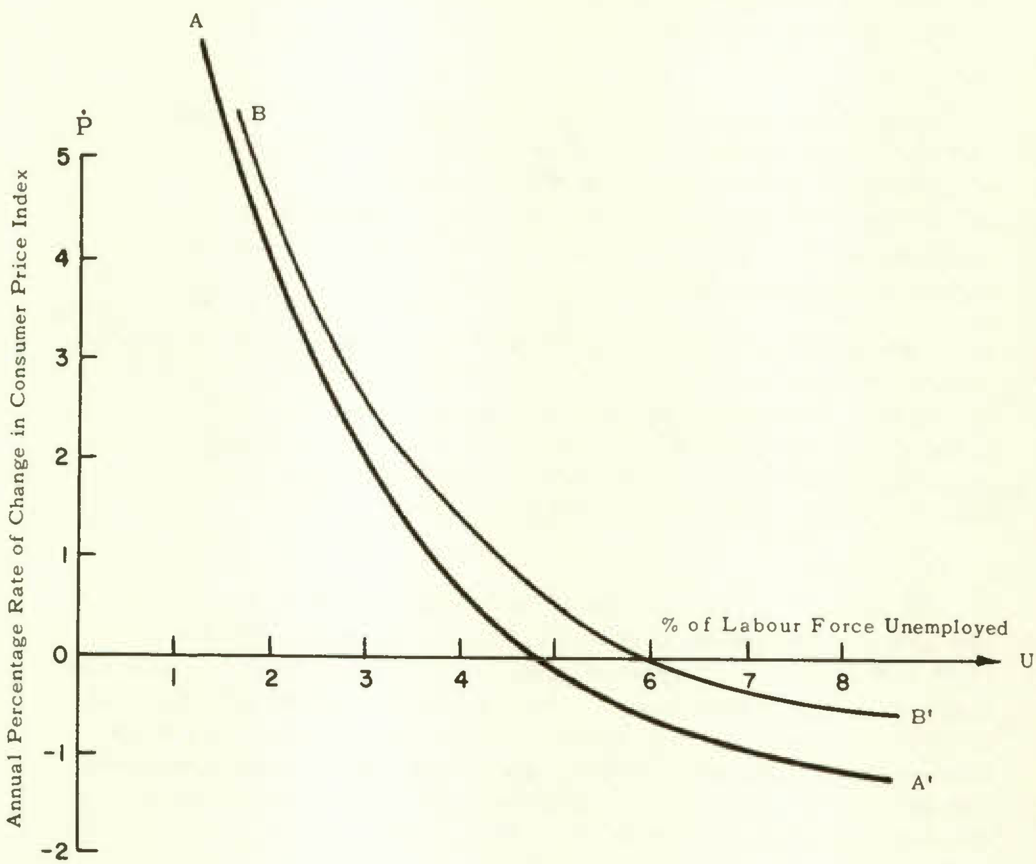
---

[1] As noted in the preceding section, some of these effects have not been incorporated into the formal model. Moreover, it is sometimes asserted that direct price and wage links play an important role in the Canadian case. We examine some of these issues in more detail, in the empirical analyses of Part II.

[2] G.L. Reuber, "The Objectives of Canadian Monetary Policy," *op. cit.*

Figure 2.1

THE INFLUENCE OF A VARIATION IN THE RATE OF CHANGE OF IMPORT PRICES ON THE TRADE-OFF CURVE



The rate of change of productivity (the $\dot{A}$ variable) is also a determinant of the rate of change of the domestic price level. The negative sign of this variable in equation (2.13) implies that, other things remaining unchanged, a faster growth of labour productivity entails a lower rate of change of the internal price level. In terms of the two-dimensional trade-off curve, an increase in the productivity growth rate would shift the curve down and towards the left (towards the axes), thus mitigating conflict between the objectives of high employment and stable prices. In common-sense terms, this result is quite understandable: rises in productivity, in addition to representing a fundamental source of higher living standards, also mitigate the cost-increasing effects of rises in the prices of the productive factors.

With continuing growth in productivity, an employer can absorb some increases in the money rewards paid to the factors of production, particularly labour, without experiencing a rise in unit costs. Thus productivity growth might be expected to have a stabilizing effect on the price level. If a constant rate of productivity growth prevails over some time period, a connection between productivity growth and the rate of change of the price level will presumably be built into any trade-off equation that the investigator estimates. If, however, the rate of productivity change shifts over time, either continuously or by discrete changes, the price-change-unemployment trade-off curve will also experience either a continuous movement or a discrete shift over time, respectively.[1]

Similarly, variations in the Z variable (or variables) may be a factor in shifting the trade-off curve, also. The Z variable might represent the power (or the attitudes) of the trade unions. In general, the trade-offs will be less favourable and the conflict between objectives intensified, the more pushful are the trade unions in their wage bargaining. This effect, which works through the cost aspects of wage increases, should be fairly obvious at this point and so it will not be belaboured further. But a somewhat different conclusion would be reached if one interpreted the Z variable as the level of corporate profits. The algebraic formulation indicates that the effect of a rise in corporate profits will be to increase, other things remaining unchanged, the rate of domestic inflation or, in other words, to shift the trade-off curve upwards. In turn, this suggests that it may be worth-while, aside from considerations of social justice, to direct stabilization policies at corporate profits as well as at money wages.

The trade-off equation (and hence the two-dimensional trade-off curve) will also shift if the parameters of equations (2.2) and (2.10), from which equation (2.13) is derived, shift. In principle, there are a very large number of background conditions and factors which might conceivably shift the trade-off function. In this section, we shall merely focus upon five: variations in the efficiency of the labour market, the degree of competitiveness in the product markets, the basic attitudes and (in addition) the short-run expectations of the public, and policies specifically designed for shifting the trade-off curve.

---

[1]In this discussion, we have been vague as to what time horizon is relevant for the productivity change variable. As noted in the preceding section, there is some evidence that the relevant productivity growth rate is not that from quarter to quarter or even year to year, but a long-run or "normal" growth rate. If this is true, this influence will be very difficult to measure statistically and may only show up in the constant term of the relationship.

An additional complication is the fact that the Z variable may be interpreted as the rate of growth of labour productivity, which conceivably influences the rate of change of money wages and so, from this partial effect, has a positive relationship to the derived rate of change of the price level. While this paradox shows up in one of the empirical studies reviewed in the following Chapter, the issue is (in principle) easily resolved. The direct price effects of productivity growth may generally be expected to be far stronger than the proximate wage effects; in other words, $\beta_2 > \alpha_3$. This suggests (since $\beta_1 \leq 1$) that the former will generally predominate; even in this special case, productivity growth will be negatively related, *ceteris paribus*, to the rate of change in the internal price level.

In its *First Annual Review,* the Economic Council of Canada advocated manpower policies designed to improve the efficiency of the functioning of the economy's labour markets.[1] This type of policy might have, as a favourable side-effect, a reduction in the conflict between the goals of high employment and price stability or, in other words, it might shift the trade-off curve towards the axes. Greater labour mobility means that the labour supply is more responsive to wage differentials among occupations and among geographical regions. Consequently, smaller changes in wages would then be required to bring the labour supply into equilibrium, and thus unemployed individuals might be expected to move more readily out of areas of industrial and regional unemployment to where jobs were available. The result would be to reduce the amount of unemployment not in contact with the labour market mechanism (the amount of so-called "structural unemployment") and to lessen the upward pressure on wages both in industries and in areas of relative labour shortage. Given the wage-price link, this means that the labour market policy, if successful in this regard, enables one to achieve simultaneously greater price stability and fuller employment; in other words, the trade-off curve might well have been shifted inwards, towards the axes.

Similarly, the degree of competitiveness in the product market may conceivably influence the shape and position of the trade-off curve. On one view, the degree of competitiveness in these markets might be expected to have very little, if any, influence on the trade-off curve. Thus monopoly power may make final output prices higher than they would otherwise be, at all points in time. But if the price level of final output is permanently and continuously above the competitive level, the *rate of change* of this price level will not be affected in any obvious way—unless the degree of monopoly power itself increases, thus pushing up the mark-up of prices over average costs. The commonly accepted view is that such a "profit-push" is unlikely, especially on a continuing basis; consequently, it would be argued that the degree of monopoly power is likely to affect primarily the level, not the rate of change, of the price of final output. However, one qualification, based on an examination of the wage-price system as a whole, may be appended to this argument. If the level of corporate profits (one interpretation of the Z variable previously introduced) does affect wage increases demanded (and obtained), and if the existence of monopoly power does raise the level of corporate profits permanently above the competitive level, then equation (2.13) suggests that the "monopoly power" trade-off curve may be higher in the field (further from the axes) than the "purely competitive" trade-off curve. In common-sense terms, the existence of noncompetitive sellers in the product markets of the economy, possibly conjoined with powerful trade unions, may lead to a faster pace of wage (and hence price) changes than would exist in their absence. This theoretical argument can hardly be regarded as conclusive, since it is difficult to judge whether the two premises on which it is based (especially the second) are valid. But the possibility that monopoly power exacerbates the conflict between the objectives of high employment and price stability should probably not be dismissed out of hand. In this case, it is possible that a more vigorous pursuit of policies attempting to make the product

[1]*Ibid.*, pp. 170–184.

market more nearly competitive (anti-combines policy, in the Canadian context) and of greater liberalization of foreign trade might, in addition to their primary effects, have beneficial side-effects on the trade-off curve.

Finally, several other possible influences on the parameters of the trade-off equation (2.13) deserve mention. An incomes policy is specifically directed at the parameters of the wage adjustment relationship, like equation (2.2), or the direct price change equation (2.10). If successful, an incomes policy will thus affect the parameters of the trade-off function so that conflict between high employment and price stability is mitigated. This is done through convincing (or, to some degree, coercing) the wage- and price-setters to act less in their own interests, narrowly conceived, and more in the policy-maker's view of the national interest.[1] Similarly, the basic attitudes and short-term expectations of the public can influence the parameters of the wage and price change equations and hence the parameters of the trade-off equation. The attitudinal factors which are of primary importance would presumably be those of the participants in the wage-price process, but it seems quite possible that public – and governmental – attitudes could have indirect repercussions, at least on occasion. Similarly, the effects of changes in short-term expectations on price movements have been thoroughly discussed in the literature, and hence one brief comment here should suffice. Formally, the effect of anticipated price increases in bringing about a faster pace of inflation than would occur otherwise can be indicated by interpreting the D variable of equation (2.10) as the anticipated rate of change of the price level, in which case the coefficient β_4 is positive. Accordingly, this variable would have a positive coefficient in equation (2.13), confirming the view that anticipated increases in the price level could be a factor in heightening the conflict between the objectives of high employment and price stability. Statistically, one might attempt to take this factor into consideration by some type of lag formulation.

The foregoing discussion raises the issue as to how stable any statistically estimated trade-off curve is likely to be. The discussion suggests that the multivariate function is likely to be more stable than the two-dimensional curve, but the additional question as to whether the parameters of the multivariate functional are reasonably stable, over some medium-term time period, is still relevant. No attempt to answer these questions will be given here. In the empirical chapters, we examine, at several points, the statistical stability of the underlying wage and price change relationships. In this manner we attempt to provide some indication of the stability to be expected in the derived trade-off relationship.

5. A Digression on the Demand-Pull versus Cost-Push Controversy

In recent years, there has been a vigorous debate, both in academic and general discussions, between the adherents of "cost-push" and "demand-pull"

[1]Policy instruments, other than an incomes policy, might also have an influence on the position (and, possibly, the shape) of the trade-off curve. Thus, as our discussion in Chapter 1 argued, the number of policy instruments available may condition the degree of compatibility between objectives. This seems particularly relevant if some weapons from the policy arsenal (labour market policies, anti-combines policy, etc.) might possibly have some beneficial side-effects on the trade-off curve. Moreover, the policy stance adopted might well affect public attitudes, and so influence the trade-off curve through this channel.

theories of inflation. No attempt to review this discussion will be made here, nor do we wish to enter this controversy explicitly. Instead, we should like to suggest that one interpretation of the differing theories of inflation advanced in this debate is in terms of the shape and position of the theoretical trade-off curve derived in the preceding section.[1]

Demand-pull theories of inflation rest on the straightforward proposition that a high and/or rising level of demand relative to the productive capacity of the economy induces upward adjustments in cost and prices. When there is substantial excess capacity in the economy, increases in demand can, it is averred, be met out of unemployed and underemployed resources with little or no change in costs and prices. But as the level of unemployment falls and firms exhaust their idle capacity, bottlenecks begin to develop in particular industries, and certain types of skilled labour become very scarce at going wage rates. As a consequence of the associated demand increases, costs and prices begin to rise more rapidly. With still further increases in demand, price rises will begin to accelerate as the supply curves of firms become highly inelastic.

Cost-push theories of inflation, while generally not denying that strong aggregate demand can induce a continuously rising price level, suggest that even when there is considerable slack in the economy, prices are likely to rise steadily because of the market power exercised jointly by profit recipients and wage-earners. The following statement, by Professor A.P. Lerner, provides a good summary of this viewpoint:

> When we have strong trade unions with power to raise wages, strong corporations with power to set prices administratively, and a general atmosphere in which it is considered normal, natural and only fair for wages to be increased regularly and by amounts greater than the average increase in productivity or in the share of the product that labour can obtain, prices increase and the economy is subject to sellers' inflation. It is now no longer a question of whether fiscal policy or monetary policy is more effective in regulating the volume of buyer's demand or expenditure, since the inflation is caused not by excess buyer's demand but by the existence of powerful institutions and mores that enable sellers to insist on and obtain continually higher prices. The widespread and generous feeling that workers are entitled to the increases in wages that they get is made much easier by the recognition that any raise need not be taken out of profits, since it is possible as well as proper to 'pass it along' to the ultimate purchaser in higher prices.[2]

Without examining any of the numerous variants of these theories, one might argue that an essential difference among them relates to the view held, perhaps

---

[1]This interpretation has already been advanced by Martin Bronfenbrenner and F.D. Holzman in their excellent article, "Survey of Inflation Theory," *American Economic Review*, Volume LIII, No. 4 (September 1963), pp. 593–661. Much of the documentation for assertions in this Chapter regarding the literature or "commonly accepted views" may be found in this survey article.

[2] A.P. Lerner, "Inflationary Depression and the Regulation of Administered Prices," *The Relationship of Prices to Economic Stability and Growth*, Compendium of papers submitted by panelists before the Joint Economic Committee of the U.S. Congress, March 31, 1958 (Washington: U.S. Government Printing Office, 1958), p. 263.

implicitly, regarding the shape and position of the trade-off curve. These differing views have been illustrated by the hypothetical curves shown in Figure 2.2. The curve DD' suggests the picture of the trade-off curve implied by demand-pull theories about the reaction of changes in the price level to rising demand and falling unemployment; the curve CC' suggests the view embedded in cost-push theories. An important difference is that, at relatively high levels of unemployment, demand-pull theories suggest that the price level will either be comparatively stable or else will decline slightly, whereas cost-push theories suggest that, even in these circumstances, the price level will continue to rise because of the market power exercised by sellers of goods and factor services. Moreover, some cost-push theorists might argue that the trade-off curve indicates that the rate of inflation accelerates sooner, in response to a rise in demand and a consequent reduction of the unemployment rate, than would most demand-pull theorists.[1] Hence, as Figure 2.2 suggests, one might attempt to make the differences between the two schools of thought more amenable to empirical testing by casting the argument in terms of what shape and position the trade-off curve possesses over the full range of the unemployment rate.[2]

6. A Theory of the Optimum Policy Combination

So far, the discussion of Chapter 1 and of the first five sections of this Chapter has concentrated attention on the trade-off relationship between the pace of inflation and the rate of unemployment, at given values of the other relevant variables and under an assumed set of institutional and public policy conditions. Suppose now that the authorities have been provided with a satisfactory estimate of this functional relationship in the form of a curve (drawn on the assumption of the relevant values of the other explanatory variables), similar to AA' in Figures 1.1 and 2.1. Suppose furthermore that the possibilities of shifting this curve by appropriate policies have been exhausted, so that the trade-off curve must be regarded as a constraint on the traditional policies (typically monetary and fiscal policies) influencing aggregate demand for categories of expenditure. The policy-maker then faces the hard choice as to which point on the trade-off curve will

---

[1]Nevertheless, paradoxically at first glance, the commonly accepted view would appear to be that the demand-pull trade-off curve accelerates more rapidly, once demand pulls unemployment below the rate at which the price level "breaks away".

[2]The argument can be further illustrated by considering the "pure" prototypes of the inset figure of this footnote. The pure demand-pull argument can be interpreted as asserting that prices are stable until demand reaches the full employment ceiling; after that, the rate of inflation is held to be indeterminate. This extreme is represented by the PDP curve, which coincides with the unemployment axis up to the full employment point and then rises vertically, thus having the appearance of an "L". The graphical representation of the pure cost-push argument may be done very easily, also. Pushed to its logical extreme, the cost-push theory might be viewed as asserting that the rate of inflation is independent of the level of unemployment. In this case, the trade-off curve degenerates into a horizontal line, as shown by PCP.

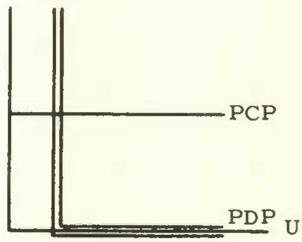
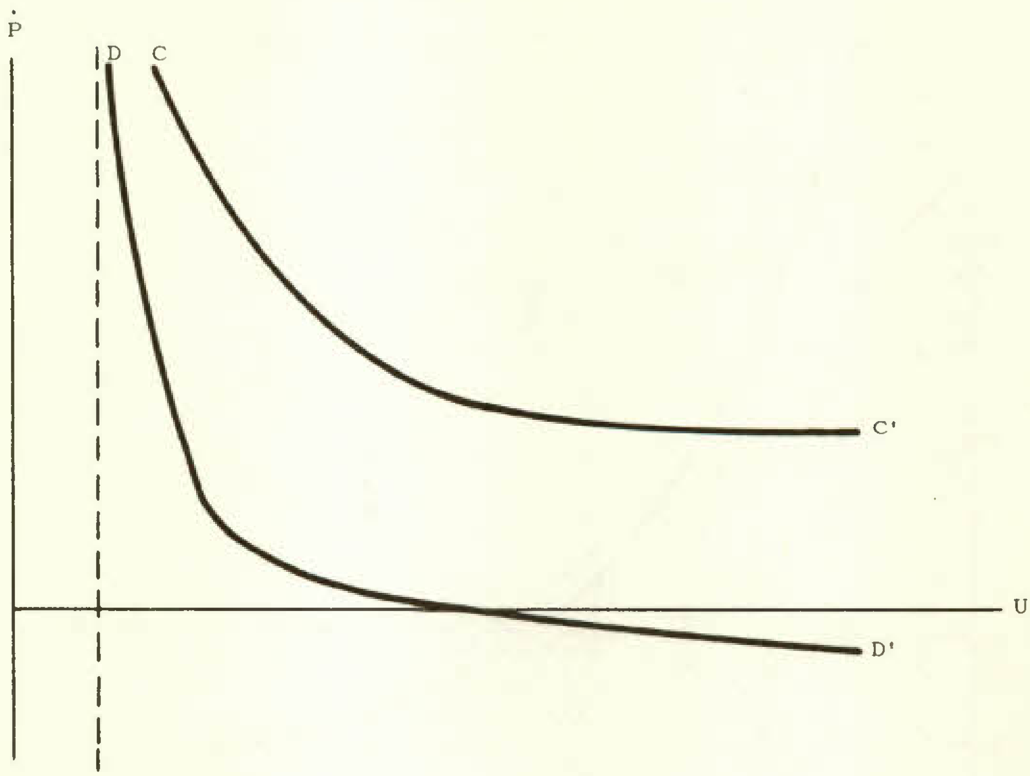


Figure 2.2

HYPOTHETICAL CURVES ILLUSTRATING ONE INTERPRETATION OF THE CONTROVERSY BETWEEN DEMAND-PULL AND COST-PUSH THEORIES OF INFLATION

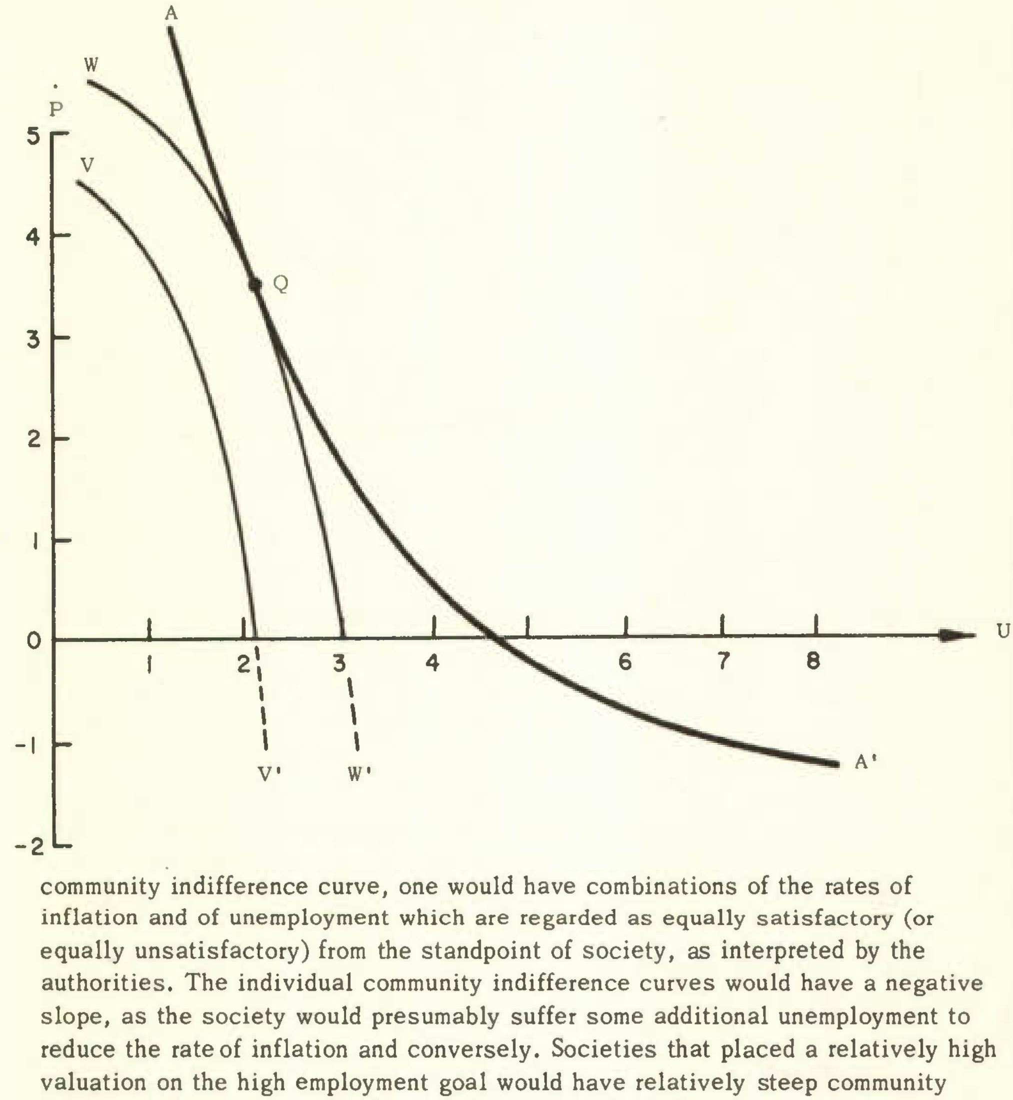


provide the optimum combination of some inflation and some unemployment. The lever of aggregate demand policy is presumed in this discussion, with some degree of simplification, to enable the policy-maker to choose the rate of unemployment which he desires; however, the associated amount of expected inflation is then, of course, determined by the relevant point on the trade-off curve. The policy problem may be paraphrased as follows: which point on the trade-off curve represents the optimal combination of the two objectives in question, given that both objectives cannot be fully achieved? In Figure 1.1, is point X preferable to point Y? If so, then the authorities should be prepared to suffer an additional one percentage point increase in the rate of change of the Consumer Price Index in order to gain a one percentage point decrease in the rate of unemployment.

The particular point on the frontier at which, under this approach, public policy should aim depends, in the ultimate analysis, on the policy-maker's estimates which, in a democratic society, may be presumed to reflect society's estimates of the relative costs of inflation and of unemployment. One way of representing these estimates is to postulate a family of community indifference curves, of which WW' in Figure 2.3 might be a typical member. Along a given

Figure 2.3

TWO COMMUNITY INDIFFERENCE CURVES AND THE GRAPHICAL DETERMINATION OF OPTIMAL RATES OF INFLATION AND UNEMPLOYMENT



community indifference curve, one would have combinations of the rates of inflation and of unemployment which are regarded as equally satisfactory (or equally unsatisfactory) from the standpoint of society, as interpreted by the authorities. The individual community indifference curves would have a negative slope, as the society would presumably suffer some additional unemployment to reduce the rate of inflation and conversely. Societies that placed a relatively high valuation on the high employment goal would have relatively steep community indifference curves (as in Figure 2.3); societies that placed a relatively high valuation on the price stability goal would have relatively flat community indifference curves. If the entire family of community indifference curves were sketched in, a curve lower in the field (such as VV' in Figure 2.3) would represent a higher (but, in this case, unattainable[1]) level of social welfare because the curve VV' represents combinations of the objectives which are equally satisfactory among

[1]VV' is unattainable because it lies continuously below the constraining curve of feasible combinations of attainable rates of unemployment and inflation, the trade-off curve AA'.

themselves and, in some ranges, closer to the full achievement of both objectives than the points of the curve WW'. The curvature of these community indifference curves, which is concave from the origin, reflects an additional assumption regarding a diminishing marginal rate of substitution of price level stability for unemployment as greater price stability is achieved at the expense of greater unemployment. In other words, as unemployment falls and prices rise more rapidly, the policy-maker is no longer willing to suffer as much additional inflation in order to achieve the same incremental reduction in the rate of unemployment.

According to Figure 2.3, the optimum point on the trade-off curve is Q, which implies a policy combination of a 2.1 per cent rate of unemployment and a 3.7 per cent annual rate of increase of the consumer price level. At this point, according to the community indifference curve WW' (which is the best attainable member of the family of community indifference curves, given the constraint that the society cannot go below its trade-off curve), the social costs of inflation exactly balance those of unemployment. A departure from Q along the trade-off curve in either direction would lead to less than a social optimum, as the costs of forgoing more of one objective would outweigh the gains of moving closer to full achievement of the other objective. In this sense, the point Q represents (under this approach) the optimum combination of some unemployment and some inflation; in other words, it is the best attainable combination of some short-fall in terms of the two objectives of complete price stability and maximum employment.

Whether in point of fact Q is indeed the point at which the relative economic costs of inflation and unemployment are equal is a very difficult question to answer, even given full knowledge of the objective trade-off curve. An earlier study by one of the authors suggests that Q approximates an optimum combination, provided that one assumes a free rate of foreign exchange and focuses only on the effects on real output and ignores the thorny issue of distributional effects.[1] However, it is quite possible to argue about the precise position and slope of the community indifference curves and hence (even given the trade-off curve AA') for a different optimum point. Thus, even if the analysis is on an aggregative basis and even if political considerations are ignored, it is still difficult to estimate the costs of inflation and unemployment with any quantitative accuracy. Secondly, both inflation and unemployment involve a redistribution of income which is even more difficult to assess in terms of costs and benefits. A further, substantial difficulty is introduced when it is recognized that society may have strong preferences for one objective over another, which cannot be assumed to reflect only the "economic" costs of one objective versus those of another.

Difficult as it is to make such estimates, it can be argued that when policy-makers adopt a particular policy combination, they are in principle labeling it as an optimum combination, regardless of whether or not they think in these terms.

---

[1]G.L. Reuber, *op. cit.*, pp. 128–131. The analysis concentrates on the reduction in real output entailed by an increase in the underutilization of the labour force, as measured by the unemployment rate, and on the "efficiency loss" associated with a correctly anticipated inflation (at various rates), in terms of real output.

Accordingly, if policy is to be formulated within the framework of a rational, democratic discussion, it is helpful if the policy-makers indicate on what grounds, however imperfect, they believe the particular combination selected to be better, under the trade-off approach, to all other feasible combinations.

The terms of reference of this study included only the estimation of the trade-off equation and did not include an evaluation of the relative costs of unemployment and inflation, leading to some estimate of the optimum policy combination. Accordingly, it is important to recognize that this study bears on only half of the policy issue in question – that is, obtaining estimates of the locus of consistent and attainable policy combinations which constitute the trade-off curve, under a given set of circumstances. Resolving the second and more difficult half of the policy problem – deciding which of the series of feasible combinations on the trade-off curve is the best – is not among our objectives.

CHAPTER 3

EMPIRICAL STUDIES OF WAGE-PRICE RELATIONSHIPS FOR DEVELOPED COUNTRIES: A SELECTIVE SURVEY

In this Chapter, we wish to present a quick review of a number of earlier empirical studies concerned with wage adjustment and/or price change relationships. In general, our discussion will also examine the (often implicit) implications of the previous authors' results for the trade-off relationship, equation (2.13), of the preceding Chapter. While no claim regarding complete coverage of previous research in this area is put forward, we have attempted to survey a number of the major contributions. Most of the discussion focuses on the wage adjustment relationship of Section 2 of the previous Chapter, as a number of these previous studies have not explicitly examined the direct price change relationship. A brief statement of *caveats* regarding comparability of estimating procedures and the underlying data precedes the examination of the individual studies themselves. The concluding section of this Chapter attempts to draw together several points on the estimated wage adjustment relationships from a number of these studies, in order to make some international comparisons.

1. Comparability of Estimating Procedures and Underlying Data

In order to compare in a meaningful way the relationships between unemployment and wage (or price level) changes of various studies, especially for different countries, it is desirable to be aware of the extent to which differences in the estimated relationships arise for technical or statistical reasons. Such differences, which are really spurious as far as the "true" relationships in question are concerned, arise mainly for two reasons. The first reason relates to differences in the definitions and methods followed in compiling the basic data from which the estimated relationships have been computed. The second reason is that there may be differences in the procedures employed in estimating the relationships from the basic data. Some comments on both of these sources of differences and the biases that they introduce may be presented, before proceeding to survey the substantive results of the previous studies.

Turning first to the second class of problems, we may observe that the problems arising from differences in estimation procedures may be grouped into several subheadings. Thus one source of noncomparability might arise from the inclusion of different explanatory variables in the estimating relationships. For example, some researchers have attempted to estimate the relationship between wage changes and unemployment as a simple two-dimensional curve. Suppose, however, that the argument of Section 2 of Chapter 2 is correct and that the rate of change of money wages depends upon other explanatory variables as well. Then, provided that there were some intercorrelation between at least some of these omitted variables and the level of unemployment, there would be a bias introduced into the estimated effect of the level of unemployment on wage changes. This would be the case because part of the influence of the other relevant variables would be attributed (wrongly) to the level of unemployment as these other relevant variables would not have been taken into account explicitly, and so the unemployment variable might, in part, pick up these other influences.

A second source of difficulty of interpretation may arise because different statistical techniques are employed to compute the parameters of the estimated relationships. Thus, one investigator may estimate these numerical characteristics by studying the scatter diagrams of the relevant variables and then utilizing his intuition and judgment. On the other hand, a second investigator may employ the method of classical least squares regression, while still a third researcher may use a more involved estimating technique which takes into account the widespread repercussions and "feedbacks" among the variables of a modern, interdependent economy.

A third source of differences in the estimation procedures relates to differences in the form of the equations and differences in the form in which the variables are included in the relationships. Illustrations of this general point abound in the studies surveyed. In much of the empirical work, a simple linear form of the relationship in which the influence of the (possibly transformed) explanatory variables is assumed to be additive has been estimated. Some work, however, has been done with logarithmic relationships, in which it is implicitly assumed that the explanatory variables are related to the dependent variable in a multiplicative fashion. A related problem is the question of the form in which the variables are included in the estimating equations. For wages and prices, this form is generally one of a change over time, rather than the direct use of the absolute level. Hence there is an option whether to use absolute or percentage changes, and examples of both may be found in the literature. If the study has been based on quarterly data, some investigators take the changes (absolute or percentage) between adjacent quarters, while others employ a change over four quarters so that corresponding quarters of adjacent years are compared.[1] Then the unemployment variable has been subjected to a variety of treatments: some authors use the absolute level of unemployment, while others utilize unemployment as a proportion of the labour force; some employ this variable in a straight linear formulation, while others employ a transformation (e.g., by taking the reciprocal), thus giving rise to a nonlinear relationship. This latter difference is the reason that some of the relationships illustrated on the charts below are straight lines and that others are curves.[2]

---

[1] At the very least, one should make a rough conversion between a quarterly rate of change and an annual rate of change in comparing two studies differing in this regard; this has been done in the discussion of the text below. With quarterly data, some treatment of the problems introduced by seasonality is called for; some investigators have used some form of seasonal adjustment procedure, while others have attempted to take this factor into account by using dummy variables.

[2] In other words, whether the graphical relationship is a straight line or a curve has been built into the estimation procedure by assumption and (in general) does not reflect independent evidence from the underlying data from which the relationship has been derived.

Without pursuing these differences further, it is apparent from the charts below and the statistical equations themselves, which are presented in the Appendix, that the estimates reviewed are based on somewhat different estimating procedures. This does not mean that they are totally incompatible or that one is correct and all others are wrong. Thus, differences in the estimation procedures, while having some influence on the estimated relationships compared, seem unlikely to alter the broad picture which emerges from these comparisons. A more serious problem of comparability arises with regard to the underlying data; to this class of problems we now turn.

Differences in the definition of wages may give rise to difficulties when one compares estimated wage adjustment relationships among studies, particularly those for different countries. Sometimes the wage variable is an average for the entire economy; in other studies (like the present one) the investigator will employ an average for the manufacturing sector, either because this sector is regarded as being of special interest or because it is thought to be representative of the economy as a whole. In point of fact, the latter assumption is at best "a first approximation"; the manufacturing sector has distinct characteristics of its own and this individuality will, of course, extend to the level and pattern of movement of money wages in the sector. Studies for Britain and Western Europe usually make use of published wage rates, while studies based on U.S. and Canadian data generally define wages as actual average hourly earnings. Average hourly earnings tend to be higher than the published rates because of higher rates of pay for overtime, because of bonus payments and a possible reporting lag between published rates and actual market conditions, because of piece-rate employment, and possibly for other reasons.[1] It is true that some workers may actually receive *less* than the published rates, but this is unusual.

In the present context, however, the relevant issue is not differences in the levels of wage earnings and wage rates, but in their rates of change. It seems plausible to assume that earnings will advance more rapidly than wage rates when the level of economic activity is high, as then there will be more overtime and more divergences from previously "agreed upon" rates; also, at such times, the information lag may increase the gap between actual and published rates of pay. Accordingly, the schedule of variations in the rate of change of money wages associated with variations in the near-full-employment range of the unemployment rate will very likely be understated for Europe, relative to North America. Moreover, we shall see that this bias arising from wage statistics generally reinforces the bias emanating from differences in the unemployment data; both of these sources of incomparability make the conflict between the objectives of full employment and price level stability appear greater for North America than for France or Britain.

---

[1] Piece-rate workers may achieve higher actual earnings because, under a piece-work system, employees are likely to reap automatically some of the gains of minor productivity improvements. The earnings approach will translate these changes into wage increases, while the wage rate approach would show no change.

As for the price indexes, these appear at first glance to be reasonably comparable internationally. Nevertheless, this comparability should not be overemphasized. Price indexes are constructed differently for various countries, reflecting the kind of index desired, the structure of the economy, the methods of collecting the individual price statistics, and related matters. To the extent that indexes for some countries assign higher weights to output whose prices tend to rise relatively rapidly (services, in the post-World-War-II world) than do indexes for other countries, the derived trade-off curve might be expected to predict higher rates of inflation, at given levels of unemployment. In addition, there is some evidence that in France the behaviour of the Consumer Price Index is deliberately affected by the payment of consumer subsidies on items included in the Index. Nevertheless, it is probably true that the price indexes, especially those constructed as a market-basket cost-of-living index, are more nearly comparable across countries than either wage or unemployment statistics.

The most serious problems of comparability, however, are posed by unemployment statistics. In fact, the definition of the concept of unemployment itself is far from clear-cut.[1] Given the range of choices open, it is hardly surprising that one nation's measure often differs from that of another. What is meant by partial unemployment? How should "temporarily laid-off workers" be classified in the labour force statistics? Does a person have to have been "fully" employed before he can be "unemployed," or does a person looking for his first job count? Does the "labour force" include all those over a certain age either working or defined as unemployed (as in the United States), or does it cover only wage- and salary-earners, excluding the self-employed (as in the Netherlands and Britain)? These are some of the questions which must be answered before statistics on the unemployed and the number of persons in the labour force can be gathered; the extent to which the answers are different in different countries affects the comparability of unemployment data for these countries.

The foregoing questions refer to the concept of unemployment and hence pose definitional problems. Another, and probably more important, source of differences among countries is the method of collecting unemployment data. There are two general approaches: 1) the sample survey method, which involves an examination of "representative" samples of the population and extrapolating the results, usually by a proportionate "blow-up", into an estimate for the economy as a whole, and 2) the registration method, which relies on actual registration by the unemployed at employment exchanges, unemployment insurance offices, and so forth. The second method usually results in lower measured unemployment than the first, since it covers only those who register with organized labour exchanges, or who are covered by insurance. Sample surveys are more comprehensive, since they do not depend

---

[1] Thorough discussions of this issue are presented in National Bureau of Economic Research, *The Measurement and Behavior of Unemployment* (Princeton: Princeton University Press, 1957) and the Joint Economic Committee of the U.S. Congress, *Measuring Employment and Unemployment* (Washington: U.S. Government Printing Office, 1963).

on the willingness of individuals to apply for insurance or enroll at a labour exchange.[1]

The survey approach is employed in Canada, the United States, and Japan. The conventional view is that the survey methods used in Canada and the United States are very similar. We shall argue, however, that the survey method used in Japan is such as to understate considerably the level of unemployment relative to North American rates.

Most Western European countries use the registration method to compile their unemployment statistics. This method usually results, as we have suggested, in a downward bias in their unemployment rates relative to those of the United States and Canada. Nevertheless, in a country in which there exist extensive insurance coverage, considerable incentives to register, and a liberal definition of unemployment as well, the unemployment rates can actually be higher when based on the registration method than when based on a survey. This was true in Canada where unemployment figures from the National Employment Service (collected up to 1960) were consistently higher than those obtained from the Labour Force Survey. A comparison of the two systems reveals that the NES figures included many people who were *not* considered unemployed under the Survey.[2] A principal difficulty with a registration system, however, is the varying coverage of the labour force; this feature, which will even affect comparisons among countries using a registration system, may result from structural or organizational differences, or may arise because of differing incentives to register.

R.J. Myers, testifying before a U.S. Congressional Committee, presented estimates of unemployment rates for eight western countries, both before and after adjustment to U.S. definitions and methods.[3] Estimates are given for the three years: 1960, 1961, and 1962. By taking an average of the ratios of adjusted to unadjusted rates, one can derive the implicit "correction factors" reported in Table 3.1.

---

[1] For a more comprehensive survey of these and other differences in unemployment measures used by various countries, see "International Comparability of Unemployment Statistics," Federal Reserve Bank of New York, *Monthly Review*, March 1961, pp. 47-51. Having discussed the shortcomings of the registration method of collecting unemployment data, the article suggests: "In general these limitations mean that coverage is less complete in registration data than in sample surveys, thus giving them a downward bias relative to survey data." (p. 49).

[2] Thus, it appeared that the NES figures included workers out of work for only a day (while the Survey required at least a week), that NES figures included employees who had found jobs but did not bother to inform the NES, and that the NES figures included individuals who were registered as available but who were in fact not actively interested in finding a job (individuals whom the Survey would not classify as in the labour force but who were still receiving benefits from previous contributions). A fuller discussion may be found in Dominion Bureau of Statistics and Research Branch, Department of Labour, *Statistics of Unemployment in Canada* (Ottawa: Queen's Printer, 1958).

[3] R.J. Myers, "The Unemployment Problem: What We Can Learn from European Experience," pp. 82-92, in *Measuring Employment and Unemployment, op. cit.* The information referred to appears on p. 85.

Table 3.1

Comparability of Unemployment Statistics, Eight Industrial Countries

Conversion to U.S. Methods and Definitions

Country	Source of Domestic Data	Correction Factor	Percentage Change from Unadjusted Data
United States	Survey	1.00	–
Canada	Survey	1.00	–
Japan	Survey	1.11	Raised by 11%
Britain	Registration	1.51	Raised by 51%
France	Registration	1.93	Raised by 93%
Sweden	Registration	1.20	Raised by 20%
Germany (Federal Republic)	Registration	0.73	Lowered by 27%
Italy	Registration	0.51	Lowered by 49%

Source: R. J. Myers, *op. cit.*

These estimates reflect in part the differences arising from the method of collecting unemployment data, although the table indicates that this is far from the entire explanation. According to Myers, conversion to U.S. definitions made no difference for Canada[1] and relatively little for Japan.[2] On the other hand, large adjustments (in both directions) are indicated for the European countries. In France and Britain, the use of the registration method appears to have the "expected" effect, with this method of gathering the unemployment figures apparently missing individuals who would be counted as unemployed under a survey system.[3] It is interesting to note, however, that German and Italian rates are

[1] According to Sylvia Ostry, our most authoritative source of information on this issue, the Canadian unemployment rates are not strictly comparable to the U.S. figures but instead are understated (for the same objective situation), relative to those of the United States. The discrepancy arises, in her view, because the survey questionnaire employed by the U.S. Department of Labor is more detailed and probes in somewhat greater depth. Since, however, Mrs. Ostry is unwilling to specify an adjustment factor at present, we have adhered to "the conventional wisdom" and assumed that the two nations' unemployment rates are strictly comparable for present purposes.

[2] These results for Japan are at odds with the opinion of other writers. See L.R. Klein and Y. Shinkai, "An Econometric Model of Japan, 1930-59," *op. cit.*, p. 83. Klein and Shinkai suggest that the Japanese rates should be expanded four or five times to make them comparable with the rates in the United States. The difference between Myers' estimate and that of Klein and Shinkai principally appears to reflect the importance attributed by Klein and Shinkai, correctly in our view, to disguised unemployment in the agricultural sector.

[3] In both France and Britain, there is a definitional emphasis on "complete" unemployment; thus, for example, the temporarily unemployed are not counted in the unemployment figures in either country. In Britain, it may appear on the surface that there is little downward bias due to potential coverage, since most of the labour force is eligible to register. However, if one registers and is offered a job, he must accept it or lose unemployment benefits. This may well reduce the willingness to register, especially under tight market conditions, when one may find his own (preferred) job rather quickly. Also, married women, widows, and pensioners may opt out of the insurance scheme, and this has apparently reduced the effective coverage (and hence the registrations) considerably. On these points, see E. Kalachek and R. Westebbe, "Rates of Unemployment in Great Britain and the United States, 1950-1960," *Review of Economics and Statistics*, Vol. XLIII, No. 4 (November 1961), pp. 340-350. It is worth noting that the principal conclusion of this article was that the observed differences in the unemployment rates between the United States and Britain reflected principally (but not exclusively) differences in the objective environment and only secondarily statistical illusion.

lowered by the correction procedure, suggesting that the registration methods used in these countries tend to *overstate* the level of unemployment (relative to that of a survey method), as was formerly the case for Canada[1]. Noncomparability of the unemployment data will, of course, affect international comparisons of the wage adjustment relationship and of the price-change-unemployment trade-off curve. In Section 6 below, we attempt to take this factor into account by converting all unemployment rates to a North American basis. The effect of making such an adjustment can be illustrated graphically at this point, however. Figure 3.1 shows estimated wage adjustment curves for Britain and for Canada.[2] When not converted to comparable unemployment rates, the curves suggest that the rate of change of money wages associated with a given level of unemployment is much lower for Britain than for Canada. However, when the curve for Britain is adjusted to bring the rate of unemployment into line with the Canadian definitions and methods, the difference between these two curves is reduced by roughly one third.[3]

Summarizing, we may again remark that there are a number of factors which limit the comparability between empirical studies of wage and price relationships, particularly when the data are drawn from different countries. With one important source of data noncomparability, we are at least able to make some rough adjustments; in the case of most of the other sources of noncomparability, the best that can be done is to take the difficulty into account in a qualitative manner. In our view, these difficulties of interpretation do not vitiate entirely the international comparisons that we wish to make, although they do lead one to put forth these comparisons somewhat cautiously and tentatively. Moreover, the sharp numerical details of an individual study should not be regarded as precise facts, particularly when they contradict the numerical details of another study. We should rather like to emphasize the broad pattern of results emerging from a number of studies. A brief review of these studies follows.

2. Estimated Relationships for Britain[4]

At least from the time of Keynes's *General Theory*, it has been recognized that the degree of wage and price stability within an economy is influenced by

[1] In Germany and Italy, the definition of unemployment appears to be more lenient; also, there appear to be greater financial incentives to register as unemployed. Possibly, structural differences between these economies and the North American economies also play a role in the explanation of this relative overstatement of the unemployment rate.

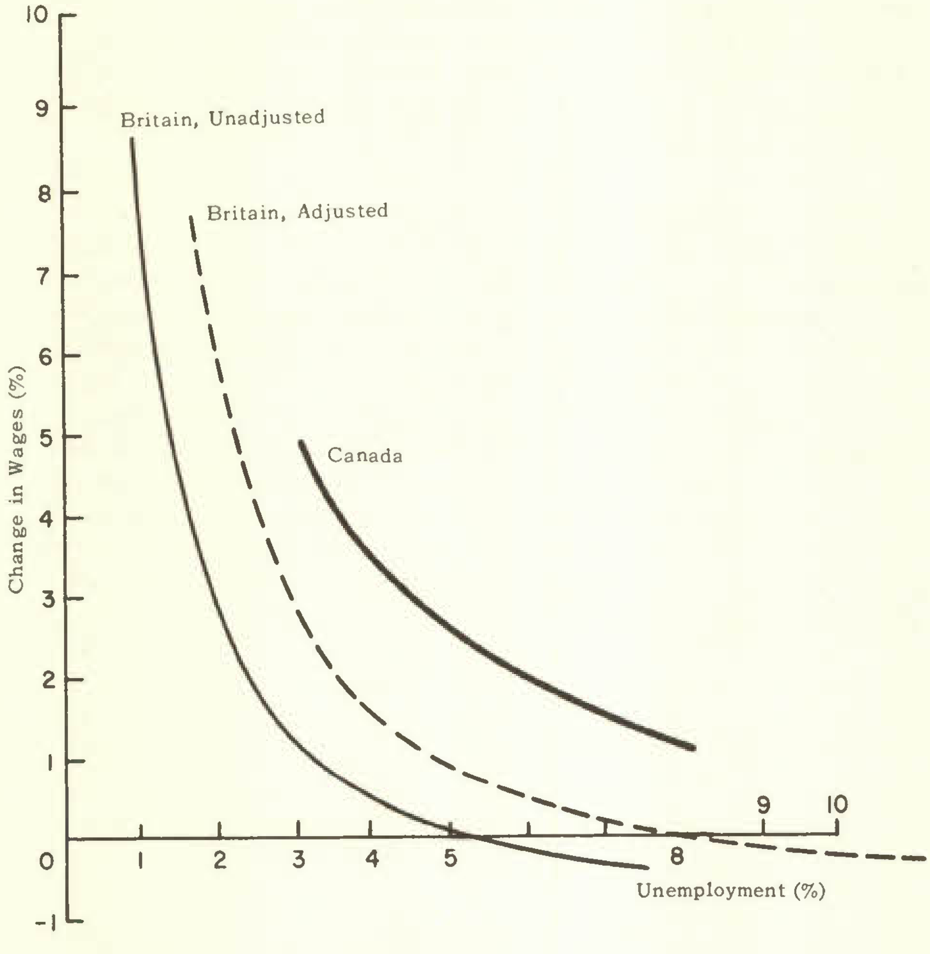
[2] The British curve is derived from the study by A.W. Phillips (the reference is given in the succeeding section, at the point of full discussion); the Canadian curve is taken from the Reuber study, "The Objectives of Canadian Monetary Policy," *op. cit.* The latter curve is drawn on the assumption of a zero rate of change of the consumer price level.

[3] Recalling the fact that the British curve is based on wage rates while the Canadian curve is based on average hourly earnings, we see another reason why the British curve might be adjusted upward, at least in the lower range of unemployment rates, to make it more comparable to the Canadian curve. This additional adjustment would, of course, reduce the apparent differences still further.

[4] The Appendix presents the mathematical equations from which the tables and charts of the surveys in this and the following three sections have been derived.

Figure 3.1

WAGE-CHANGE-UNEMPLOYMENT RELATIONSHIPS FOR CANADA AND BRITAIN, WITH ADJUSTMENT FOR A COMMON TREATMENT OF THE UNEMPLOYMENT DATA



the level of unemployment. Some early work on empirical wage adjustment relationships appeared in the first half of the decade of the 1950's.[1] However, most of the empirical work on this relationship, as well as most of the general discussion of

[1] A wage adjustment relationship may be found embedded in two econometric models published in 1955; see L. R. Klein and A. S. Goldberger, *An Econometric Model of the United States: 1929-1952* (Amsterdam: North Holland Publishing Company, 1955) and Stefan Valavanis-Vail, "An Econometric Model of Growth: U.S.A. 1869-1953," *American Economic Review, Papers and Proceedings,* Volume XLV, No. 2 (May 1955), pp. 208-221. An early study with Britain may be found in A. J. Brown's, *The Great Inflation; 1939-1951* (London: Oxford University Press, 1955). Probably the earliest published reference to a wage adjustment relationship appears in Lawrence R. Klein's *Economic Fluctuations in the United States: 1921-1941* (New York: John Wiley & Sons, Inc., 1950).

the central relevance of the wage adjustment relationship to the price stability issue, has followed in the wake of an already classic article by Professor A.W. Phillips.[1] In that article Phillips estimated the empirical relationship between the level of unemployment as a percentage of the labour force and the percentage rate of change of wage rates for Britain. In addition, Phillips pointed out the implications of the fitted relationship for the issue of a possible conflict between the objectives of full employment and price level stability. Since the publication of this article, much work has been done in refining Phillips' estimating procedures and in estimating similar relationships for countries other than Britain. These estimated wage adjustment relationships may be presented graphically, as we shall do in this exposition. Diagrammatic presentations of such wage adjustment relationships are often called "Phillips Curves".[2]

Phillips employed British data for the years 1861–1957. Table 3.2 gives his estimates of the empirical relationship between different rates of unemployment and the percentage rate of wage change. These estimates are also shown graphically in Figure 3.2 on page 45.

Table 3.2
Estimated Relationship between Wage Changes and Unemployment for Britain, 1861–1913 (Phillips)[1]

Unemployment Rate (Per Cent of the Labour Force)	Associated Annual Percentage Change in Wage Rates
1.0	8.74
2.0	2.77
3.0	1.18
4.0	0.50
5.0	0.12
6.0	–0.11
7.0	–0.26
8.0	–0.37

[1] Phillips, *op. cit.* This table and, in addition, the following tables have been calculated from the original authors' estimated equations for the indicated sample periods. In the Appendix, a mathematical restatement of the underlying relationships is presented.

Phillips' estimates, based on data for the years from 1861 to 1913, imply that a zero rate of change of money wage rates can be expected to occur in Britain at an unemployment rate of about $5\frac{1}{2}$ per cent. A 2 per cent level of unemployment implies an annual increase in wage rates of 2.8 per cent.

As a check on the usefulness of his estimates as a policy guide, Phillips re-estimated the relationship for the period 1948–57. He found that the relationship had remained fairly stable -- i.e., that the predicted wage changes had remained about the same.

[1] A. W. Phillips, "The Relationship Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957", *Economica*, N.S., November 1958, pp. 283-299.

[2] We have, however, avoided the use of this term because of the ambiguity that has arisen concerning its meaning; some writers use this term to mean what we have termed the trade-off curve (the two-dimensional representation between the rate of change of the price level and the level of unemployment from equation (2.13) of the preceding Chapter).

Phillips did not attempt to estimate directly the relationship between unemployment and the rate of change in prices. However, if one is prepared to make an assumption about annual increases in productivity and to assume that the share of wages in Gross National Product (total sales proceeds) remains constant, one can use a simple mark-up equation to derive a relationship between unemployment and the rate of change in prices. (See the discussion in Section 3 of Chapter 2 above.) On this basis, if one assumes a 2 per cent per annum increase in productivity, the annual percentage change in prices for each level of unemployment will be two percentage points less than the annual percentage change in wages associated with each level of unemployment in Table 3.2. Accordingly, an unemployment level of 2 ½ per cent, which is associated by Phillips' calculations with an annual increase in wages of approximately 2 per cent, implies complete stability of price level, i.e., a zero rate of change of the price level.[1]

In subsequent work, Professor Richard G. Lipsey attempted to reassess the Phillips wage adjustment relationship for Britain.[2] Investigating a suggestion of Phillips which was not developed, Lipsey attempted to assess the effect of *changes* in the percentage rate of unemployment on wage changes as well as the effect of the percentage *level* of unemployment. In addition, he included the percentage rate of change of consumer prices as a determinant of the rate of wage changes—a determinant which Phillips had largely ignored.

Lipsey found that, for the years 1923 to 1939 and 1948 to 1957, 91 per cent of the variation in the percentage rate of change in wage rates could be explained by these three variables—the percentage level of unemployment, changes in the percentage level of unemployment, and the percentage rate of change in consumer prices. Moreover, his results indicated not only that the changes in consumer prices were important as an explanatory variable, but also that they had become much more important as a determinant of the change in money wages in the more recent period. The rate of change in consumer prices explained 76 per cent of the variation in the rate of change in wages not associated with the unemployment variables in the 1948–57 period, compared to roughly 17 per cent during the period from 1862 to 1913.

The important effect which the rate of price change has on the rate of wage change is evident from Table 3.3 and Figure 3.3. For example, while a 3 per cent level of unemployment is associated with a 1 per cent per annum increase in wage rates if the cost of living remains constant, the same rate of unemployment is associated with a 3.1 per cent increase in wage rates when the cost of living increases by 3 per cent per year. It is also important to note that wage changes do not adjust fully to variations in the rate of change in prices, according to the

---

[1] This calculation assumes no pressure on domestic prices from rising import prices and also that wage earnings do not rise more rapidly than wage rates (basically the wage drift problem).

[2] Richard G. Lipsey, "The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1862-1957: A Further Analysis," *Economica*, N.S., February 1960, pp. 1-31.

Table 3.3

Estimated Relationship between Wage Changes, Unemployment, Changes in Unemployment, and Changes in Prices for Britain, 1923–39, 1948–57 (Lipsey)

Unemployment Rate (Per Cent of the Labour Force)	Percentage Change in Wages Per Annum with Zero Annual Change in Unemployment and an Annual Percentage Increase in Prices of:		
	0	1	3
1.0	12.35	13.04	14.42
2.0	1.65	2.34	3.72
3.0	1.02	1.71	3.09
4.0	0.89	1.58	2.96
5.0	0.84	1.53	2.91
6.0	0.82	1.51	2.89
7.0	0.81	1.50	2.88
8.0	0.80	1.49	2.87

relationship estimated by Lipsey.[1] Although the effect is strong, money wages may be expected to increase by only 0.69 of a percentage point more each year when prices are assumed to increase 1 per cent per year than when there is assumed to be no change in prices.

It is interesting to compare Lipsey's estimates, assuming no change in either prices and unemployment, with those of Phillips. Lipsey's estimates suggest that when unemployment is anywhere in the range from 3 to 10 per cent, wage rates increase at about the same percentage rate– about 1 per cent per year–irrespective of the level of unemployment. Lipsey's estimates also suggest that there is no rate of unemployment within the range considered which would be sufficient to hold the rate of change of wages to zero. As unemployment falls below 3 per cent, the rate of wage inflation accelerates very rapidly according to Lipsey's figures. Phillips' estimates, on the other hand, imply a zero rate of change of wages when the level of unemployment is approximately 5 ½ per cent. Below a 5 ½ per cent level of unemployment, wages begin to rise, at first rather slowly and then very rapidly, as the unemployment level falls below 2 per cent.

Lipsey's estimates also suggest that the wage adjustment relationship did not remain stable over the past century. Instead, the relationship for the period since the 1920's was considerably different from that for the period from 1862–1913 and, in the more recent period, the expected annual rate of increase in wages was considerably greater at every level of unemployment. Thus, on one interpretation, there may have been an increase in labour pushfulness after the First World War.

[1] In general, this conclusion (that wage changes do not fully adjust to changes in consumer prices, at least for the time period utilized in the regression analysis) appears to be confirmed by most of the other studies reviewed below.

Finally, Lipsey estimated the effect of changes in the unemployment rate on wage changes. For the nineteenth century, he found that this variable had a significant negative influence, while in the twentieth century, the rate of change of unemployment had a positive and significant regression coefficient. Lipsey interpreted his findings as reflecting aggregation error, rather than a true "structural" relationship. Lipsey argued that, because of the nonlinearity of the wage adjustment relationship characterizing individual labour markets, the rate of change of wages would be greater, at a given unemployment rate for the economy as a whole, the greater the degree of sectoral inequality in unemployment rates. Hence, Lipsey interpreted his results as indicating that sectoral inequalities in unemployment rates increased during recessions in the twentieth century and during recoveries in the nineteenth.[1]

Several other estimates of wage adjustment relationships for the British economy have been made; we shall examine two of these in some detail. However, these are not in the exact form of the two previous relationships and, consequently, completely precise comparisons cannot be made. These estimates, nevertheless, are interesting because they tend to corroborate Phillips' (rather than Lipsey's) view of the sensitivity of wage changes to the level of unemployment. In particular, these other estimates suggest that the wage adjustment relationship is not so flat as Lipsey estimated it to be at unemployment rates above 3 per cent, and that there may be some levels of unemployment consistent with a zero rate of change of wages.

L.R. Klein and R.J. Ball investigated an empirical relationship for Britain between the absolute change in money wage rates as the dependent variable and a set of independent variables which included the absolute level of unemployment and the absolute change in prices. They also found good evidence that wage rate movements were sensitive to the level of unemployment.[2] Using quarterly data for the period between first quarter of 1948 and the fourth quarter of 1956, they related the annual change in the index of weekly wage rates to a four-quarter average of current and past changes in the price level and a similar average of levels of unemployment. The estimated relationship was linear, with a break in the relationship after 1951. At the same values of the unemployment level and price change variables, the predicted increase in money wages was 2.9 index points higher after 1951 than it was earlier.[3]

---

[1] Phillips also observed that the change in the unemployment rate appeared to have an influence on wage rate changes, although he arrived at this conclusion through a graphical examination of the residuals rather than by a more formal procedure. Phillips interpreted the negative (partial) association between the rate of change of unemployment and wage changes as indicating that the rate of change of unemployment is an additional indicator of demand pressures in the labour market. Bowen and Berry (reference given at the point of full discussion below), while not rejecting Lipsey's explanation of the importance of changes in the unemployment rate, argue that his explanation does not preclude Phillips' nor the possibility that changes in the unemployment rate may be a good proxy for expected *future* labour market conditions.

[2] L. R. Klein and R. J. Ball, "Some Econometrics of the Determination of Absolute Prices and Wages," *Economic Journal*, September 1959, pp. 465-482.

[3] The coefficient of the dummy variable, F, was 2.90. F, which was defined to be zero before 1952 and unity during 1952 and afterwards, was included to show a structural change in the relationship due to political factor. British trade unions became more aggressive in their wage demands under a Conservative government, which was returned to power at this time.

By choosing the fourth quarter of 1956 as a reference date, the relationship for absolute changes in wages and prices and the absolute level of unemployment was transformed into a relationship for the percentage changes in wages and prices and the unemployment rate. Table 3.4 and Figure 3.4 present this relationship, which has a different appearance from both Phillips' and Lipsey's estimates. The wage adjustment relationship is linear in the Klein-Ball estimates, while it was highly nonlinear in the earlier estimates. The major differences in the estimated relationships, therefore, appear to occur at rates of unemployment greater than 2 per cent. With an unchanged level of prices, a 3 per cent rate of unemployment is associated with roughly a 1 per cent *decline* in wages in the Klein-Ball relationship. However, a 3 per cent level of unemployment in Britain is not a "full employment" level.[1] More appropriate comparisons would be for levels of unemployment between 1.5 to 2.5 per cent. In this range of unemployment, the differences in the respective estimates are less great. With a zero rate of price change, a 2 ½ per cent rate of wage increase is associated with a level of unemployment slightly less than 2 per cent in the Klein-Ball estimates compared to a 1.7 per cent level of unemployment in Lipsey's estimates and a 2.1 per cent level of unemployment in Phillips' estimates.

Table 3.4

Wage Adjustment Relationship for Britain, Fourth Quarter 1956 (Klein and Ball)

Unemployment Rate (Per Cent of the Labour Force)	Percentage Change in Wages under the Assumption of a Percentage Change in Prices of:		
	0	1	3
1.0	5.68	6.45	8.00
2.0	2.34	3.11	4.66
2.5	0.68	1.45	3.00
3.0	–0.99	–0.22	1.33

For levels of unemployment in excess of 2 ½ per cent, the estimated Klein-Ball relationship seems inappropriate. The evidence seems to point to a decidedly nonlinear relationship in that range.[2]

A particularly important result of the Klein and Ball estimates was the appearance of an almost fully compensatory relationship between changes in the price level (after a time lag) and changes in wage rates. A one index point increase per annum in the consumer price level would result in a 0.85 index point

[1] See Section 1 above, in which comparability in the measurement of unemployment for various countries, including Britain, is discussed.

[2] In a recent study ("The Prediction of Wage-Rate Changes in the United Kingdom 1957-60," *Economic Journal*, March 1962, pp. 27-44), R. J. Ball has studied the forecasting accuracy of his and Klein's wage adjustment relationship, for a period of time after that to which the relationship had been fitted. Ball found that this relationship predicted actual wage changes most poorly during the period between the third quarter of 1958 and the third quarter of 1959, a time of recession in Britain. In turn, one possible explanation of these results is a nonlinearity in the wage adjustment relationship, which never became apparent during the sample period because the level of unemployment was never very large.

increase per year of money wage rates.[1] Figure 3.4 depicts the upward shift of the wage adjustment relationship associated with increases in the four-quarter average of price level changes equal to 1 per cent and also to 3 per cent.

Dicks-Mireaux and Dow studied the relationship between the rate of change in wages and the demand for labour, which was measured by an index combining data on unemployment and unfilled vacancies.[2] Quarterly data for the period 1950–56 were used, and the rate of change in retail prices was included as an explanatory variable. Several conclusions were drawn from that study. As expected, the demand for labour had a considerable effect on the rate of change in wages. A one percentage point increase in the level of excess demand (approximately equal to a one percentage point decrease in the rate of unemployment) was associated with an additional increase of three or four percentage points in the annual rate of wage change.[3] The rate of price change was also an important explanatory variable but a one percentage point increase in the annual change in prices was associated with significantly less than a one percentage point additional increase in the rate of change in wages. Finally, the relationship indicated an increase in wages of 2 ½ per cent per annum even at a zero level of excess demand and in the absence of any change in prices. A zero level of excess demand for labour is approximately equivalent to full employment of the labour force (roughly a 2 per cent rate of unemployment, for Britain). With the assumptions that productivity increases by about 2 ½ per cent per year and that the share of wages, in total value added, remains constant, a simple mark-up equation would predict that the price level would remain stable (again ignoring the questions of wage drift and changes in import prices). This result is closely in line with Phillips' original estimates.[4]

---

[1]See the Appendix for the actual equations involved. It should be observed that, for the fourth quarter of 1956, this result means that a one *percentage* point (per annum) average increase in the consumer price level is associated with an additional annual increase in wages of 0.77 of a percentage point.

[2]L.A. Dicks-Mireaux and J.C.R. Dow, "The Determinants of Wage Inflation: United Kingdom, 1946-1956," *The Journal of the Royal Statistical Society*, Vol. CXXII, Part 2 (1959), pp. 145-184.

[3]*Ibid.*, pp. 154-155.

[4]Phillips, in a verbal discussion of the Dicks-Mireaux and Dow results, noted this similarity *(loc. cit.*, pp. 176-177).

A later article by L.A. Dicks-Mireaux ("The Interrelationship between Cost and Price Changes 1946-1959: A Study of Inflation in Post-War Britain," *op. cit.)* yields conclusions which are broadly similar to those of the earlier article.

The review of British wage adjustment relationships should not be concluded without mention at least in a footnote of those estimated by A.G. Hines in "Trade Unions and Wage Inflation in the United Kingdom 1893-1961," *Review of Economic Studies*, Vol. XXXI, No. 88 (October 1964), pp. 221-252. Hines' principal thesis appears to be that much of the short-run variation in the rate of change of wages can be explained by variations in the change in the percentage of the labour force which is unionized, which he regards as a proxy for trade union pushfulness. Moreover, Hines found that direction of effect of the unemployment rate, although negative as expected, was not statistically significant in the wage adjustment relationships estimated for the period 1921-38 and 1949-61.

Hines' very interesting results can be in part reconciled with previous work. As the theoretical discussion of Chapter 2 pointed out, other explanatory variables, such as trade union pushfulness, can be grafted onto the excess demand or unemployment variable in the explanation of variations in the rate of change of money wages. Thus, both demand and pushfulness variables may play a role in the explanation of wage changes; one does not necessarily rule out the other. It is interesting to observe that Dicks-Mireaux and Dow made some trial computations over the longer period 1946-56 with an attitudinal variable which attempted to measure trade union pushfulness; this variable was highly significant in the regression, although the authors' excess demand for labour variable retained its statistical significance, in the expected direction. Hines' results also suggest that profits are one determinant, with a lag, of the change in unionization. In turn, this suggests that one interpretation of the importance of a profits variable in a wage adjustment relationship, which has been found by Perry (reference below) and the present study, might be that this variable serves as a partial indicator of trade union pushfulness.

Figure 3.2

WAGE ADJUSTMENT RELATIONSHIP FOR BRITAIN (1861-1913): PHILLIPS

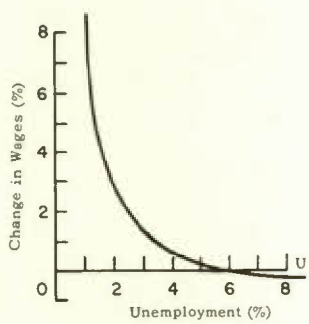


Figure 3.3

WAGE ADJUSTMENT RELATIONSHIP FOR BRITAIN (1923-39, 1948-57): LIPSEY

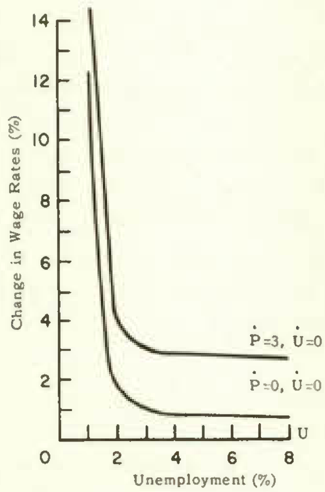
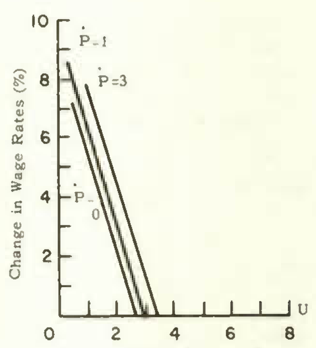


Figure 3.4

WAGE ADJUSTMENT RELATIONSHIP FOR BRITAIN (Fourth Quarter 1956, from 1948-56 Data): KLEIN & BALL



3. Estimated Relationships for the United States

As in the case of Britain, a number of studies have attempted to estimate the empirical relationship between the rate of wage changes and the level of unemployment in the United States. However, the dependent variable in the U.S. studies has usually not been changes in wage rates, but changes in average hourly earnings, which tend to be more volatile than wage rates.[1] In one such U.S. study, Samuelson and Solow made some rough calculations of the relationship between percentage rates of unemployment and percentage changes in wage earnings.[2] The relationship was then translated into a price-change-unemployment relationship (a trade-off curve) as depicted in Figure 3.5 on page 52. According to these estimates, a zero rate of change of the price level is associated with roughly a 5 ½ per cent rate of unemployment, under the assumption of a 2 ½ per cent annual rate of growth of both labour productivity and wages. A full-employment policy geared to an unemployment rate of 3 per cent suggests an increase in prices of approximately 4 ½ per cent per annum.[3] These estimates should be accepted with great caution.[4] The correlation between the variables was low, the estimation techniques are fairly rough, and the derivation of the estimated changes in price levels from the predicted wage changes also has the character of a "first approximation."

A more detailed investigation of the U.S. relationship between unemployment and the percentage rate of change in earnings was done by Bhatia for the years 1948–58.[5] Again the rate of wage change was sensitive to unemployment rates, but the correlation was low and the regression coefficients for unemployment and its rate of change were not significant.[6] Nevertheless, it is interesting to compare Bhatia's results with those of Samuelson and Solow. The former are presented in Table 3.5 and in Figure 3.6.

With Bhatia's estimates, if one assumes no change in the level of prices, a 3 per cent (approximately full employment) level of unemployment implies a 4.4 per

---

[1] As implied in the discussion of Section 1, it is entirely possible that wage rates may remain unchanged and that demand pressures in the labour market may be reflected in increased earnings due to greater overtime worked, special premiums, and so forth.

[2] Paul A. Samuelson and Robert M. Solow, "Analytical Aspects of Anti-Inflation Policy," *American Economic Review*, May 1960, pp. 177-194.

[3] The relevant points are shown as A and B in Figure 3.5.

[4] Samuelson and Solow themselves warn that the relationship should not be expected to hold for decreases in price levels.

[5] R.J. Bhatia, "Unemployment and the Rate of Change of Money Earnings in the United States, 1900-1958," *Economica*, N.S., August 1961, pp. 286-296. The equation presented in the Appendix pertains to the years 1948-58. Bowen and Berry, whose study is discussed immediately below, assert that they attempted to reproduce some of Bhatia's results but were unable to do so. Thus, a special word of caution regarding the Bhatia study seems in order.

[6] Only 51 per cent of the variation in changes in wage earnings is accounted for by changes in the independent variables. Moreover, the standard errors of the coefficients of the unemployment percentage and of the rate of change of unemployment were larger than the respective coefficients themselves. The coefficient of the percentage change of the unemployment rate was .02. Thus this effect, if any, is small as well as not statistically significant.

Table 3.5

Relationship between the Rate of Unemployment and Percentage Changes in Earnings for the United States, 1948-58 (Bhatia)

Unemployment Rate (Per Cent of the Labour Force)	Annual Percentage Change in Wage Earnings with an Annual Percentage Increase in Prices of:		
	0	1	3
2.5	4.54	5.18	6.46
3.0	4.35	4.99	6.27
4.0	3.98	4.62	5.90
5.0	3.61	4.25	5.53
6.0	3.24	3.88	5.16
7.0	2.87	3.51	4.79
8.0	2.50	3.14	4.42

cent increase in wages. An unemployment rate of 8.0 per cent is associated with a 2.5 per cent increase in wages and hence a stable price level, provided one assumes that productivity grows at a 2.5 per cent annual rate and that the mark-up on labour cost per unit of output remains constant. This critical rate of unemployment "required" for price stability, as estimated by Bhatia, is somewhat larger than the Samuelson-Solow estimate. In fact the Bhatia wage adjustment relationship generally lies to the right and is less steep than that of Samuelson and Solow.

Judging from Bhatia's estimates, one may conclude that the rate of change in wage earnings is not very sensitive to the rate of unemployment: a one percentage point decrease in the rate of unemployment implies only an additional increase in the rate of change in wage earnings of 0.4 of a percentage point, given the change in consumer prices. On the other hand, the rate of change in earnings is significantly affected by variations in the rate of change in consumer prices: a one percentage point per year additional increase in consumer prices adds 0.6 of a percentage point to the annual percentage increase in earnings.[1] Figure 3.6 presents the wage adjustment relationship when an increase in prices of 3 per cent per year is assumed. A 3 per cent rate of unemployment in this situation is associated with a 6.3 per cent increase in wages annually.[2]

[1] The coefficient of the rate of change of the price level is 0.64 (percentage points). For the estimated equation, see the Appendix.

[2] Robert R. France, in "Wages, Unemployment, and Prices in the United States," *Industrial and Labor Relations Review*, January 1962, pp. 171-190, has studied the wage adjustment relationship for the United States during the period 1947-59. His results are quite similar to those of Bhatia presented in Table 3.5. For example, a 3 per cent rate of unemployment is associated with a 4.48 per cent annual rate of wage increase in the absence of changes in the price level. Some 73 per cent of the variation in the rate of change of average hourly earnings was accounted for by variations in the rate of unemployment, the rate of change of unemployment, the percentage decline in wholesale prices, and the percentage increase (for positive movements only) in the consumer price level. All variables except the rate of change of the unemployment rate were statistically significant.

Bowen and Berry also studied the wage adjustment relationship for the United States during the same period, 1948–58.[1] Price changes were not included as an explanatory variable because the authors believed that the causal link between wages and prices could run in either direction and hence they could not offer a satisfactory interpretation of a single-stage least squares regression which included price changes as an independent variable.[2] Consequently, the percentage rate of change in wage earnings was regressed as a linear function of the rate of unemployment and the absolute change in that rate. The results were not completely convincing as the coefficient of multiple determination was only 0.66 and the coefficient of the level of unemployment was not highly significant.

Nevertheless, the absolute change in the rate of unemployment did appear to be a highly significant variable in the estimated wage adjustment relationship. A one percentage point decrease in the unemployment rate was associated with an additional increase in wage earnings of 0.8 of a percentage point. A theoretical explanation for this phenomenon would be that wage changes depend not only upon present conditions in the labour market (for which the rate of unemployment is a proxy), but also upon future labour market conditions, for which the absolute change in the unemployment rate is a good indicator. Table 3.6 and Figure 3.7 present Bowen and Berry's results.

Table 3.6

Relationship between the Rate of Unemployment and Percentage Changes in Wage Earnings for the United States, 1948-58 (Bowen and Berry)

Unemployment Rate (Per Cent of the Labour Force)	Annual Percentage Change in Wage Earnings with an Annual Absolute Decline (in Percentage Points) in the Rate of Unemployment of:		
	0	1	3
2.5	5.69	6.50	8.12
3.0............................	5.41	6.22	7.84
4.0............................	4.85	5.66	7.28
5.0............................	4.29	5.10	6.72
6.0............................	3.73	4.54	6.16
7.0............................	3.17	3.98	5.60
8.0............................	2.61	3.42	5.04

According to Bowen and Berry, a 3 per cent rate of unemployment would imply a 5.4 per cent annual increase in wages if the level of unemployment remained constant, but a 7.8 per cent increase in wages if the rate of unemployment were to

[1] William G. Bowen and R. Albert Berry, "Unemployment Conditions and Movements of the Money Wage Level," *The Review of Economics and Statistics*, May 1963, pp. 163-172.

[2] L.A. Dicks-Mireaux *(op. cit.)*, John Vanderkamp (reference given at the point of full discussion in Section 5 below), and the present study have all found that a single-stage (simple) least squares regression yields results that are very close to those generated by more intricate methods of estimation which take simultaneity into account. Accordingly, it would appear that inclusion of a price change variable in estimating the parameters of a wage adjustment relationship by ordinary least squares techniques is merited on statistical as well as theoretical grounds.

decrease by three percentage points. Similarly, if productivity grew by 2.5 per cent per year, then a 2.5 per cent increase in wage earnings (and hence a zero rate of change of the price level, under certain assumptions) is associated with an unchanging unemployment rate of 8.2 per cent of the labour force. On the other hand, if the unemployment rate has increased by one percentage point, a 2.5 per cent increase in wages is associated with a 6.7 per cent rate of unemployment (not shown in the table). In the absence of changes in unemployment, the Bowen and Berry estimates are slightly higher than those of Bhatia, which may reflect the fact that Bhatia's study explicitly included price changes as an explanatory variable while Bowen and Berry's did not.[1]

Professor Lawrence R. Klein and one of the present authors studied a relationship, for the United States, between absolute changes in the level of wages as the dependent variable and a set of independent variables which included the absolute level of unemployment and absolute changes in the price level.[2] Quarterly data for the period from 1948 to 1957 were used as the sample period. The coefficients of the estimated relationship may be interpreted in the following manner. An increase in the average level of unemployment of one million workers will reduce the normal increase in the level of annual wage payments by approximately $45 per year, while an average annual increase of one index point in the price index will be accompanied by an additional increase in wage payments per worker of $15.59 per annum. Finally, a trend coefficient was estimated, which indicated that the relationship had shifted upward over time. Over a period of one year, the upward shift of the relationship alone would result in an additional $6.40 increase in annual wage payments.[3]

If one reformulates this relationship in terms of a relationship between percentage wage changes, unemployment as a percentage of the labour force, and percentage changes in the consumer price level, one finds that a 5.6 per cent rate of unemployment would be required to keep the annual percentage increase in wage payments in line with the annual rate of increase in productivity (assumed to be 2.5 per cent per year) and so to maintain price stability. Table 3.7 presents the transformed wage adjustment relationship and Figure 3.8 depicts it graphically. The effect of price increases upon wage increases is readily apparent from the estimate that a 4.4 per cent annual increase in wages is associated with a 3 per cent rate of unemployment in the absence of a rise in the price level, while the

---

[1] It may also reflect computational errors. See footnote 5 on page 46.

[2] Lawrence R. Klein and Ronald G. Bodkin, assisted by Motoo Abe, "Empirical Aspects of the Trade-Offs among Three Goals: High Level Employment, Price Stability, and Economic Growth," in *Inflation, Growth, and Employment*, a Series of Research Studies for the Commission on Money and Credit (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1964). As with the other studies in this Chapter, the mathematical formulation appears in the Appendix. It may be observed that the money wage variable utilized in the Klein-Bodkin study refers to an average wage for the entire economy, while the wage variables used in the other U.S. studies summarized in this section are based upon earnings in the manufacturing sector. For the Klein-Bodkin study, both the unemployment variable and changes in the cost of living were assumed to affect wage changes with an average time lag of 4½ months.

[3] The coefficient of the trend value was estimated at 1.60. The trend value was a chronological listing of quarterly periods with the trend variable equal to unity (1) in the first quarter of 1946.

same rate of unemployment can be expected to induce a 5.5 per cent per year increase in wages if consumer prices are increasing at the rate of 3 per cent per year.

Table 3.7

Wage Adjustment Relationship for the United States, First Quarter 1960 (Klein & Bodkin)

Unemployment Rate (Per Cent of Labour Force)	Annual Percentage Change in Wages under the Assumption of an Annual Percentage Increase in Prices of:		
	0	1	3
2.5	4.7	5.0	5.8
3.0	4.4	4.7	5.5
4.0	3.7	4.0	4.8
5.0	3.0	3.3	4.1
6.0	2.3	2.6	3.4
7.0	1.6	1.9	2.7
8.0	0.9	1.2	2.0

Finally, we may close this survey of estimated wage adjustment relationships for the United States with a brief discussion of G.L. Perry's interesting study.[1] Using quarterly data for a sample period from 1947 through 1960, Perry expressed the annual rate of wage earnings (the dependent variable) as a linear function of the following independent variables: the reciprocal of a four-quarter average of the unemployment rate; the annual rate of change of the consumer price level, lagged one quarter; a four-quarter average of after-tax profits as a percentage of stockholders' equity, also lagged one quarter; and the first difference of his profits variable. Perry's study differs from the other studies surveyed in this Chapter in the inclusion of the two profits variables.[2] Moreover, it is the only U.S. study reviewed here (with the possible exception of the Samuelson-Solow

[1] G.L. Perry, "The Determinants of Wage Rate Changes and the Inflation-Unemployment Trade-off for the United States," *Review of Economic Studies*, Vol. XXXI, No. 88 (October 1964), pp. 287-308.

[2] A very similar variable (after-tax profits as a ratio to stockholders' equity) was employed by Otto Eckstein and Thomas A. Wilson in "The Determination of Money Wages in American Industry," *Quarterly Journal of Economics*, Volume LXXVI, No. 3 (August 1962), pp. 379-414. This study was not surveyed in this Section because it utilizes the "wage round" concept, rendering comparisons with annual rates of change difficult. A profits variable is also introduced in the wage adjustment equations estimated for the various sectors of the Brookings model (Charles L. Schultze and Joseph L. Tryon, "Prices and Wages," Chapter 9 of Duesenberry, Fromm, Klein, and Kuh, eds., *The Brookings Quarterly Econometric Model of the United States* [Chicago: Rand McNally & Company, 1965]). Furthermore, the wage adjustment relationship for the private sector estimated in a recent revision of Professor Klein's post-war U.S. quarterly model (Maurice Liebenberg, Albert A. Hirsch, and Joel Popkin, "A Quarterly Econometric Model of the United States: A Progress Report," *Survey of Current Business*, May 1966, pp. 13-39) also makes use of a profits variable. These latter two studies, which also utilize the reciprocal formulation for the influence of the unemployment rate, appeared too late for a convenient inclusion in the text of this Chapter but are briefly discussed in Parts II and III below. Finally, Bhatia, in a sequel to the study discussed in this Section, found some evidence that a profits variable was significant in his wage adjustment relationships; see his "Profits and the Rate of Change in Money Earnings in the United States, 1935-1959," *Economica*, August 1962, pp. 255-262.

article) which employs the nonlinear formulation for the influence of the unemployment rate. It should be noted that all four of Perry's explanatory variables were highly significant, by conventional tests. Perry's results are presented in tabular form below and graphically in Figures 3.9 and 3.10. According to these results,

Table 3.8

Wage Adjustment Relationship for the United States, 1947-60 (Perry)

Unemployment Rate (Per Cent of Labour Force)	Annual Percentage Change in Wages: With a Percentage Rate of Profits of 10, and an Annual Percentage Price Increase of:			With a Percentage Rate of Profits of 10.8 and an Annual Percentage Price Increase of:			With a Percentage Rate of Profits of 11.8, and an Annual Percentage Price Increase of:		
	0	1	3	0	1	3	0	1	3
2.5	5.8	6.1	6.9	6.2	6.6	7.3	6.6	7.0	7.7
3.0	4.8	5.2	5.9	5.2	5.5	6.3	5.6	6.0	6.7
4.0	3.6	4.0	4.7	3.9	4.3	5.0	4.4	4.7	5.5
5.0	2.9	3.2	4.0	3.2	3.6	4.3	3.6	4.0	4.7
6.0	2.4	2.7	3.5	2.7	3.1	3.8	3.1	3.5	4.2
7.0	2.0	2.4	3.1	2.4	2.7	3.5	2.8	3.1	3.9
8.0	1.8	2.1	2.9	2.1	2.5	3.2	2.5	2.9	3.6

if after-tax profits remain unchanged at 10.8 per cent of stockholders' equity (the 1953–60 average), then a 3 per cent rate of unemployment is associated with a 5.2 per cent annual increase in wages and a 6 per cent unemployment rate is associated with a 2.7 per cent wage increase, under the assumption of unchanged consumer prices. If the same unchanging profit rate is assumed with the consumer price level rising at the rate of 3 per cent per year, then wages are estimated to rise at the rate of 6.3 per cent per annum when the unemployment rate is 3 per cent and at the rate of 3.8 per cent with an unemployment rate of 6 per cent. As noted above, the influence of unemployment on wage changes is nonlinear for Perry's relationship, which makes comparisons with the other U.S. relationships summarized in this section difficult.[1] Nevertheless, if one considers the range of unemployment rates between 2.5 and 8 per cent, the Perry wage adjustment relationship seems more sensitive to variations in the unemployment rate than those of Bhatia and of Bowen and Berry, but roughly as sensitive as that of Klein and Bodkin. It is interesting to observe that Perry's results suggest that wage changes are less responsive to variations in the rate of change of the consumer price level than Bhatia found, but the agreement with Klein-Bodkin on the magnitude of the partial response to this variable is very close. In both studies (after a suitable transformation, in the case of the Klein-Bodkin relationship), an additional increase of one percentage point per year in the rate of change of consumer prices is associated with an additional annual increase in wages of only 0.37 of a percentage point.

[1] Thus, as Figures 3.9 and 3.10 make apparent, the nonlinearity of the influence of this variable means that a variation in the unemployment rate has a relatively big impact when the unemployment rate is low, but a relatively small effect when the unemployment rate is high.

Figure 3.5

TRADE-OFF CURVE FOR THE UNITED STATES (1946-60): SAMUELSON & SOLOW

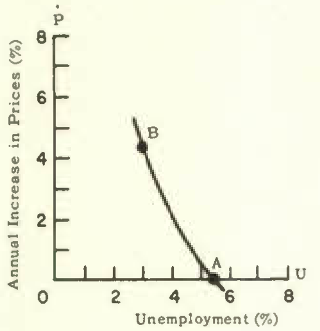


Figure 3.6

WAGE ADJUSTMENT RELATIONSHIP FOR THE UNITED STATES (1948-58): BHATIA

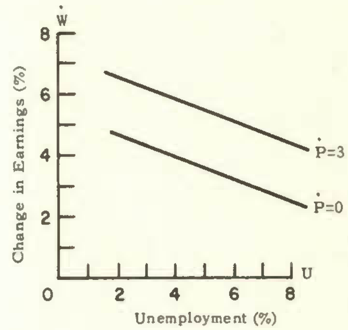
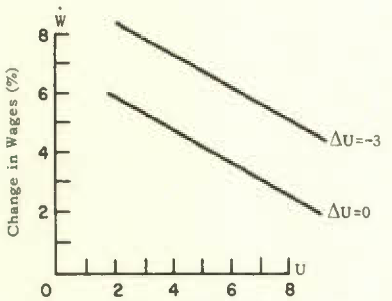


Figure 3.7

WAGE ADJUSTMENT RELATIONSHIP FOR THE UNITED STATES (1948-58): BOWEN & BERRY[a]



[a] ΔU=Absolute change in Unemployment Rate.

Figure 3.8

WAGE ADJUSTMENT RELATIONSHIP FOR THE UNITED STATES (First Quarter 1960, from 1948-57 Data): KLEIN & BODKIN

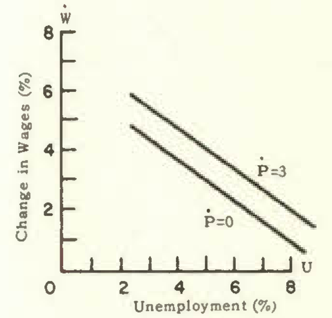


Figure 3.9

WAGE ADJUSTMENT RELATIONSHIP
FOR THE UNITED STATES, WITH ALTERNATIVE
PRICE INFLATION RATES (1947-60):[a]
PERRY

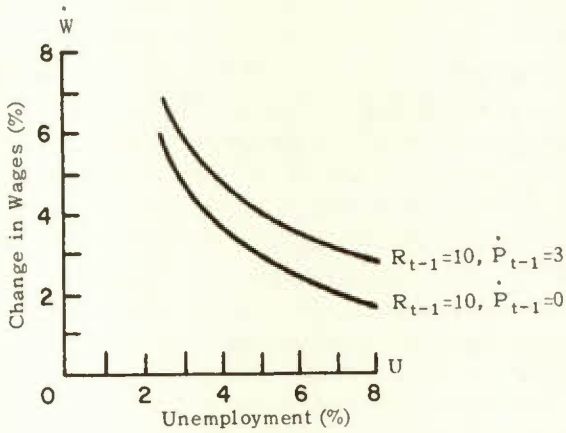
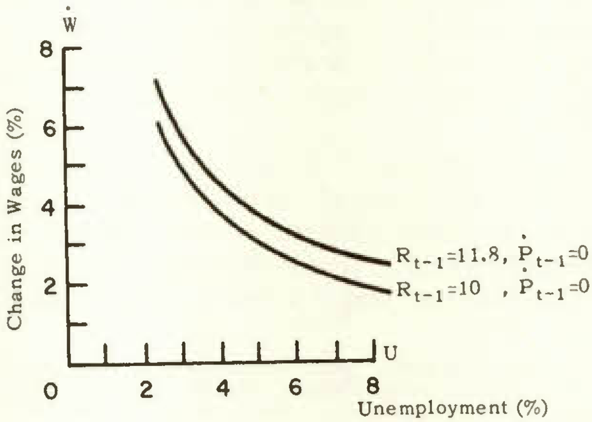


Figure 3.10

WAGE ADJUSTMENT RELATIONSHIP
FOR THE UNITED STATES, WITH ALTERNATIVE
PROFIT RATES (1947-60):[a]
PERRY



[a]R = Profit Rate (%).

If one continues to assume an unchanged profit rate of 10.8 per cent, then a 6.6 per cent rate of unemployment would be associated with an annual rate of increase in money wages equal to 2.5 per cent. This same rate of unemployment would also be associated with stability of the price level under the additional assumptions that productivity rises at the same 2.5 per cent per annum rate and relative shares remain unaltered. This critical rate is below that estimated by Bhatia and Bowen-Berry, on the one hand, but above the Samuelson-Solow and Klein-Bodkin estimates.

Finally, Perry's results do suggest a perceptible influence of profits on the rate of change of wages. As pointed out in Chapter 2 and by Perry himself, this might represent an additional lever by which public policy might attempt to make the objectives of high employment and price stability more compatible. The partial effect of a one percentage point increase in after-tax profits as a proportion of stockholders' equity is to induce an expected increase in the annual rate of change of money wages of an additional 0.42 of a percentage point. Thus Table 3.8 indicates that, for example, the expected annual rate of increase of wages is 5.2 per cent when the profit rate is 10.8 per cent, the unemployment rate 3 per cent, and the rate of change of consumer prices is zero. However, the same values of the unemployment rate and the rate of change of the consumer price level may be expected to induce an annual rate of increase of wages equal to 5.6 per cent if the level of profits shifted to (and remained at) a rate of 11.8 per cent. Another way of indicating the influence of profits on wage changes is to note that if the profit rate were to shift to an unchanging level of 10.0 per cent, the rate of unemployment associated with a zero rate of change of the price level (under the above assumptions) is only 5.7 per cent, while this critical unemployment rate rises to 8.0 per cent if the rate of profits rises to (and remains at) 11.8 per cent.

4. Estimated Relationships for West Germany, France, Belgium, and Japan

Klein and Bodkin also estimated wage adjustment relationships for a number of other countries for the period 1952–59. In all of these estimates, the annual percentage rate of change in wages was explained by the rate of unemployment, the annual percentage change in the price level, and a time trend. For each country except France these explanatory variables explained a very high proportion of the variation in the rate of change of wages.[1]

Table 3.9 below and Figure 3.11 present the estimated wage adjustment relationship for the Federal Republic of Germany. With no change in prices, an unemployment rate of roughly 4 per cent is associated with a zero rate of change in wage levels; a 3 per cent level of unemployment is associated with an increase in wages of 3.2 per cent per year. The rate of change in wages appears to be quite

---

[1] Lawrence R. Klein and Ronald G. Bodkin, *op. cit.* In presenting the Klein-Bodkin results for the various countries discussed below, the first quarter of 1960 has been chosen as the reference point for the comparisons. Such a reference point is necessary because the computed relationships contain a time trend variable, and so a continuous shift over time has been assumed in estimating the parameters of these wage adjustment relationships. For this reason, the relationships presented in Tables 3.9 through 3.12 below refer, in principle, to only this particular point in time.

sensitive to the rate of unemployment, a one percentage point decrease in the rate of unemployment adding 3.1 percentage points to the annual rate of increase in wages. Figure 3.11 depicts the wage adjustment relationship when a 3 per cent per year increase in the price level is assumed. As indicated, when prices rise at this rate, a 3 per cent rate of unemployment is associated with a 4.7 per cent increase in wages annually.

Table 3.9

Wage Adjustment Relationship for West Germany, First Quarter 1960 (Klein & Bodkin)

Unemployment Rate (Per Cent of Labour Force)	Annual Percentage Change in Wages with an Annual Percentage Increase in Prices of:		
	0	1	3
2.0	6.3	6.8	7.8
3.0	3.2	3.7	4.7
4.0	0.1	0.6	1.6
5.0	-3.1	-2.6	-1.5

The wage adjustment relationship for France is presented in Table 3.10 and Figure 3.12. It appears that the rate of change in wages is extremely sensitive to the level of unemployment but not very sensitive to variations in the rate of change of consumer prices. If one assumes no changes in prices, a 1.5 per cent rate of unemployment is associated with an annual increase of 3.5 per cent in wages. However, a 2.5 per cent level of unemployment, with prices unchanged, is associated with a decrease in wages of over 2 per cent per year. Moreover, the assumption of an annual rate of change of consumer prices of 3 per cent has very little effect on the resulting increase in wages. Thus, while with stable prices a 1.5 per cent level of unemployment is associated with an annual rate of increase in wages of 3.5 per cent, Table 3.10 indicates that the same rate of unemployment may be expected to induce a rate of increase in wages equal to 3.8 per cent annually if prices rise at the rate of 3 per cent per year.

Table 3.10

Wage Adjustment Relationship for France, First Quarter 1960 (Klein & Bodkin)

Unemployment Rate (Per Cent of Labour Force)	Annual Percentage Change in Wages with an Annual Percentage Increase in Prices of:		
	0	1	3
1.0	6.3	6.4	6.7
1.5	3.5	3.6	3.8
2.0	0.6	0.7	0.9
2.5	-2.3	-2.2	-2.0

Even after correction for differences in the measurement of unemployment, it would appear that wages are far more sensitive to the level of unemployment in West Germany and France than in the United States. On the other hand, wage changes appear to be much more sensitive to changes in consumer price levels in the United States and in West Germany than in France.[1]

The wage adjustment relationship estimated for Belgium by Klein and Bodkin is shown in Figure 3.13 and in Table 3.11. It appears that the rate of change in wages is sensitive to the level of unemployment though less so than in France. An addition of one percentage point to the rate of unemployment is associated with a reduction of 2.4 percentage points in the annual rate of change in wages. The sensitivity does, however, appear to be greater than that in the United States. Perhaps the most striking feature of the Belgian wage adjustment relationship in relation to those of France and West Germany is the large amount of annual wage increases which will occur in the absence of any changes in prices and with quite moderate degrees of utilization of the labour force. With an unemployment rate of 4 per cent and a zero rate of change of consumer prices, the expected annual rise in wages is 4.3 per cent. If one assumes the rate of wage increase to be equal to a productivity growth rate of 2.5 per cent per annum, the implied unemployment rate for price level stability is approximately 4.7 per cent.

Table 3.11

Wage Adjustment Relationship for Belgium, First Quarter 1960 (Klein & Bodkin)

Unemployment Rate (Per Cent of Labour Force)	Annual Percentage Change in Wages with an Annual Percentage Increase in Prices of:		
	0	1	3
2.0	9.0	9.7	11.1
3.0	6.6	7.4	8.8
4.0	4.3	5.0	6.4
5.0	1.9	2.6	4.0
6.0	-0.5	0.2	1.6

Changes in the price level, on the other hand, appear to have a greater effect on expected wage changes in Belgium than in either France, West Germany, or the United States. For example, a 3 per cent rate of unemployment is associated with a 6.6 per cent per year increase in wages in the absence of price changes, but with an 8.8 per cent per year increase in wages if prices increase by an average of 3 per cent annually.

[1] French wage changes may in fact be more sensitive to price changes than the Klein-Bodkin results (and those of the present study, presented in Chapter 8 below) suggest. The French consumer price level may not, as argued in Section 1 above, be representative of "true" variations in the cost of living. If this is so, the resulting regression coefficients may be more a reflection of errors in the data on French consumer prices than an indication of the sensitivity of wage changes to this influence.

L.R. Klein and Y. Shinkai studied a wage adjustment relationship for the Japanese economy as part of an econometric model of Japan.[1] The derived wage adjustment relationship is presented in Table 3.12 below and in Figure 3.14.

Table 3.12

Wage Adjustment Relationship for Japan, 1930-36, 1951-58 (Klein & Shinkai)

Unemployment Rate (Per Cent of Labour Force)	Annual Percentage Change in Wages with an Annual Percentage Increase in Prices of:		
	0	1	3
1.0	9.0	9.8	11.3
1.1	7.3	8.1	9.6
1.2	5.6	6.4	7.9
1.3	3.9	4.7	6.2
1.4	2.2	3.0	4.5
1.5	0.5	1.3	2.8
1.7	-2.9	-2.1	-0.6

These estimates suggest that the rate of change in Japanese wages is very sensitive to the rate of unemployment. If one uses the Japanese definition of unemployment, a movement from 1.0 to 1.7 per cent in the rate of unemployment implies, in the absence of price changes, a variation in the expected rate of change of wages from an increase of 9 per cent per year to an annual decline of 3 per cent. In order to limit the annual increase in wages to 2.5 per cent, an unemployment rate of approximately 1.4 per cent would be required. By Japanese standards, this is a quite high level of unemployment: for example, the average rate of unemployment for the period of study (1930–36 and 1951–58), which included the years of the world-wide Great Depression as well as a subperiod of post-war prosperity, was only 1.18 per cent. The Klein-Shinkai wage adjustment relationship, converted with their adjustment factors into the North American definition of unemployment rates, is depicted in Figure 3.14 by the dashed lines. This adjustment was made by multiplying the Japanese unemployment rates by a factor of 4.0 in order to obtain estimates of equivalent North American rates.[2]

According to Klein-Shinkai results, the predicted rise in Japanese wages shows roughly the same degree of sensitivity to variations in the rate of change of consumer prices as the Belgian relationship. According to Table 3.12, an unemployment rate of 1.0 per cent and an annual rate of increase in consumer prices of 3 per cent might be expected to induce a wage increase of 11.3 per cent per year.

[1] L.R. Klein and Y. Shinkai, "An Econometric Model of Japan, 1930-1959," *op. cit.*

[2] As pointed out in our discussion of Section 1 above (especially footnote 2 on page 36), Klein and Shinkai argue that the Japanese measure of unemployment has a widely different meaning from that utilized in the United States and Canada. As noted in that discussion, we have decided to settle on the Klein-Shinkai view.

Figure 3.11

WAGE ADJUSTMENT RELATIONSHIP FOR WEST GERMANY (First Quarter 1960, from 1952-59 Data): KLEIN & BODKIN

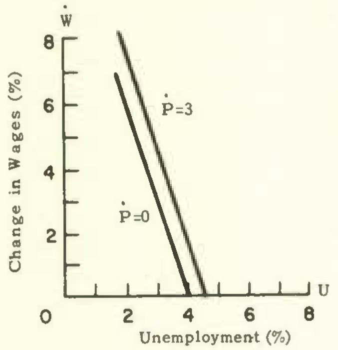


Figure 3.12

WAGE ADJUSTMENT RELATIONSHIF FOR FRANCE (First Quarter 1960, from 1952-59 Data): KLEIN & BODKIN

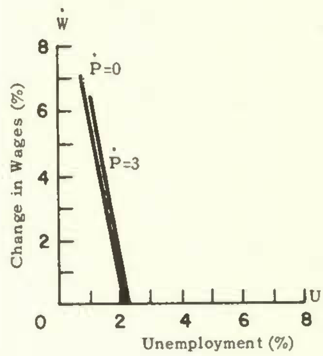


Figure 3.13

WAGE ADJUSTMENT RELATIONSHIP FOR BELGIUM (First Quarter 1960, from 1952-59 Data): KLEIN & BODKIN

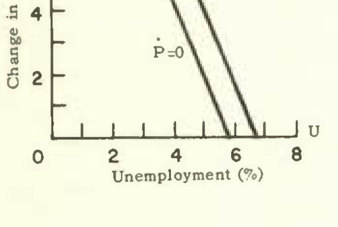
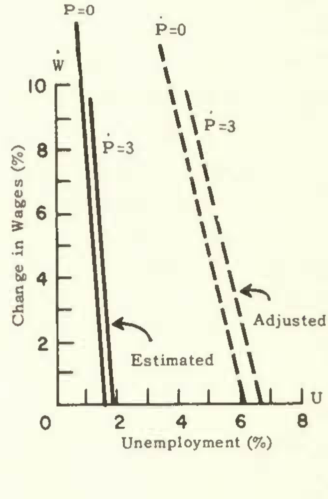


Figure 3.14

WAGE ADJUSTMENT RELATIONSHIP FOR JAPAN (1930-36, 1951-58): KLEIN & SHINKAI



This indicates a partial response of annual rates of change of wages equal to 0.74 of a percentage point for each additional percentage point in the rate of rise of consumer prices.[1]

5. Estimated Relationships for Canada

Employing quarterly data for the years 1952–59, Klein and Bodkin estimated a linear form of the wage adjustment relationship for Canada[2] (Table 3.13 and Figure 3.15).

It is apparent from the estimated relationship that a full-employment (say 3 per cent) rate of unemployment is associated with a large (6.2 per cent) annual increase in wages, under the hypothetical assumption that prices remain constant. If the rate of increase of wages is assumed to be equal to a 2.5 per cent annual growth in productivity, a 5.6 per cent rate of unemployment is implied–an unemployment level that is substantially higher than the conventional 3 or 4 per cent rate usually regarded as the full-employment level. The wage changes predicted by the Klein-Bodkin relationship are quite sensitive (after a short time lag) to

---

[1] It is interesting to compare the Klein-Shinkai wage adjustment relationship for the Japanese economy with that estimated by Klein and Bodkin *(op. cit.)* and with one recently estimated by Professor Tsunehiko Watanabe in "Price Changes and the Rate of Change of Money Wage Earnings in Japan, 1955-1962," *Quarterly Journal of Economics*, Vol. LXXX, No. 1 (February 1966), pp. 31-47. In general, these studies appear to confirm the broad conclusions from the Klein-Shinkai article, although there are some differences in the estimates of the quantitative effects involved.

Both the Klein-Bodkin and the Watanabe studies suggested a partial effect of variations in the rate of change of consumer prices on the rate of wage changes equal to 0.4; this is considerably lower than the Klein-Shinkai estimate of this parameter. Also, the effect of variations in the rate of unemployment appears to be greater for the Klein-Shinkai study than for the wage adjustment relationships estimated by Klein-Bodkin and Watanabe, although in the case of the Watanabe study the use of a different unemployment variable (the percentage of total employees receiving unemployment insurance) prevents precise comparisions. On the other hand, the expected rates of change of Japanese wages in the Watanabe study are, if anything, slightly more inflationary in the customary range of unemployment rates than the estimates of Klein and Shinkai. It is worth pointing out that the Klein-Bodkin and the Watanabe wage adjustment relationships are based on quarterly data for the post-war period only; moreover, both the Klein-Bodkin and the Watanabe relationships assume some lag in the response of wage changes to price changes and both the Klein-Bodkin and most variants of the Watanabe relationships were estimated by ordinary least squares, in contrast to the Klein-Shinkai relationship, which assumes a simultaneous impact of price changes on wage changes and which was estimated by the method of two-stage least squares. Hence some differences in the numerical details are to be expected.

Watanabe also estimates a direct price change equation, in which the annual rate of change of the consumer price level is negatively and significantly related to the annual rate of growth of labour productivity, and positively and significantly related to the annual rate of change of money wages. (Watanabe interprets this latter variable as a demand variable, but, as the argument of Chapter 2 above indicates, a labour cost interpretation is also clearly possible.) Although Watanabe stops short of doing so, one could combine his wage adjustment and price change relationships to derive a trade-off relationship in which the rate of change of consumer prices is negatively related to both the unemployment rate and the growth rate of labour productivity. This derivation requires the additional assumption that the rate of price change is constant through time, so that one is dealing with a steady state relationship. The derived trade-off relationship for the Japanese economy indicates a very large value for the expected rate of change of the consumer price level (between 5 and 11 per cent per annum) in the range of Watanabe's unemployment rate where most of his observations lie (i.e. between 2 and 4 per cent) even with an assumed productivity growth rate of 7.0 per cent per year.

[2] Klein and Bodkin, *op. cit.*

Table 3.13

Wage Adjustment Relationship for Canada, First Quarter 1960 (Klein & Bodkin)

Unemployment Rate (Per Cent of Labour Force)	Annual Percentage Change in Wages with an Annual Percentage Increase in Prices of:		
	0	1	3
2.5	6.9	7.7	9.1
3.0	6.2	6.9	8.4
4.0	4.8	5.5	6.9
5.0	3.3	4.0	5.5
6.0	1.9	2.6	4.0
7.0	0.5	1.2	2.6
8.0	-1.0	-3.0	1.2

changes in price level. Although the escalation does not result in complete adjustment, an additional annual increase in the price level (over the current and preceding three quarters) of one percentage point is associated with an additional annual increase in wages of 0.7 of a percentage point, with the other determinants remaining unchanged. A 3 per cent rate of unemployment, which might be expected to induce a 6.2 per cent annual rise in wages in the absence of changes in the price level, implies an 8.4 per cent predicted annual increase in wages when prices rise by 3 per cent per year.

Using a nonlinear relationship, S. F. Kaliski estimated a wage adjustment relationship for Canada.[1] His estimates are presented in Figure 3.16 and in Table 3.14 below.

Table 3.14

Wage Adjustment Relationship for Canada, 1946-58 (Kaliski)

Unemployment Rate (Per Cent of Labour Force)	Annual Percentage Change in Wages Associated with an Annual Percentage Increase in Prices of:		
	0	1	3
2.5	5.85	6.12	6.66
3.0	5.11	5.38	5.92
4.0	4.18	4.45	4.99
5.0	3.62	3.89	4.43
6.0	3.24	3.51	4.05
7.0	2.98	3.25	3.79
8.0	2.78	3.05	3.59

[1] S.F. Kaliski, "The Relation Between Unemployment and the Rate of Change of Money Wages in Canada," *International Economic Review*, January 1964, pp. 1-33. Equation 134 of Kaliski's Table IV was selected. Kaliski used as his wage variable in this equation average *weekly* wage and salary earnings for an industrial composite. It should be pointed out that Kaliski's unemployment variable is based on the old definition of unemployment—hence the temporarily laid-off are counted as *employed*.

It is apparent that Kaliski's computations suggest that a 2.5 per cent annual increase in wages is not consistent with a rate of unemployment in the range of post-war experience, even in the absence of cost of living increases. The relationship indicates very little sensitivity of wage increases to the rate of unemployment in the range of 5 to 8 per cent. However, at lower rates of unemployment, because of the nonlinear form of the relationship, rapid wage increases are predicted even in the absence of price level increases. A 3 per cent level of unemployment is associated with an annual increase in wage earnings of 5.1 per cent, while a 2.5 per cent rate of unemployment would be associated with a 5.8 per cent annual increase in wages. It may be observed that there is no rate of unemployment which might be expected to induce negative wage changes, according to this relationship.

Kaliski's estimate of the effect of the rate of change in prices on the rate of change in wages is also indicated in Figure 3.16 and Table 3.14. If prices are assumed to increase by 3 per cent per year, then a 3 per cent rate of unemployment is associated with a 5.9 per cent increase in wages annually.

Another of the present authors has also made some estimates of the wage adjustment relationship for Canada.[1] Using quarterly data for the period 1949–61, G.L. Reuber related percentage changes in wage earnings to the unemployment rate and percentage changes in the Consumer Price Index. Like Kaliski, Reuber assumed a nonlinear form of the wage adjustment equation. Figure 3.17 and Table 3.15 below

Table 3.15
Wage Adjustment Relationship for Canada, 1949-61 (Reuber)

Unemployment Rate (Per Cent of Labour Force)	Annual Percentage Change in Wages Associated with an Annual Percentage Increase in the Consumer Price Index of:		
	0	1	3
2.5	6.2	6.8	8.1
3.0	5.0	5.6	6.9
4.0	3.5	4.2	5.4
5.0	2.6	3.2	4.5
6.0	2.0	2.6	3.9
7.0	1.6	2.2	3.5
8.0	1.3	1.9	3.2

present the estimated relationship. The relationship is steeper than that estimated by Kaliski, which indicates a greater degree of sensitivity of wage changes to the rate of unemployment. According to Reuber's estimates, a 3 per cent rate of unemployment with a constant consumer price level implies a 5 per cent annual increase in wage earnings, a value quite close to Kaliski's estimate. Both wage adjustment relationships indicate that full employment is incompatible with a 2.5 per cent annual increase in wages. On the other hand, Reuber's estimates suggest that a 2.5 per cent annual increase in wage earnings is consistent with a rate of unemployment slightly greater than 5 per cent, in contrast to the estimate beyond the range of the data (10 per cent) implied by Kaliski's relationship.

[1] G.L. Reuber, "The Objectives of Canadian Monetary Policy, 1949-61," *op. cit.*

Changes in the consumer price level also had an important effect on the rate of wage changes predicted by Reuber's relationship. Figure 3.17 shows the relationship when an increase in the price level of 3 per cent per year is assumed. A 3 per cent level of unemployment then predicts a 6.9 per cent increase in wage earnings annually, compared to a 5.0 per cent increase when prices remain unchanged.

Instead of employing a simple mark-up equation to derive the trade-off relationship between the rate of change in prices and the level of unemployment, Reuber chose to make changes in consumer prices a linear function of changes in wages and changes in import prices. As argued in Chapter 2 above, in an open economy like the Canadian, imported materials may be an important cost of production, and so the Reuber price level equation seems preferable to a simple mark-up equation which ignores foreign price levels. Reuber was unable to uncover any significant impact of changes in labour productivity on changes in the consumer price level. However, it is interesting to observe that the numerical value of the constant of the (transformed) price level equation is negative and implies that, with money wages and import prices unchanged, domestic consumer prices would have declined on average by roughly 1.5 per cent per annum over the sample period (1949–61). This would appear to be the right order of magnitude for one to interpret this constant term as reflecting the price-damping effects of the long-term upward trend in labour productivity.

The combined relationship for price changes and unemployment, as estimated by Reuber, is presented in Figure 3.18 and Table 3.16 below. It is readily apparent that not only the percentage rate of change in wages, but also the percentage rate of change in the price level, is sensitive to variations in the rate of unemployment. For example, a reduction in the unemployment rate from 6 per cent to 3 per cent would imply a variation in the predicted annual rate of price level changes from a reduction in prices of 0.6 per cent per year to an increase in prices of 1.7 per cent per year, under the assumption of a zero rate of change of import prices. A stable price level would be consistent with rate of unemployment slightly less than 5 per cent if foreign prices remained unchanged.

Table 3.16

Trade-Off Relationship for Canada, 1949-61 (Reuber)

Unemployment Rate (Per Cent of Labour Force)	Annual Percentage Change in the Consumer Price Index Associated with an Annual Percentage Increase in Import Prices of:		
	0	1	3
2.5	2.6	3.2	4.5
3.0............................	1.7	2.3	3.6
4.0............................	0.5	1.2	2.4
5.0............................	-0.2	0.4	1.7
6.0............................	-0.6	0.0	1.2
7.0............................	-1.0	-0.3	0.9
8.0............................	-1.2	-0.6	0.7

The rate of foreign inflation, as one might expect, appears to have a substantial effect upon the position of the trade-off relationship. Figure 3.18 shows that the estimated trade-off curve shifts upward when the rate of change of import prices (denoted in the graph by $\dot{F}$) is assumed to be 3 per cent per year. Under this assumption, a 3 per cent rate of unemployment is associated with a predicted annual increase in the consumer price level of 3.6 per cent. Moreover, with a 3 per cent increase in import prices annually, the rate of unemployment would have to exceed the observed range by a wide margin in order to be consistent with complete stability of the consumer price level.

John Vanderkamp has also studied wage adjustment and trade-off relationships for Canada, employing post-war quarterly data for the period 1946 through 1962.[1] His model differs from that of Reuber in that the labour force and hence the wage adjustment mechanism is divided into two sectors. In the organized sector, which includes mining, manufacturing, construction, and public utility industries, an average of more than 40 per cent of the employees are union members. The unorganized sector therefore comprises agriculture, forestry, trade, finance, and services, industries in which only 8 per cent (roughly and on the average) of the workers are unionized.

For the organized sector, wages were expressed as a linear function of the reciprocal of the sectoral unemployment rate, the rate of change in consumer prices, and the rate of change in sectoral productivity expressed as real output per man. The resulting relationship between the rate of wage changes and unemployment was therefore nonlinear. Moreover, the coefficients of all the variables were positive and statistically significant. An increase in the rate of growth of productivity of one percentage point was associated with an additional increase in the rate of change of wages of 0.47 of a percentage point. As a theoretical explanation for this phenomenon, Vanderkamp has argued against the view that high productivity gains lead workers to press for above-normal wage increases, a view held by some writers on this subject. Moreover, he argues that the productivity change variable is dominated by cyclical movements unlikely to be related to a "true" long-term improvement factor; instead, he asserts that productivity changes are a proxy for some portion of the excess demand for labour which is not reflected in the rate of unemployment. For instance, as demand declines, a firm may choose not to lay off labour immediately. Hence, the ratio of employment to output will rise or, in other words, productivity will fall. An increase in the rate of growth of productivity would therefore be associated with an increase in the excess demand for labour and hence might be expected to induce comparatively large increases in wages. Vanderkamp also tried corporate profits as a percentage of Gross National Product as an explanatory variable in the organized sector's wage adjustment relationship but found that the influence of this variable was statistically insignificant.

Table 3.17 and Figure 3.19 present Vanderkamp's estimated wage adjustment relationship for the organized sector with the unemployment rate adjusted to the

[1] John Vanderkamp, "Wage and Price Level Determination: An Empirical Model for Canada," *Economica*, N.S., Vol. XXXIII, No. 130 (May 1966), pp. 194-218.

national average. The adjustment was made by assuming a stable ratio between the sectoral and the national rates of unemployment; during the period of study, the unemployment rate in the organized sector averaged 1.64 times as great as the rate for the over-all economy. Productivity in the organized sector was assumed to grow at the rate of 2.5 per cent per year.

Table 3.17

Wage Adjustment Relationship for Canada, Organized Sector, 1946-62 (Vanderkamp)

Unemployment Rate (Per Cent of Labour Force)	Annual Percentage Change in Wages Associated with an Annual Percentage Increase in the Consumer Price Index of:		
	0	1	3
2.5	5.1	5.8	7.1
3.0	3.9	4.6	5.9
4.0	2.5	3.2	4.5
5.0	1.6	2.3	3.6
6.0	1.1	1.7	3.1
7.0	0.7	1.3	2.7
8.0	0.4	1.1	2.4

According to these estimates, a national rate of unemployment of 3 per cent (hence an unemployment rate of 4.9 per cent in the organized sector of the labour market) would be associated with a 3.9 per cent annual rise in wages in the organized sector with a zero rate of change of consumer prices, and with a 5.8 per cent increase in wages in that sector if consumer prices increased by 3 per cent annually. Moreover, wage changes in the organized sector appear to be fairly sensitive to variations in the level of unemployment: a 6 per cent unemployment rate, together with a zero rate of change of consumer prices, might be expected to induce an annual rate of change of wages in the organized sector equal to only 1.1 per cent per annum.

Table 3.18 and Figure 3.20 present the wage adjustment relationship for the unorganized sector, again with the unemployment rate adjusted to the national average.[1] In this sector, wages were expressed as a linear function of the reciprocal of the unemployment rate, the absolute change in the reciprocal of the unemployment rate, and the rate of change in the Consumer Price Index.

These estimates suggest that a 3 per cent national rate of unemployment (and hence a rate of unemployment in the unorganized sector equal to 2.2 per cent) would be associated with a 6.4 per cent annual increase in wages in that sector with a zero rate of price change and with a 7.5 per cent rise in wages if consumer prices rose 3 per cent annually.

---

[1]This was done by dividing the unemployment rate in the unorganized sector by 0.73, the sample period average of the ratio of the sectoral rate of unemployment to the national average.

Table 3.18

Wage Adjustment Relationship for Canada, Unorganized Sector, 1946-62 (Vanderkamp)

Unemployment Rate (Per Cent of Labour Force)	Annual Percentage Change in Wages Associated with an Annual Percentage Increase in the Consumer Price Index of:		
	0	1	3
2.5	7.2	7.6	8.3
3.0	6.4	6.8	7.5
4.0	5.5	5.9	6.6
5.0	5.0	5.3	6.1
6.0	4.6	5.0	5.7
7.0	4.4	4.7	5.4
8.0	4.2	4.6	5.3

A comparison of the wage adjustment relationships for the two sectors produces some interesting results. It appears that wage increases are less sensitive to price changes in the unorganized sector, a result which seems in line with the expected influence of unions in having wage increases more closely related to increases in the cost of living. More interesting is the fact that the unemployment coefficient in the unorganized sector was appreciably smaller than the corresponding coefficient for the organized sector, even after the sectoral rates have been adjusted to the national average rate of unemployment.[1] Wage changes appear to be less sensitive to variations in unemployment for the unorganized sector! Vanderkamp himself notes that "whatever the reason for this may be, it cannot easily be used to support the view which is sometimes voiced that unions tend to frustrate the operation of the competitive market mechanism."[2] Moreover, it appears that wage changes in the unorganized sector are generally larger, in the customary range of the national unemployment rate, than organized sector wage changes. (Compare Tables 3.17 and 3.18 or Figures 3.19 and 3.20.) Although factors other than the degree of unionization may be important in explaining this result, the evidence again does not point to a large amount of autonomous trade union pushfulness in Canada.

Like Reuber, Vanderkamp chose not to use a simple mark-up equation to explain price level formation and thus to determine a trade-off relationship for Canada. Instead, his estimated price change relationship allows one to express (after the elimination of the lagged dependent variable through the assumption that consumer prices change at a constant rate over time) the rate of change of the Consumer Price Index as a linear function of the rate of change of wages in the organized sector, the rate of change of unorganized sector wages, and the rate of change in import prices. If, in addition, one assumes that organized sector productivity rises at the rate of 2.5 per cent annually and that there is no change in the rate of unemployment over time, one can then derive a trade-off relationship

[1] This conclusion is somewhat qualified by the fact that there appears to be a relatively large transient effect of changes in the reciprocal of the unemployment rate on unorganized sector wage increases.

[2] Vanderkamp, *op. cit.*, p. 203.

for Canada.[1] This relationship is presented in Table 3.19 below and in Figure 3.21.

Table 3.19

Trade-Off Relationship for Canada, 1946-62
(Vanderkamp)

Unemployment Rate (Per Cent of Labour Force)	Annual Percentage Change in the Consumer Price Index Associated with an Annual Percentage Increase in Import Prices of:		
	0	1	3
2.5	2.4	2.9	3.9
3.0	1.9	2.4	3.3
4.0	1.2	1.7	2.6
5.0	0.8	1.2	2.2
6.0	0.5	1.0	1.9
7.0	0.3	0.8	1.7
8.0	0.1	0.6	1.6

These estimates suggest that, in the absence of any change in import prices, complete price stability (a zero rate of change of the domestic Consumer Price Index) can be expected to occur only at an unemployment rate of 8.5 per cent. On the other hand, if a 3 per cent rate of unemployment were to be maintained, the expected rate of change of consumer prices is 1.9 per cent per year, again under the assumption of no change in the level of import prices. A further (permanent) reduction in the rate of unemployment, say to 2.5 per cent, might be expected to induce an appreciable increase in the rate of inflation (to a rate of 3.9 per cent per annum with a zero rate of change in import prices). The expected rate of change of the domestic price level is quite insensitive to the rate of unemployment for higher values of this variable, but the sensitivity increases markedly at lower levels of the unemployment rate. The Vanderkamp trade-off curve lies above that estimated by Reuber for high rates of unemployment, but the Reuber curve rises more rapidly as the rate of unemployment is reduced. In consequence, the predicted rate of inflation is greater for the Reuber trade-off curve, at very low values of the unemployment rate.

It is also apparent that, according to the Vanderkamp trade-off relationship, the predicted rate of increase of the domestic price level is also responsive to the rate of change of international prices. An increase in the annual rate of change of import prices of one additional percentage point may be expected to induce an

[1] The mathematical derivation is presented in the Appendix. It is interesting to note the paradoxical result that the predicted rate of change of consumer prices, according to the derived trade-off relationship, varies directly, not inversely, with the rate of growth of labour productivity in the organized sector. (This sort of possibility was discussed in Chapter 2 above; it presumably arises because the price-damping effects of a fast rate of (long-term) productivity growth are not captured in the estimated price level formation equation. Vanderkamp also notices this effect, attempts to explain it away by his view of the productivity change variable as a proxy for additional excess demand for labour, and points out that, in any case, the quantitative effect is small.

additional increase of 0.49 of a percentage point in the annual rate of change of the Canadian Consumer Price Index. Thus, if import prices were to increase by 3 per cent annually, a 3 per cent rate of unemployment might be expected to induce a 3.3 per cent per year rate of domestic inflation, while a 6 per cent rate of unemployment would be associated with a 1.9 per cent annual increase in consumer prices. It is interesting to observe that Vanderkamp's results suggest that the rate of change of the domestic price level is slightly less sensitive to changes in import prices than do Reuber's estimates. However, both sets of results agree that, should foreign prices increase by 3 per cent annually, there is no rate of unemployment within the observed range which might be expected to be associated with complete stability (a zero rate of change) in the domestic price level.

6. International Comparisons

In concluding this survey of the existing literature, one can compare systematically the wage adjustment relationships for the various countries that have been studied. Most of these comparisons are rather tentative: the variation in periods of study, techniques of estimation (in the broadest sense), and underlying data preclude a high degree of precision. The result of such differences is apparent in our tables presenting the international comparisons: often differences in the estimates for a single country are as great as the discrepancies across countries. Nevertheless, it seems worth-while to form some tentative picture of the differences in the wage adjustment relationships for the various countries for which we have estimates. In Chapter 8 below, we return to the question of international comparisons, employing the approach applied to the Canadian economy in Part II below.

Visual comparisons of the various wage adjustment relationships examined in this Chapter can be made, on a rough and ready basis, from Figures 3.2 through 3.20 (excluding Figure 3.18). Tables 3.20 and 3.21 present, as a single body of information, some salient features of these wage adjustment equations. Columns (3) and (4) present some estimates of critical unemployment rates, while columns (5) through (8) give the estimated rates of wage change under selected assumptions regarding the level of unemployment and the rate of change of the price level. Table 3.20 utilizes each country's own definition and measurement of unemployment; Table 3.21 presents estimates of the same conceptual magnitudes as those of Table 3.20, with unemployment rates standardized (as nearly as possible) to a North American basis. The adjustment factors employed are those based on Myers' estimates and given in Table 3.1 above, except for Japan where the adjustment factor is the one suggested by Klein and Shinkai. Most of the discussion will focus on Table 3.21, as this adjustment procedure is believed to be better than no adjustment at all.[1]

The level of unemployment required to hold the rate of rise of wages to 2 ½ per cent per annum appears to vary considerably from country to country. This critical unemployment rate, which can be interpreted as the unemployment rate

[1] No adjustment factor is available for Belgium, which is therefore not included in Table 3.21.

Figure 3.15

WAGE ADJUSTMENT RELATIONSHIP FOR CANADA (First Quarter 1960, from 1952-59 Data): KLEIN & BODKIN

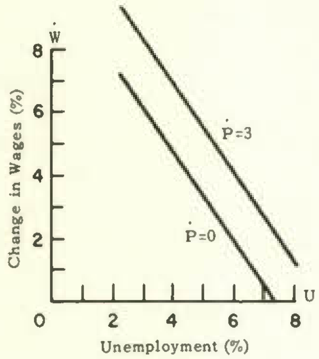


Figure 3.16

WAGE ADJUSTMENT RELATIONSHIP FOR CANADA (1946-58): KALISKI

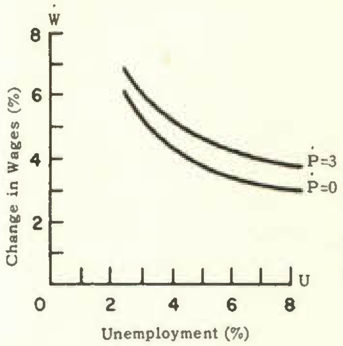


Figure 3.17

WAGE ADJUSTMENT RELATIONSHIP FOR CANADA (1949-61): REUBER

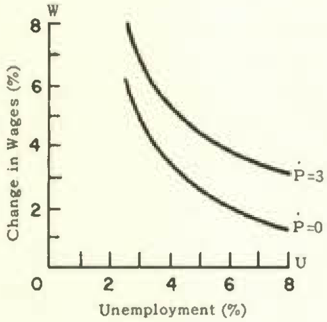


Figure 3.18

TRADE-OFF CURVE FOR CANADA (1949-61): REUBER

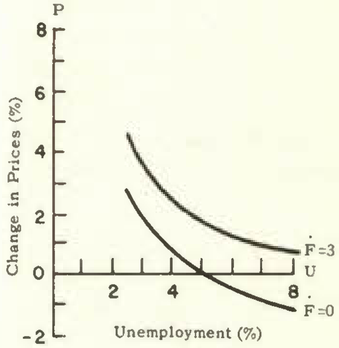


Figure 3.19

WAGE ADJUSTMENT RELATIONSHIP FOR CANADA, ORGANIZED SECTOR (1946-62): VANDERKAMP

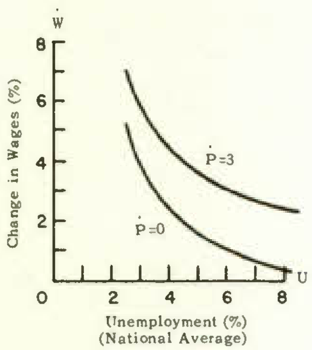


Figure 3.20

WAGE ADJUSTMENT RELATIONSHIP FOR CANADA, UNORGANIZED SECTOR (1946-62): VANDERKAMP

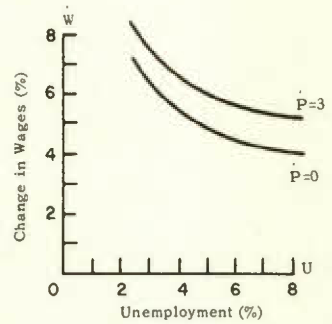


Figure 3.21

TRADE-OFF CURVE FOR CANADA (1946-62): VANDERKAMP

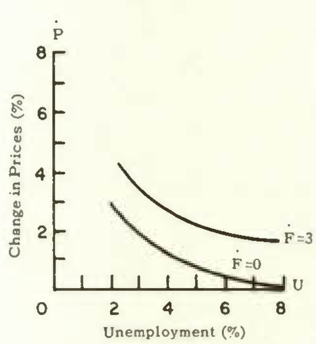


Table 3.20

A Comparison of Wage Adjustment Relationships
(Unadjusted Unemployment Rates)

Country	Source of Estimate	Annual Rate of Unemployment Associated with a Percentage Change in Wages: Equal to Country's Own Productivity Growth Rate	Equal to 2½ Per Cent per Year	Annual Rate of Change in Wages: Associated with No Change in Prices and an Unemployment Rate of: 3%	6%	Associated with a 3 Per Cent per Year Change in Prices and an Unemployment Rate of: 3%	6%
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Britain	Phillips (1861-1913)	2.3	2.1	1.2	-0.1	–	–
Britain	Lipsey (1923-39, 1948-57)	1.8	1.7	1.0	0.8	3.1	2.9
Britain	Klein & Ball (4th quarter, 1956)	2.1	2.0	-1.0	-11.0*	1.3	-8.7*
Britain	Dicks-Mireaux & Dow (1950-56)	–	2.0	–	–	–	–
United States	Samuelson & Solow (Post-War)	–	5.5	–	–	–	–
United States	Bhatia (1948-58)	7.5	8.0	4.4	3.2	6.3	5.2
United States	Bowen & Berry (1948-58)	7.8	8.2	5.4	3.7	–	–
United States	Klein & Bodkin (1948-57)	5.4	5.6	4.4	2.3	5.5	3.4
United States	Perry (1947-60)	6.0	6.6	5.2	2.7	6.3	3.8
West Germany	Klein & Bodkin (1st quarter, 1960)	2.0	3.2	3.2	-6.2*	4.7	-4.6*
France	Klein & Bodkin (1st quarter, 1960)	1.2	1.7	–	–	–	–
Belgium	Klein & Bodkin (1st quarter, 1960)	–	4.7	6.6	-0.5	8.8	1.6
Japan	Klein & Shinkai (1930-59)	1.0	1.4	–	–	–	–
Canada......	Klein & Bodkin (1st quarter, 1960)	5.2	5.6	6.2	1.9	8.4	4.0

Continued...

Table 3.20 (Cont'd)

Canada......	Kaliski (1946-58)	6.5	10.0	5.1	3.2	5.9	4.1
Canada......	Reuber (1949-61)	4.4	5.2	5.0	2.0	6.9	3.9

* There is reason to suspect that the wage adjustment relationship is not linear at rates of unemployment over 4 or 5 per cent. Thus the large rate of wage decline indicated by the estimated relationship at higher levels of unemployment would not be relevant.

"required" for complete price stability if one assumes stable shares and a productivity growth rate of also 2 ½ per cent per annum, is shown in column (4) of Tables 3.20 and 3.21. According to these estimates, only Germany, France, and Britain can expect to have moderate rates of wage increases (and hence price stability) at equivalent North American unemployment rates of 4 per cent or less. Japan and Canada appear to require an unemployment rate in the range of 5 or 6 per cent (excepting Kaliski's dissenting estimate). Although the estimates of this critical rate vary widely for the United States, the median estimate is Perry's 6.6 per cent, which is the highest for all the countries surveyed.

Column (3) presents estimates of the critical rate of unemployment required to hold wage increases to the productivity growth rate actually experienced by the nation in question during some recent post-war period.[1] In general, this set of comparisons alters the picture very little. Germany, France, and Britain can still experience price stability with less than 4 per cent unemployment (under North American definitions), although the critical unemployment rate for France now falls below that of Britain, due to faster productivity growth in the former country. Due to extremely rapid productivity growth in Japan, the critical unemployment rate moves very close to the 4 per cent rate, suggesting that this factor may have been a mitigating influence in the conflict between the objectives of high employment and stable prices, for the Japanese economy. The median critical rates for Canada and the United States fall slightly with the assumption of a marginally faster growth of labour productivity, but the rates of unemployment required for price stability under the above assumptions still appear to exceed 5 per cent. The distinct impression of a conflict of objectives, for the two North American economies, remains.

Turning to the question of the responsiveness of wage changes to variations in the rate of unemployment, one can make these comparisons on the basis of columns (5) and (6) [or, alternatively, (7) and (8)] of Table 3.21. A hypothetical reduction of the unemployment rate from 6 to 3 per cent results in a very large increase in the rate of change of wages in West Germany and Japan, with a lesser but still very pronounced response in France. (Based on the unadjusted data, the response in Belgium seems to be of the same order of magnitude as that in France.)

[1] The assumed productivity growth rates were 2.1 per cent per year for Britain, 2.7 per cent per year for the United States, 3.1 per cent per year for Canada, 5.4 per cent per year for France, 6.2 per cent per year for West Germany, and 8.3 per cent per year for Japan. These figures represent geometric averages of the growth of output per man-hour in manufacturing over the period 1950-61 (except for Japan, where the period is 1954-61). The data were taken from G.L. Reuber's Working Paper for the Porter Commission *(The Objective of Monetary Policy* [Ottawa: Queen's Printer, 1962], p. 76).

Table 3.21

A Comparison of Wage Adjustment Relationships
(Unemployment Adjusted to a Common Definition)

Country	Source of Estimate	Annual Rate of Unemployment Associated with a Percentage Change in Wages: Equal to Country's Own Productivity Growth Rate	Annual Rate of Unemployment Associated with a Percentage Change in Wages: Equal to 2½ Per Cent per Year	Annual Rate of Change in Wages Associated with No Change in Prices and Unemployment Rate of: 3%	Annual Rate of Change in Wages Associated with No Change in Prices and Unemployment Rate of: 6%	Annual Rate of Change in Wages Associated with a 3 Per Cent per Year Change in Prices and an Unemployment Rate of: 3%	Annual Rate of Change in Wages Associated with a 3 Per Cent per Year Change in Prices and an Unemployment Rate of: 6%
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Britain......	Philips (1861-1913)	3.5	3.2	2.8	0.5	—	—*
Britain	Lipsey (1923-39, 1948-57)	2.7	2.6	1.7	0.9	3.7	3.0
Britain	Klein & Ball (4th quarter, 1956)	3.2	3.0	2.4	-4.2	4.7	-1.9
Britain	Dicks-Mineraux & Dow (1950-56)	—	3.0	—	—	—	—
United States	Samuelson & Solow (Post-War)	—	5.5	—	—	—	—
United States	Bhatia (1948-58)	7.5	8.0	4.4	3.2	6.3	5.2
United States	Bowen & Berry (1948-57)	7.8	8.2	5.4	3.7	—	—
United States	Klein & Bodkin (1948-57)	5.4	5.6	4.4	2.3	5.5	3.4
United States	Perry (1947-60)	6.0	6.6	5.2	2.7	6.3	3.8
West Germany	Klein & Bodkin (1st quarter, 1960)	1.5	2.4	-0.3	-13.1*	1.2	-11.6*
France	Klein & Bodkin (1st quarter, 1960)	2.3	3.2	3.1	-5.8*	3.5	-5.4*
Japan	Klein & Shinkai (1930-59)	4.2	5.5	13.3	0.5	15.5	2.8
Canada	Klein & Bodkin (1st quarter, 1960)	5.2	5.6	6.2	1.9	8.4	4.0
Canada	Kaliski (1946-58)	6.5	10.0	5.1	3.2	5.9	4.1
Canada	Reuber (1949-61)	4.4	5.2	5.0	2.0	6.9	3.9

*There is reason to suspect that the wage adjustment relationship would not continue to be linear, in this range of the unemployment rate.

The sensitivity of wage changes to variations in the unemployment rate appears to be much less in Canada and in Britain, while the median estimate for the United States (Klein-Bodkin) suggests that this sensitivity is lowest in that country.[1]

Finally, a comparison of columns (5) and (7)[or (6) and (8)] in Table 3.21 suggests that the rate of change in wages is least responsive to variations in the rate of change of consumer prices in France, somewhat more responsive in the United States and West Germany, and still more responsive in Britain and in Canada (again largely discounting Kaliski's dissenting estimate). The greatest sensitivity of wage changes to changes in workers' cost of living appears to be found in Belgium and Japan.[2]

Such comparisons inevitably prompt one to ask why the wage adjustment relationships and the price-change-unemployment trade-offs differ from one country to another. A comprehensive answer to this question would constitute a study in itself. The various factors entering the explanation can be readily identified, however, They are the same general factors which determine the shape and position of the trade-off curve within one country and which account for shifts in this relationship, as described in Chapter 2.

One major difference is the "openness" of the different economies to international influences and the structure of each country's international economic relationships. Foreign trade plays a much smaller role for the U.S. economy than for any of the other countries under consideration. At the same time, it is evident that the Canadian economy is very closely tied through both trade and factor movements to developments in the United States, while the continental European economies are more closely tied to each other. Consequently, it is hardly surprising that the wage-change-unemployment relationship and the inflation-unemployment relationship for the United States should differ from those of the other countries considered; that the estimated relationships for Canada should bear some resemblance to those for the United States; that the estimated relationships for continental European countries should resemble each other; and that those for Britain and Japan should have certain peculiarities of their own.

Secondly, it is evident that the countries in question differ considerably as far as the efficiency and the structure of their domestic markets are concerned. One obvious point of difference is the power of the trade unions, which varies considerably: they are probably strongest in Britain and weakest in West Germany and Japan. Moreover, business competition in domestic markets may also vary considerably

---

[1] Our work in Chapter 8 suggests that the great responsiveness of wage changes to variations in the rate of unemployment for France and Germany is mainly confined to very low values of the unemployment rate. In turn, this suggests that international comparisons which are based on an assumed linear influence of the unemployment rate may be somewhat misleading if a large proportion of the observations underlying the estimated wage adjustment relationship are drawn from conditions of very low unemployment rates. This point would appear to apply to Japan as well.

[2] One should recall that point (discussed in footnote 1 on page 56) that the French results may reflect imperfect data as much as (or even more than) a true characteristic of the French economy. Also, the Klein-Bodkin and the Watanabe estimates of the Japanese price change coefficient suggest that the responsiveness of Japanese wage changes to variations in Japanese price changes is much lower and approximately of the same order of magnitude as in the United States.

among these countries. In addition, the differences in the geographic size of the countries under review, the interregional mobility of labour within each country, the compactness of the domestic market, and possibly the seasonality patterns of unemployment in the various countries may have an influence on the relationship between wage changes and unemployment and hence on the relationship between price level changes and unemployment.

Thirdly, the average or normal rate of productivity growth differs considerably from country to country for various reasons which cannot be considered here. This has a direct effect on the inflation-unemployment trade-off relationship, as we have seen. The normal rate of productivity growth will determine the rate of increase in money factor prices that can be absorbed without raising final prices. However, there may be an offsetting effect of a high rate of productivity growth on the wage adjustment relationship; this possibility was discussed in Chapter 2 above. For this reason, the unemployment rates in column (3) of Table 3.21 are better estimates of the critical rate of unemployment "required" for price level stability than the column (4) values. It is interesting to note that the three countries with high productivity growth rates (France, Germany, and Japan) experienced relatively little conflict between the goals of high employment and price stability. On the other hand, the United States and Canada, which are both countries with relatively low productivity growth rates, would seem to have experienced considerable conflict among these objectives.[1]

Finally, the differences in the wage-change-unemployment relationship and the inflation-unemployment trade-off relationship may reflect differences in the policies adopted in the countries in question, differences in the effectiveness of these policies, and differences in popular expectations and in attitudes based on past experience. For example, the continental countries generally seem to fear mild inflation less than the two North American countries; their monetary and fiscal policies have differed considerably as have their international economic policies.[2] Another example is provided by differences in wage bargaining tactics adopted by the British trade unions under the post-war Labour government and under later Conservative governments. In addition, a further set of differences which may be important relates to immigration policies and foreign investment policies. The fact that the West Germany economy seems subject to such mild inflationary pressures at or even beyond North American standards of full employment may be attributable in part to policies encouraging the temporary immigration of Spanish,

---

[1] In the case of Britain (the third country with a low productivity growth rate), the apparent absence of a conflict between the goals of high employment and price level stability may merely reflect the difficulties encountered in transforming British unemployment rates into comparable North American values, particularly with regard to a target rate for economic policy. It is interesting to observe that A.W. Phillips (in "The Relation Between Unemployment and the Rate of Change in Money Wage Rates in the United Kingdom, 1861-1957," *op. cit.)* considered a 2 per cent, rather than a 2½ per cent, per year rate of increase in money wages to be non-inflationary. This point of view was followed in the summary discussion of the results of Phillips' study, in Section 2 above.

[2] The presence or absence of an incomes policy is an obvious instrument which might well have an influence on the wage adjustment and trade-off relationships. This possibility is examined in some detail in Chapter 8 below.

Italian, and Greek workers in occupations experiencing a labour shortage, as well as to the heavy inflow of migrants from East Germany.

In short, there are many reasons why one should expect the wage-change-unemployment and the price-change-unemployment relationships to differ from country to country. Indeed, one would be very surprised to find the opposite result. At the same time, if one takes the underlying features of an economy as given, it is interesting to compare the relationship between unemployment and changes in the price level (or between wage changes and unemployment) for various countries. Such a comparison might suggest how these relationships could be altered. More importantly, perhaps, such differences among countries have an important bearing on international economic relationships and on the entire issue of policy harmonization among nations.[1]

[1] A suggestive discussion of the problems arising in this context is presented in an as yet unpublished paper by Harry G. Johnson, "Some Aspects of the Theory of Economic Policy in a World of Capital Mobility" (mimeographed, 1965).

APPENDIX

Mathematical Presentation of the Estimated Relationships

In this Appendix, a mathematical restatement of estimated relationships (generally wage adjustment relationships), which have been presented in the text verbally, graphically, and with tables, is given. The sources of these relationships are not repeated, as this information may be found in the footnotes of the text. In some cases, both the author's original equation and a transformed version of it are presented; in all cases, the transformed variant was computed to facilitate comparisons with the relationships estimated by other investigators. The symbols employed in this Appendix have slightly different meanings from study to study, depending upon the statistical series selected by the particular investigators; however, there is a broad continuity in the choice of symbols. Thus, w always represents the money wage (per unit of labour), U the rate of unemployment, and P a price level for the domestic sector of the economy in question. The dot symbol over a variable (as in $\dot{w}$) always denotes a relative or percentage rate of change, while the symbol Δ represents an absolute change in the variable under consideration from an earlier period to the current period.

1. A.W. Phillips, "The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861–1957"

Some symbols may be introduced. Let w_t represent the index of hourly wage rates at year t (constructed by Phelps-Brown and Hopkins)[1] and let U_t be unemployment as a percentage of the labour force during year t. Then $\dot{w}_t$ is the percentage rate of change of money wage rates at time t, measured as a first central difference. This variable is defined by the formula:

$$(3.1) \qquad \dot{w}_t = \frac{w_{t+1} - w_{t-1}}{2\, w_t} \cdot 100 \ .$$

Phillips fitted a function of the form:

$$(3.2) \qquad \dot{w}_t + a = b\, U_t^{c} \ .$$

The constants b and c were estimated by the method of least squares; Phillips used the subgroup mean values of the $\dot{w}_t$ and U_t variables for unemployment rates in the range between 0 and 5 per cent. The constant a was chosen by trial and error to make the estimated relationship pass as closely as possible to the remaining subgroup mean values of the $\dot{w}_t$ variable, which lay in the range of the unemployment rate between 5 and 11 per cent.

[1] This index of hourly wage rates refers to selected occupations in a number of major industries and so it may be considered to be an economy-wide wage level.

For the period 1861–1913, Phillips obtained the following relationship:

(3.3) $$\dot{w}_t + 0.900 = 9.638\, U_t^{-1.394} \quad .$$

Alternatively, this equation may be written:

(3.4) $$\log (\dot{w}_t + 0.900) = 0.984 - 1.394 \log U_t \quad \cdot$$

where the symbol "log" denotes the logarithm to the base 10 of the succeeding variable.

2. Richard G. Lipsey. "The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1862–1957: A Further Analysis"

As with Phillips' study, the exposition may start with a definition of symbols. Let w_t denote the money wage rate, U_t unemployment as a percentage of the labour force, and P_t the retail price index for Britain. (The subscript t represents a time-dating of the variable in question.) Lipsey employed basically the same data as Phillips; consequently, the wage concept refers to the economy as a whole. As before, the "dot" symbol represents a percentage rate of change, expressed as a first central difference; for example,

(3.5) $$\dot{U}_t = \frac{\dot{U}_{t+1} - U_{t-1}}{2\, U_t} \cdot 100 \quad .$$

For the period 1923–39 combined with 1948–57, Lipsey obtained the result:

(3.6) $$\dot{w}_t = 0.74 + \underset{(2.10)}{0.43}\, U_t^{-1} + \underset{(6.00)}{11.18}\, U_t^{-4} + \underset{(0.012)}{0.038}\, \dot{U}_t + \underset{(0.08)}{0.69}\, \dot{P}_t$$

This equation was estimated by the use of least squares regression. The numbers in parentheses under the regression coefficients are the associated standard errors. The coefficient of multiple determination (R^2) was 0.91; corrected for degrees of freedom, this statistic became 0.89. The squared partial correlation coefficients for the explanatory variables, U_t, $\dot{U}_t$, and $\dot{P}_t$, were 0.38, 0.30, and 0.76, respectively. In addition, there was no evidence that the computed residuals of this relationship were significantly autocorrelated, at the 5 per cent level of probability, for lags of one, two, or three periods.

3. L.R. Klein and R.J. Ball, "Some Econometrics of the Determination of Absolute Prices and Wages" [based on British data]

Let w_t be a quarterly average of weekly wage rates for the economy as a whole, expressed as an index number, let u_t be an index of the absolute level of unemployment, and let P_t be a quarterly index of the consumer price level. F_t is a dummy variable which is zero for all quarters before the first quarter of 1952 and is unity during that quarter and afterwards. (This variable was introduced in order to capture the wage adjustment aspects of a more aggressive attitude on the part of the trade unions, in response to the change from a Labour to a Conservative government.) Klein and Ball provided for seasonal adjustment in the regressions themselves; the Q_i variables are seasonal dummies, equal to unity in the i–th quarter and otherwise equal to zero. (There are three such dummy variables defined; that is, i = 1, 2, 3. When the fourth quarter is under consideration, all three of the Q_i dummy variables are zero; since this can only occur during the fourth quarter, this condition identifies an observation as occurring during the fourth quarter). For all the variables which are index numbers, the base period is the first quarter of 1948. As before, the time subscript t indicates the particular time period (in this case, the quarter) to which an observation on a variable belongs. The symbol Δ represents the absolute change in a variable between the current quarter and four quarters previously (i.e., the same quarter of the preceding year).

Using the technique of limited information maximum likelihood estimation, Klein and Ball estimated the following relationship:

$$(3.7)\quad \Delta w_t = w_t - w_{t-4} = \underset{(1.41)}{10.26} - \underset{(0.013)}{0.091}\left[\frac{u_t + u_{t-1} + u_{t-2} + u_{t-3}}{4}\right] + \underset{(0.092)}{0.854}\left[\frac{(P_t - P_{t-4}) + (P_{t-1} - P_{t-5}) + (P_{t-2} - P_{t-6}) + (P_{t-3} - P_{t-7})}{4}\right] + \underset{(0.40)}{2.90}F_t + \underset{(0.57)}{0.10}\,Q_{1t} + \underset{(0.57)}{0.30}\,Q_{2t} + \underset{(0.57)}{0.19}\,Q_{3t}\ .$$

The period for which this relationship was fitted was the 36 quarters between the first quarter of 1948 and the fourth quarter of 1956. The coefficient of multiple determination, adjusted for degrees of freedom, was 0.87. As before, the numbers in parentheses are the standard errors of the associated parameter estimates.

It is desirable to put this relationship in a form comparable to the other wage adjustment relationships. To do this, additional information is required. Let the symbol LF_t denote the labour force at time t. From the larger monograph describing the British econometric model,[1] the level of LF_t for the fourth quarter of 1956, in index points with the first quarter of 1948 as a base, was 107. For the fourth quarter of 1955, the (index) values of w_t and P_t were 132 and 146, respectively. Finally, the unemployment rate (u_t as a percentage of LF_t) was 2.0 in 1948. This is enough information to transform equation (3.7) so that, ignoring time lags within one year, one obtains the following relationship for the fourth quarter of 1956:

$$(3.8)\quad \left(\frac{\Delta w_t}{w_{t-4}} \cdot 100\right) = 9.014 - 3.335\left(\frac{u_t}{LF_t} \cdot 100\right) + 0.7721\left(\frac{\Delta P_t}{P_{t-4}} \cdot 100\right) .$$

[1] L.R. Klein, R.J. Ball, A. Hazlewood, and P. Vandome, *An Econometric Model of the United Kingdom* (Oxford: Basil Blackwell, 1961).

4. L.A. Dicks-Mireaux and J.C.R. Dow, "The Determinants of Wage Inflation: United Kingdom, 1946–1956"

Let $\tilde{w}_t$ be a ratio expressing the relative change in the economy-wide wage rate between corresponding quarters of successive years, and let $\tilde{P}_t$ be a similar ratio expressing the relative change in the retail price index, with an average time lag of 4 ½ months. The symbol d_t denotes a measure of the level of the excess demand for labour (which is based on both unemployment and vacancy statistics); this variable also is constructed with an average time lag of 1½ quarters. As before, the t subscript measures time, here in quarterly intervals.

Using a least squares regression with the period between the fourth quarter of 1950 and the fourth quarter of 1956 as the sample period, Dicks-Mireaux and Dow estimated the following relationship:

$$(3.9) \qquad \tilde{w}_t = 1.026\ \tilde{P}_t^{0.52}\ d_t^{3.64} \ .$$

Alternatively, this equation may be written:

$$(3.10) \qquad \log \tilde{w}_t = \underset{(0.001)}{0.011} + \underset{(0.05)}{0.52} \log \tilde{P}_t + \underset{(0.40)}{3.64} \log d_t \ .$$

where, as before, the symbol "log" denotes the logarithm to the base 10 and the numbers below the estimated regression coefficients, in parentheses, are the associated standard errors. The coefficient of multiple determination was 0.89

5. Paul A. Samuelson and Robert M. Solow, "Analytical Aspects of Anti-Inflation Policy" [U.S. data]

Samuelson and Solow present a scatter diagram between and U_t. Here $\dot{w}_t$ represents the annual percentage change in average hourly earnings in manufacturing (the wage series includes supplements), while U_t denotes the percentage of the labour force unemployed. No mathematical formulation of the implicitly estimated wage adjustment equation is given. Nevertheless, it seems apparent from their scatter diagram that the correlation between the two variables is not high.

6. Rattan J. Bhatia, "Unemployment and the Rate of Change of Money Earnings in the United States, 1900–1958"

Let U_t denote unemployment as a percentage of the labour force at time t, and let $\dot{w}_t$ represent the annual percentage change in money hourly earnings in the manufacturing sector at time t, expressed as a first central difference. The "dot" operator, which is also applied to the U_t and the P_t (Consumer Price Index of the U.S. Bureau of Labor Statistics) variables, has an identical interpretation for both variables; for example, $\dot{U}_t$ may be expressed by the following formula:

$$(3.11) \qquad \dot{U}_t = \frac{U_{t+1} - U_{t-1}}{2U_t} \cdot 100 \ .$$

Using the period 1948–58, Bhatia computed the following least squares regression:

$$(3.12) \qquad \dot{w}_t = 5.46 - \underset{(0.47)}{0.37}\ U_t - \underset{(0.03)}{0.02}\ \dot{U}_t + \underset{(0.28)}{0.64}\ \dot{P}_t$$

The numbers in parentheses below the estimated regression coefficients are the corresponding standard errors: these indicate that the coefficients of both the U_t and the $\dot{U}_t$ variables do not differ significantly from zero, at conventional levels of statistical significance. The coefficient of multiple determination, for equation (3.12), was 0.51.

7. William G. Bowen and R. Albert Berry, "Unemployment Conditions and Movements of the Money Wage Level" [based on U.S. data]

Let w_t represent the average hourly earnings of production workers in manufacturing industries during year t, and let U_t be the percentage of the civilian labour force unemployed during the same period. Bowen and Berry have assumed that all of the annual data refer to the middle of the calendar year and that consequently their wage change variable, $\dot{w}_t$, refers to the beginning of the year. This variable is defined as:

$$(3.13) \qquad \dot{w}_t = \frac{w_t - w_{t-1}}{w_{t-1}} \ .$$

The unemployment variable utilized in the regressions, $\hat{U}_t$, is also centred on the beginning of the year by averaging the current and the preceding values of this variable; thus,

$$(3.14) \qquad \hat{U}_t = \frac{U_t + U_{t-1}}{2} \ .$$

Finally, ΔU is the absolute change in the unemployment rate or $U_t - U_{t-1}$. Bowen and Berry's estimated wage adjustment relationship, for the period 1948–58, is:

$$(3.15) \qquad \dot{w}_t = 7.09 - \underset{(0.36)}{0.56}\ \hat{U}_t - \underset{(0.22)}{0.81}\ \Delta U_t\ , \qquad R^2 = 0.66$$

As before, the numbers below the computed regression coefficients in parentheses are the associated standard errors.

8. Lawrence R. Klein and Ronald G. Bodkin, "Empirical Aspects of the Trade-Offs among Three Goals" [U.S. wage adjustment relationship]

Let w_t be the annual rate of economy-wide money wage payments (per man-year, for a standardized working year) during the t-th quarter, and let u_t be the absolute level of unemployment at the time t. P_t is the implicit deflator of personal consumption expenditures, at time t , from the GNP accounts, and the variable t is a chronological listing of quarterly periods, in unit intervals, with t equal to unity in the first quarter of 1946. For the post-war period running between the first quarter of 1948 and the fourth quarter of 1957, Klein and Bodkin estimated the following relationship:

$$(3.16)\qquad w_t - w_{t-4} = 199.1 - 0.045\left[\frac{u_t + u_{t-1} + u_{t-2} + u_{t-3}}{4}\right]$$
$$+ 15.59\left[\frac{P_t - P_{t-4} + P_{t-1} - P_{t-5} + P_{t-2} - P_{t-6} + P_{t-3} - P_{t-7}}{4}\right]$$
$$+ 1.60\ t.$$

As was the case with the Klein-Ball relationship, this equation can also be transformed into a relationship with the percentage change in money wages as the dependent variable and the unemployment percentage and the percentage change in the consumer price level as the independent variables. To do this, one must specify a time date and obtain some additional information on the other variables. The first quarter of 1960 was selected; t was equal to 57 in this quarter. Let LF_t denote the labour force at time t; for the first quarter of 1960, LF_t was equal to approximately 70 million workers. Finally, for the first quarter of 1959, approximate values for w_t and P_t were, respectively, $4,500 and 108.2. Ignoring time lags within a year, one can utilize this information to transform equation (3.16) as follows:

$$(3.17)\qquad \left(\frac{w_t - w_{t-4}}{w_{t-4}} \cdot 100\right) = 6.451 - 0.700\left(\frac{u_t}{LF_t} \cdot 100\right)$$
$$+ 0.3749\left(\frac{P_t - P_{t-4}}{P_{t-4}} \cdot 100\right) .$$

9. G.L. Perry, "The Determinants of Wage Rate Changes and the Inflation-Unemployment Trade-off for the United States"

Let w_t be the straight-time average hourly earnings of production workers in the manufacturing sector during the t-th quarter, and let P_t be the Consumer Price Index of the U.S. Bureau of Labor Statistics at time t. The dependent variable $\dot{w}_t$ is expressed as a percentage change over the same calendar quarter one year earlier; thus,

$$(3.18)\qquad \dot{w}_t = \frac{w_t - w_{t-4}}{w_{t-4}} \cdot 100 \cdot$$

$\dot{P}_{t-1}$ represents the average annual percentage change in the Consumer Price Index, with a one-quarter lag. The formula for this variable is:

$$(3.19)\qquad \dot{P}_{t-1} = \frac{1}{4}\left[\frac{P_{t-1} - P_{t-2}}{P_{t-2}} \cdot 100 + \frac{P_{t-2} - P_{t-3}}{P_{t-3}} \cdot 100\right.$$
$$\left. + \frac{P_{t-3} - P_{t-4}}{P_{t-4}} \cdot 100 + \frac{P_{t-4} - P_{t-5}}{P_{t-5}} \cdot 100\right] \cdot$$

Let U_t represent an average of unemployment as a percentage of the labour force for the current and preceding three quarters, and let R_{t-1} be the level of after-tax corporate profits as a percentage of stockholders' equity, expressed as an average of the values for the immediately preceding four quarters. (Hence, as the symbols imply, a one-quarter lag is built into this variable.) Finally, ΔR_t is the first difference (presumably from quarter to quarter, although Perry is not explicit on this point) of the R_t series.

For the period between the first quarter of 1947 and the third quarter of 1960, Perry estimated the following wage adjustment relationship:

$$(3.20) \qquad \dot{w}_t = -4.313 + \underset{(0.054)}{0.367}\ \dot{P}_{t-1} + \underset{(2.188)}{14.711}\ U_t^{-1} + \underset{(0.068)}{0.424}\ R_{t-1} + \underset{(0.176)}{0.792}\ \Delta R_t\ ,$$

where, as before, the numbers in parentheses are the associated standard errors and where the coefficient of multiple determination (R^2) is 0.870. It should be observed that the rate of unemployment enters the wage adjustment equation as a reciprocal, which implies a nonlinear influence for this variable.

10. Klein and Bodkin, "Empirical Aspects of the Trade-Offs among Three Goals" [wage adjustment equations for West Germany, France, Belgium, and Canada]

Some symbols may be defined. Let w_t be the money wage payment to a unit of labour in the t-th quarter, and let P_t be the level of a Consumer Price Index at time t. U_t is unemployment during the t-th quarter as a percentage of the labour force, and the time trend variable, t, is equal to unity during the first quarter of 1952 and increases by one unit for each quarter elapsed since that date. The "dot" symbol will represent the percentage change, for the variable in question, between the current quarter and the corresponding quarter of the previous year; for example, one would have:

$$(3.21) \qquad \dot{w}_t = \frac{w_t - w_{t-4}}{w_{t-4}} \cdot 100 \cdot$$

The general format of the wage adjustment equations estimated by Klein and Bodkin, for their international cross-section, was:

$$(3.22) \qquad \dot{w}_t = a + \beta \left[\frac{U_t + U_{t-1} + U_{t-2} + U_{t-3}}{4}\right] + \gamma \left[\frac{P_t + P_{t-1} + P_{t-2} + P_{t-3}}{4}\right] + \delta t\ ,$$

where a, β, γ, and δ represent parameters.

Employing the technique of least squares regression for a sample period of the quarters between the first quarter of 1952 and the fourth quarter of 1959, Klein and Bodkin obtained estimates of the regression parameters for seven countries, four of which are presented in Table 3.22 immediately below. For these regressions, the coefficients of multiple determination are all high (0.56 or over), except for the regression with French data, where this measure is 0.30. All of the individual regression coefficients are statistically significant with conventional tests, except for the price change coefficient for France. For the tabular and graphical presentations in the text, it was necessary to select a time date and so to fix the value of the time trend variable; the first quarter of 1960, for which t was equal to 33, was chosen.

Table 3.22

Estimates of the Parameters of the Wage Adjustment Equation, West Germany, France, Belgium, and Canada, Quarterly Data, 1952-59

Country	Constant Term (α)	Coefficient of the Unemployment Percentage Variable (β)	Coefficient of the Percentage Price Change Variable (γ)	Time Trend Coefficient (δ)
West Germany ..	32.67	-3.12	0.51	-0.61
France	19.01	-5.75	0.12	-0.21
Belgium	23.06	-2.39	0.70	-0.28
Canada	8.00	-1.44	0.71	0.077

Source: Klein and Bodkin, *op. cit.*, p. 397.

11. L.R. Klein and Y. Shinkai, "An Econometric Model of Japan, 1930–59"

In their econometric model of the Japanese economy, Klein and Shinkai included a wage adjustment equation. In equation (3.24) below, w_t represents the average wage per man for the nonagricultural sector of the economy at time t in thousands of current yen, while P_t is the implicit deflator of Gross National Product for year t. (P_t is an index number, of course; the base period for this index was 1934.) U_t is unemployment (as measured in the Japanese statistics) as a percentage of the labour force. Finally, in equation (3.24), the "dot" symbol will represent the percentage change of the variable in question, between the current and the preceding year; for example, $\dot{P}_t$ may be expressed symbolically by the following equation:

$$(3.23) \qquad \dot{P}_t = \frac{P_t - P_{t-1}}{P_{t-1}} \cdot 100 \cdot$$

Klein and Shinkai employed annual data for the split sample period 1930–36 and 1951–58, making use of the method of two-stage least squares as their technique of parameter estimation. The resulting Japanese wage adjustment equation was:

$$(3.24) \qquad \dot{w}_t = \underset{}{26.0} - \underset{(10.8)}{16.98}\, U_t + \underset{(0.183)}{0.746}\, \dot{P}_t$$

where, as before, the numbers under the computed regression coefficients, in parentheses, are the associated standard errors of these parameter estimates. The coefficient of multiple determination was 0.64.

12. S.F. Kaliski, "The Relation between Unemployment and the Rate of Change of Money Wages in Canada"

Let w_t be an annual average of current dollar weekly wages and salaries, for an industrial composite (hence this series refers to the nonagricultural segment of the economy). Let U_t be the average annual percentage of the labour force unemployed; and let P_t be the index of consumer prices. As before, the subscript t denotes a time date; in the case of Kaliski's study, the unit of time was the year. Finally, the "dot" symbol represents the percentage rate of change of the variable in question, expressed as a first central difference; thus, for example, one can write:

$$(3.25) \qquad \dot{U}_t = \frac{U_{t+1} - U_{t-1}}{2\,U_t} .100.$$

For the period 1946–58, Kaliski estimated the following wage adjustment relationship, by the method of least squares:

$$(3.26) \qquad \dot{w}_t = 1.38 + \underset{(2.43)}{11.18}\ U_t^{-1} - \underset{(0.012)}{0.020}\ \dot{U}_t + \underset{(0.09)}{0.27}\ \dot{P}_t .$$

As before, the numbers in parentheses are the standard errors of the corresponding regression coefficients. The coefficient of multiple determination was 0.92.

13. G.L. Reuber, "The Objectives of Canadian Monetary Policy, 1949–61"

Let w_t be a quarterly average, for the t-th quarter, of an index of average hourly earnings in manufacturing; let U_t be the percentage of the labour force unemployed at time t; let P_t be the level of the Consumer Price Index during the t-th quarter; and let F_t be the implicit deflator of import expenditures, from the national income accounts, at time t . Finally, two operators may be defined. The "tilde" symbol denotes the ratio of the value in the succeeding quarter to the value in the current quarter, for the variable under consideration. The "dot" symbol, as always, denotes a percentage rate of change; in this section, it denotes the percentage change between the succeeding and the current quarters, of the variable in question. (Hence all percentage rates of change calculated from the equations in this section must be multiplied by four (4) in order to make them comparable to the rates of change generated by the other studies reviewed in this Appendix, as the rates of change have previously been defined as *annual* rates. The Reuber equations were so converted in the text, in order to ensure comparability.) The relationship between the "tilde" and the "dot" operators may be illustrated by the following equation:

$$(3.27) \qquad \tilde{w}_t = \frac{w_{t+1}}{w_t} = 1 + \frac{w_{t+1} - w_t}{w_t} = 1 + \frac{\dot{w}_t}{100} .$$

Employing seasonally adjusted, quarterly data for the period 1949–61, Reuber estimated a number of least squares regressions. His computed wage adjustment regression was:

$$(3.28) \qquad \tilde{w}_t = 0.36028 + \underset{(0.10353)}{0.63729}\ \tilde{P}_t + \underset{(0.00994)}{0.04483}\ U_t^{-1}$$

The numbers in parentheses are the computed standard errors of the regression coefficients; for this regression, the coefficient of multiple determination was 0.68. Simple algebraic manipulation of equation (3.28) yields the following relationship in terms of the percentage rates of change of money wages and the consumer price level:

$$(3.29) \qquad \dot{w}_t = -0.243 + 0.63729\ \dot{P}_t + 4.483\ U_t^{-1}\ .$$

From Reuber's estimated price level relationship, one can derive the following "steady state" equation among changes in the consumer price level, changes in import prices, and changes in money wages:

$$(3.30) \qquad \dot{P}_t = -0.370 + 0.42163\ \dot{F}_t + 0.51910\ \dot{w}_t\ .$$

One can combine equations (3.29) and (3.30) eliminating $\dot{w}_t$, the quarterly rate of change of money wages. After terms are rearranged, the derived relationship is:

$$(3.31) \qquad \dot{P}_t = -0.741 + 0.630\ \dot{F}_t + 3.477\ U_t^{-1}$$

Equation (3.31) is a concrete illustration of a trade-off relationship: when a rate of change of import prices is given, the resulting trade-off curve generates predictions of the rate of change of consumer prices, at varying rates of unemployment. Equation (3.31) can also be inverted to obtain a predicted rate of unemployment, at given rates of foreign and domestic inflation. The illustrative trade-off curves of Chapters 1 and 2 above were in fact based on equation (3.31).

14. John Vanderkamp, "Wage and Price Level Determination: An Empirical Model for Canada"

Let w_t^o denote labour income divided by employment in the organized sector during the t-th quarter, and let w_t^u represent a similar measure of average wage earnings in the unorganized sector at time t. (It will be recalled that the organized sector includes the mining, manufacturing, construction, transportation, communication and storage, and the public utility industries; the unorganized sector includes agriculture, forestry, fishing and trapping, retail and wholesale trade, finance, insurance and real estate, and other services.) U_t^o and U_t^u denote the percentage of the labour force unemployed in the organized and unorganized sectors, respectively, during quarter t. (Vanderkamp's description of his data indicates that the unemployment rate for the organized sector only was adjusted for short-falls of average weekly hours worked from a "full potential" work week.) The productivity variable for the organized sector, R_t^o , is an index of output per unit of employment. P_t denotes the Consumer Price Index for the t-th quarter, and I_t is the price index of imported goods only (hence the prices of imported services are excluded). As with the Reuber study, the rates of change of the variables are defined to be from the preceding to the current quarter; thus, for example,

$$(3.32) \qquad \dot{P}_t = \frac{P_t - P_{t-1}}{P_{t-1}}\ .$$

This means that all rates of change calculated from equations in this Appendix are on a quarterly basis; in the text, the derived rates of change have been converted to an annual basis by multiplication by a factor of four (4). Vanderkamp did not use seasonally adjusted data; instead, the complications of seasonality were taken into account by the use of seasonal dummies in the equations themselves, as with the Klein-Ball study. (However, we shall follow Vanderkamp's textual exposition and incorporate the coefficients of the seasonal dummies into the constant terms, in our presentation of his relationships.)

The estimated wage adjustment relationship for the organized sector is:

$$(3.33) \qquad \dot{w}_t^o = -0.745 + \underset{(2.899)}{7.096} \frac{1}{U_t^o} + \underset{(0.198)}{0.679} \dot{P}_t + \underset{(0.075)}{0.466} \dot{R}_t^o$$

After the unemployment variable is adjusted to the national rate of unemployment, U_t (see the discussion in the text), the organized sector wage adjustment relationship becomes:

$$(3.34) \qquad \dot{w}_t^o = -0.745 + 4.327 \frac{1}{U_t} + 0.679 \dot{P}_t + 0.466 \dot{R}_t^o$$

Similarly, the estimated wage adjustment equation for the unorganized sector is:

$$(3.35) \qquad \dot{w}_t^u = 0.703 + \underset{(2.695)}{9.281} \frac{1}{U_{t-1}^u} - \underset{(2.561)}{7.299} \frac{1}{U_{t-2}^u} + \underset{(0.255)}{0.363} \dot{P}_t \,.$$

Rearranging the reciprocals of the lagged unemployment rates so that there is one absolute level and a first difference, we obtain:

$$(3.36) \qquad \dot{w}_t^u = 0.703 + 1.982 \frac{1}{U_{t-1}^u} + 7.299 \left[\frac{1}{U_{t-1}^u} - \frac{1}{U_{t-2}^u} \right] + 0.363 \dot{P}_t \,.$$

Finally, after adjusting the sectoral rate of unemployment to the national average rate, this equation becomes:

$$(3.37) \qquad \dot{w}_t^u = 0.703 + 2.715 \frac{1}{U_{t-1}} + 9.999 \left[\frac{1}{U_{t-1}} - \frac{1}{U_{t-2}} \right] + 0.363 \dot{P}_t \,.$$

The two wage adjustment relationships were estimated by the technique of full information maximum likelihood, for the three-equation system. The price change equation, which completes the system and which was estimated in the same manner, is:

$$(3.38) \qquad \dot{P}_t = -0.018 + \underset{(0.062)}{0.139} \dot{w}_t^o + \underset{(0.086)}{0.015} \dot{w}_t^u + \underset{(0.034)}{0.150} \dot{I}_t + \underset{(0.077)}{0.594} \dot{P}_{t-1} \,.$$

If equations (3.34) and (3.37) are substituted into equation (3.38), one obtains a reduced-form relationship in which the rate of change of the Consumer Price Index is expressed as a linear function of the rate of change of productivity in the organized sector, the reciprocals of the unemployment rate for the current and the preceding two periods, and the lagged rate of change of the consumer price level itself. If one assumes (after abstracting from seasonal movements) that the unemployment rate remains unchanged over time, the reduced form of the equation becomes:

$$(3.39) \qquad \dot{P}_t = -0.123 + 0.712\frac{1}{U} + 0.166\ \dot{I}_t + 0.0719\ \dot{R}^{\circ}_t + 0.659\ \dot{P}_{t-1}\ ,$$

where the U symbol without the "t" subscript indicates the stationary value of the unemployment rate. If we further assume that the rate of change of the consumer price level attains its "steady state" value so that consumer prices change by a constant rate over time, equation (3.39) reduces to:

$$(3.40) \qquad \dot{P} = -0.361 + 2.088\frac{1}{U} + 0.487\ \dot{I}_t + 0.211\ \dot{R}^{\circ}_t\ .$$

(Notice that this trade-off relationship implies that consumer prices will increase at a faster rate if the rate of growth of productivity in the organized sector were to speed up; this paradoxical result was discussed in the text.) Finally, assuming a rate of growth of organized sector productivity equal to 2.5 per cent per year (0.625 per cent per quarter), we obtain the following version of the trade-off equation:

$$(3.41) \qquad \dot{P} = -0.229 + 2.088\frac{1}{U} + 0.487\ \dot{I}_t\ .$$

Table 3.19 of the text is in fact based on this equation.

PART II

NEW EVIDENCE FOR POST-WAR CANADA

CHAPTER 4

EXTRAPOLATION OF ESTIMATED CANADIAN WAGE ADJUSTMENT RELATIONSHIPS BEYOND THE PERIOD TO WHICH THEY WERE FITTED

1. Introduction

In the previous Chapter, we examined the results of a number of studies of wage adjustment relationships, along with several relationships linking price level changes to changes in wage and nonwage costs. These studies attempted to estimate these relationships as embodied in data reflecting the performance of the economy over a particular period of time (the sample period). Statistical analysis of time-series data is useful for testing hypotheses and for seeing whether one's theoretical notions appear to be confirmed or discredited by the sample data with which one is working. However, in fitting a relationship to data, there is always a danger (among others) that one is "forcing" agreement between the data and one's prior ideas about the relationships in question. A more stringent test of the generality of an estimated statistical hypothesis than the conventional tests of statistical significance, the appropriateness of the signs, the reasonableness of the parameters and still others based on a given set of data is provided by confronting a regression equation with a new body of data and seeing how well the previously calculated results apply to this new data. In broad outline, this is what we attempt to do in this Chapter for three of the four studies of Canadian wage and price level relationships reviewed in the previous Chapter.[1]

The general plan of attack is as follows. The relationships estimated in the Reuber, Kaliski and Klein-Bodkin studies are re-estimated for three periods: (i) the original sample period;[2] (ii) the post-sample period beginning after the end of the original sample period and ending in 1965; and (iii) the entire period encompassing both subperiods—i.e., original sample period and the post-sample period. Two formal statistical tests are then made, in order to verify as objectively as possible whether the relationship in question may be said to have shifted "perceptibly" or "in an important manner." In addition, each estimate is examined to see how well the (revised) sample period relationship forecasts the dependent

[1] The Vanderkamp study is not re-examined in this Chapter because the sample period of this study ends too recently — in other words, not enough quarters have elapsed since the end of the sample period to provide for efficient testing of the stability of his relationships. Moreover, a moderately large amount of research effort has to be invested in generating the data which Vanderkamp utilizes, as a careful reading of his article (especially the appendix on the data employed) will corroborate. Consequently, in view of the limited resources available to this study, we decided not to investigate the post-sample-period stability of the estimated Vanderkamp relationships.

[2] If the reader compares the revised relationships for the original sample periods with those obtained in the original studies, he will notice some slight discrepancies. These discrepancies, which are always small, are in two cases accounted for by the choice of a slightly different earlier sample period for which to present an "original" relationship. In the two other cases, we suspect that the discrepancies are accounted for by revisions of data, which seem to occur almost continuously.

variable after the end of the original sample period. The predictive accuracy of the estimated relationships is compared to that of two "naive" models, as well as to the estimated variance of the residuals (the variance of the dependent variable about the regression plane), for the earlier subperiod.

2. Re-examination of G. L. Reuber's Study

i. *The wage adjustment equation*

In "The Objectives of Canadian Monetary Policy, 1949-61," G. L. Reuber fitted a wage adjustment relationship of the form:

$$(4.1) \qquad \dot{w}_t = \alpha_0 + \alpha_1 U_t^{-1} + \alpha_2 \dot{P}_t + v_{1t} ,$$

where the α's are parameters and v_{1t} is a stochastic disturbance. For the variables of this relationship, $\dot{w}_t$ is the percentage change, between the current and the succeeding quarter, of average hourly earnings in manufacturing; U_t^{-1} is the reciprocal of the unemployment rate (unemployment as a percentage of the labour force) at time t; and $\dot{P}_t$ is the change, at time t, in the Consumer Price Index. All of the series underlying this regression were seasonally adjusted. To test the stability of this relationship, we re-estimated it for three sample periods: the first quarter of 1949 through the fourth quarter of 1960 (the original relationship had been fitted to the period 1949-I through 1961-IV); the first quarter of 1961 through the second quarter of 1965; and a "combined" sample period running from the first quarter of 1949 through the second quarter of 1965. The results are presented in Table 4.1 below. The parameter estimates are given by the upper figure in the column headed by the corresponding Greek letter with a "^" symbol above it; thus, for the period 1949-60, 4.445 is $\hat{\alpha}_1$, the estimate of the hypothetical parameter α_1. As is conventional, the numbers under the parameter estimates, in parentheses, are the associated standard errors of these sample regression coefficients. In the final column, the upper figure, R^2, is the coefficient of multiple determination (uncorrected for degrees of freedom), and the lower figure, $\bar{S}_u$, is the estimated standard deviation of the residuals (or standard error of the estimate), adjusted for degrees of freedom lost. The column headed by $\hat{\alpha}_3$ will be explained below.

Table 4.1

Re-estimates of the Parameters of G. L. Reuber's Wage Adjustment Equation

Period	$\hat{\alpha}_0$	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\alpha}_3$	$R^2/\bar{S}_u$
1949-I	-0.227	4.445	0.6826	–	0.647
-1960-IV		(1.040)	(0.1084)		0.61
1961-I	0.299	2.380	0.3346	–	0.139
-1965-II		(4.421)	(0.6657)		0.41
1949-I	-0.190	4.314	0.6740	–	0.626
-1965-II		(0.850)	(0.0982)		0.56
1949-I	-0.181	4.290	0.6744	-0.011	0.626
-1965-II		(0.940)	(0.0992)	(0.172)	0.57

When the two separate subperiods are compared, the first impression is deceptive; the parameter estimates of the later subperiod are subject to a wide variability, as indicated by the associated sampling errors.[1] In our view, a more accurate picture is obtained by comparing the relationship for the earlier subperiod with that for the total period. (This comparison is also shown graphically in Figure 4.1, page 104.) It seems clear from this latter comparison that the relationship did not shift much; a policy-maker who used the relationship fitted for the earlier subperiod as his guide for the relationship ruling during the entire period 1949-I through 1965-II would not have been badly misled.

As mentioned in the introductory remarks, one needs an objective test to determine whether there is any evidence of a shift in the relationship—subjective judgments on this question are likely to vary unduly, even among qualified observers. Two such tests were made. For the first test, we simply added another explanatory variable to equation (4.1) which is fitted to the entire period 1949-I through 1965-II. This additional explanatory variable was a dummy which took on a value of zero in the first subperiod and a value of unity in the later subperiod. The dummy variable effectively shifts the constant term between the subperiods; if significant, the coefficient of this dummy variable would suggest that the relationship had shifted between the two subperiods. The coefficient of this dummy variable ($\hat{\alpha}_3$) is reported in Table 4.1. As indicated, the coefficient of this variable is swamped by the associated standard error; consequently, there is no evidence from this test that the relationship shifted significantly from the earlier to the later subperiod.

Now it is quite possible that the relationship shifts from the earlier to the later subperiod, but that such a shift would not show up in the intercept term of the regression plane—one or more of the slope coefficients might have borne the brunt of such a structural change. Thus, one wants a statistical test which tests for a possible shift in any of the regression coefficients between the two subperiods examined. Fortunately, such a statistical test is available—the Chow test, which is called after the man who developed it.

While the technical details of the Chow test are relegated to an appendix,[2] the broad outline of the test may be sketched here. For the first three regressions

[1] Thus, if one makes a formal statistical test (which is subject to the qualifications outlined in footnote 2 below), there is no evidence of a significant difference in the parameter estimates $\hat{\alpha}_1$ and $\hat{\alpha}_2$, between the two subperiods.

[2] References to more detailed descriptions of this test also appear in the Appendix. It should be pointed out that the Chow test is based on the assumptions of the classical linear regression model, which rule out errors in the variables, complications due to simultaneity, and autocorrelated residuals. For the Kaliski and the Klein-Bodkin wage adjustment relationships the estimated residuals do appear to display autocorrelation as judged by the Durbin-Watson test statistic. This complication appears (by the same criterion) to be absent from the Reuber wage adjustment equation. However, since the first two problems are present to some degree in all three studies, there is some amount of misspecification in all our applications in this Chapter of formal statistical tests including the Chow test. Thus, the results of such tests should be regarded as indicative and illustrative, and their precision should not be exaggerated.

shown in Table 4.1, one can compute the sum of squared residuals. If the relationship had "really" shifted between the subperiods, in all likelihood, the sum of the squared residuals for the relationship fitted to the total period would greatly exceed the combined sum of the squared residuals for the separate subperiod regressions. The Chow test, in which one computes a ratio which has the F probability distribution under the null hypothesis,[1] basically tests whether the first sum of squares exceeds the second by more than can "reasonably" (with standard probabilities of committing a Type I error, i.e., rejecting the null hypothesis when it is in fact true) be attributed to the operation of chance forces.

In the case of the Reuber wage adjustment equation, this test was applied and an F ratio (with 3 and 60 degrees of freedom) equal to 0.51 was computed. Since the ratio is less than 1.0, it is clear that it is not statistically significant, because significant F ratios are obtained only when the mean of the sum of squares in the numerator exceeds the denominator mean sum of squares.[2] Consequently, our earlier impression of no significant shift in the parameter estimates of this wage adjustment relationship is confirmed by this test.[3]

A final–and more stringent–test may be made by employing the fitted relationship for the initial sample period (first quarter of 1949 through fourth quarter of 1960) to forecast wage changes in a later period (1961-64). Accordingly, we employed the first set of parameter estimates of Table 4.1 to forecast *average* quarterly wage changes for the four "post-sample" years 1961, 1962, 1963, and 1964.[4] The results are presented graphically in Figure 4.2 and in Table 4.2 below.[5]

As the graph indicates, the wage adjustment relationship appears to predict the average quarterly wage changes remarkably well beyond the quarter for which

---

[1] The F probability distribution is, in a sense, a generalization of the Student t probability distribution, which can be employed to test the statistical significance of individual regression coefficients. With one degree of freedom in the numerator of the F ratio, the F variable is simply the square of the t-ratio with the appropriate number of degrees of freedom.

[2] The critical values of the F statistic, with 3 degrees of freedom in the numerator and 60 degrees of freedom in the denominator, are 2.76 at the 5 per cent level of statistical significance and 4.13 at the 1 per cent level.

[3] One might argue that, for the later subperiod, the regression coefficients of the explanatory variables are not significantly different from zero, which in turn suggests the possibility that in the later period the relationship disintegrates. Although one cannot rule out this possibility on the basis of the evidence presented, we prefer the alternative interpretation adopted in the text, namely, that the hypothetical universe regression coefficients are unchanged from the earlier to the later subperiod. In this view, maximum likelihood estimates of these regression coefficients are given, under classical assumptions, by the sample regression coefficients estimated over the entire period.

[4] Instead of taking the 18 post-sample quarters as our forecasting period, we merely chose to take quarterly averages over four years of the post-sample period, as indicated in the text. This was done for two reasons: first, we were not altogether confident about the seasonal adjustment procedure, especially for the post-sample period; secondly, it seemed that deviations in the relationship that cancel out over the course of a year are of minor importance, both on a theoretical plane and for practical policy measures. In the case of the unemployment variable, we took the mean of the reciprocal of the unemployment rate (and then inverted it again, where that was necessary, as in the graphical presentation), rather than first taking the mean of the unemployment rate over the four quarters of a given year and then taking the reciprocal of this number.

[5] The vertical axis of Figure 4.2 does not measure the straight wage changes for either the actual values or for the predicted rates of change. Instead, wage changes corrected for any influence that a changing consumer price level might be expected to exert are measured along the vertical axis. In the case of the actual wage changes, this was done by subtracting the estimated price effect (equal to the coefficient of the price level change variable, $\hat{a}_2$, multiplied by the average change in the consumer price level for the year) from the measured value of the average wage change.

it is fitted. However, in less clear-cut cases, there is some question as to how well one should require a model to predict. To give an objective standard, some econometricians recommend a comparison against a "naive" model. A "naive" model is an alternative forecasting model which generally involves very little thought or computational effort but which still stands some chance of giving a reasonably accurate guess or first approximation. In this Chapter, two "naive" models were employed: in the first, the predicted wage change was merely taken to be the average wage change for the initial period; in the second, the average wage change in the current year was predicted to be the same as that experienced during the preceding year. Let $\hat{\dot{w}}_t$ be the predicted average wage change for the year t; then, one can symbolically represent the two "naive" models outlined above as follows:

$$(4.2a) \qquad \hat{\dot{w}}_t = \bar{\dot{w}}_{(1949-60)}, \quad \text{and}$$

$$(4.2b) \qquad \hat{\dot{w}}_t = \dot{w}_{t-1},$$

where $\bar{\dot{w}}$ represents the mean wage change over the initial period. A comparison can then be made by computing the root-mean-square of the deviations between the actual and the forecasted wage changes, for the regression model and for both "naive" models, over the four post-sample-period years. In symbols, the following statistic is computed and reported in the fifth row of Table 4.2.[1]

$$(4.3) \qquad D = \sqrt{\frac{1}{n} \sum_{t=1}^{n} (\dot{w}_t - \hat{\dot{w}}_t)^2}.$$

Table 4.2 confirms our impression from Figure 4.2: the regression model forecasts much more accurately, for the years 1961-64, than either of the two "naive" models under consideration.[2] In fact, the regression model forecasts better than either of its rivals for every year under consideration. This confirms the impression that the structure of the wage adjustment relationship did not alter appreciably between the earlier and the more recent subperiods. If there had been such a structural change, it is unlikely that the wage adjustment relationship fitted to the earlier period would give such relatively accurate predictions in the later period.

[1] For the comparisons in this section n is equal to 4, the number of post-sample-period observations (years).

[2] The root-mean-square deviation, for the regression model, is much smaller than the estimated standard deviation of the residuals, for either of the subperiods to which this relationship was fitted, as may be seen by scanning the lower figures in the cells of the final column of Table 4.1. This is presumably due in part to the use of annual averages of the quarterly values of the variables, which is likely to remove much of the variability in the dependent variable. It also would appear to reflect the small degree of variability in the dependent variable, for the later subperiod.

Table 4.2

Predictive Accuracy of the Reuber Wage Adjustment Relationship and Two Comparison "Naive" Models, over the Period 1961-64

Year or Statistic	Actual Average Wage Change $\dot{w}_t$	Predicted Average Wage Change from Regression Model $\hat{\dot{w}}_t$	Predicted Average Wage Change from Naive Model a $\hat{\dot{w}}_t$	Predicted Average Wage Change from Naive Model b $\hat{\dot{w}}_t$	Deviation, Regression Model $\dot{w}_t - \hat{\dot{w}}_t$	Deviation, Naive Model a $\dot{w}_t - \hat{\dot{w}}_t$	Deviation, Naive Model b $\dot{w}_t - \hat{\dot{w}}_t$
1961..........	0.5450	0.4975	1.3098	0.7000	0.0476	- 0.7648	- 0.1550
1962..........	0.8550	0.8541	1.3098	0.5450	0.0009	- 0.4548	0.3100
1963..........	0.9400	0.8746	1.3098	0.8550	0.0654	- 0.3698	0.0850
1964..........	1.1475	1.0566	1.3098	0.9400	0.0909	- 0.1623	0.2075
Root Mean Squared Deviation (D)					0.06084	0.4886	0.2064

ii. *The proximate price level equation*

Next, we may turn to the price level relationship estimated in the Reuber study. The price level equation had the form:

$$\dot{P}_t = \beta_0 + \beta_1\dot{F}_t + \beta_2\dot{w}_t + \beta_3\dot{P}_{t-1} + u_t , \qquad (4.4)$$

where the β's are parameters and u_t is a stochastic disturbance. All of the variables appearing in this relationship have been defined previously, with the exception of $\dot{F}_t$, which denotes the percentage rate of change, between the current and the succeeding quarter, of the (seasonally adjusted) deflator of imports of goods and services, from the GNE accounts. ($\dot{P}_{t-1}$ represents, of course, the value of $\dot{P}_t$ in the immediately preceding quarter.) As before, the relationship was re-run for an initial sample period (1949-II through 1960-IV), for a later sample period (1961-I through 1965-II), and for both periods combined. The results are given in Table 4.3 below. The coefficient $\hat{\beta}_4$ for the fourth row of this table is that of a dummy variable which has the value zero in the earlier subperiod and the value unity in the later subperiod. As before, this shift variable permits one to test whether there was any shift in the constant term of this relationship, from the earlier subperiod to the later.

Scanning Table 4.3, one observes that the picture is very similar to that presented for the wage adjustment relationship, in Table 4.1. Thus, superficially, the relationships for the two subperiods appear to differ somewhat, as judged by the point estimates of the regression coefficients. But when one takes account of the accompanying standard errors, which appear to be large because of the shortness of the second subsample period and the small variability in the dependent variable, these discrepancies appear to be no more than one might expect from the chance variations accompanying the sampling procedure. Thus, the regression for the total period given in the third row is very similar to that for the earlier subperiod.

Table 4.3
Re-estimates of the Parameters of G. L. Reuber's Price Level Change Equation

Period	$\hat{\beta}_0$	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$	$\hat{\beta}_4$	$R^2/\bar{S}_u$
1949-II -1960-IV	-0.13	0.2005 (0.0367)	0.2348 (0.0839)	0.5145 (0.0979)	–	0.802 0.40
1961-I -1965-II	0.02	0.0969 (0.0698)	0.1105 (0.1160)	0.6305 (0.2357)	–	0.399 0.19
1949-II -1965-II	-0.11	0.1924 (0.0308)	0.2192 (0.0681)	0.5343 (0.0823)	–	0.791 0.35
1949-II -1965-II	-0.12	0.1919 (0.0310)	0.2228 (0.0702)	0.5328 (0.0832)	0.025 (0.100)	0.791 0.35

As far as formal statistical tests are concerned, there is no evidence that the relationship shifted between the earlier and the later subperiod. Thus, in the fourth row, we have incorporated a dummy variable which allows the constant term of the regression to shift between the subperiods. As the estimate of β_4 indicates, this constant term has a small and insignificant coefficient, which suggests that no such shift actually took place. We also performed a Chow test in order to gauge whether there was any evidence of a possible shift in any of the coefficients of the regression, between the two sample periods. The computed value of the F statistic was 0.17, which is far from being statistically significant.[1] Accordingly, one can accept the null hypothesis of no shift in any of the slope coefficients of the price change regression.

Next, we examined how accurately the fitted price level change relationship of the earlier subperiod predicted changes in the consumer price level for the second subperiod. To do this, we employed the price equation of the first row of Table 4.3 to predict the average quarterly changes in the consumer price level for the four second subperiod years 1961, 1962, 1963, and 1964. (As before, we used four-quarter averages of the explanatory variables, also. This eliminates much of the very short-run variability in the dependent variable, as explained above.) The results of these calculations are shown in Figure 4.3 and also in Table 4.4.

As before, the forecasting adequacy of the relationship was tested against two "naive" models of the predicted change in the price level, analogous to the "naive" models embodied in equations (4.2a) and (4.2b) above to predict wage changes. In the first "naive" model, the predicted change in the consumer price level is set equal to the average change in this variable during the first subperiod (1949-II through 1960-IV). For the second "naive" model, the forecasted change in consumer prices is the change experienced during the preceding year. One can then calculate the root mean square of the deviations of the observed changes in the price level from those predicted by the regression and by the "naive" models (the D statistic defined above), with small values of this root mean square indicating good forecasting accuracy. The predictions of the two "naive" models, along with the D statistic for all three models, are shown in Table 4.4.

Figure 4.3 suggests, at a casual glance, that the regression model (fitted to observations during the first subperiod) gives reasonably accurate predictions during the second subperiod. This impression is confirmed by Table 4.4: in every year but one (1964), the regression model outperforms its two "naive" model competitors, generally by substantial margins. In terms of the statistic of the root mean square of the deviations, the regression model shows less than one half the variability in the deviations of the actual from the observed values than that displayed by either of the two "naive" models. Thus, in terms of forecasting accuracy, the Reuber price level equation appears to meet this criterion satisfactorily.[2]

[1] As mentioned above, a significant value of the F ratio occurs only when the numerator mean sum of squares sufficiently exceeds the denominator mean sum of squares, so that the ratio is significantly greater than unity. In this instance, the 5 and 1 per cent values of the F statistic are 2.53 and 3.67, respectively.

[2] It may be noted (by a quick comparison with Table 4.3) that the D statistic for the regression model, in predicting average quarterly changes in the consumer price level for the four years in question, is much less than the estimated standard deviation of the residuals of this relationship during the subsample period to which it was fitted. In part, this reflects the use of yearly averages of the quarterly values, which eliminates some of the random variability and, in part, it also reflects the smaller degree of variability in the dependent variable during the second subsample period, which is also indicated by Table 4.3.

Table 4.4

Predictive Accuracy of the Reuber Price Change Relationship and Two Comparison "Naive" Models, over the Period 1961-64

Year	Actual Average Changes in the Consumer Price Level	Changes in CPI Predicted by Regression Model	Changes in CPI Predicted by "Naive" Model (a) (predicted change is the mean change of earlier subperiod)	Changes in CPI Predicted by "Naive" Model (b) (predicted change is last year's change)	Deviation of Actual from Predicted Regression Model	Deviation of Actual from Predicted "Naive" Model (a)	Deviation of Actual from Predicted "Naive" Model (b)
1961..........	0.1375	0.2582	0.5513	0.2925	-0.1207	-0.4138	-0.1550
1962..........	0.4800	0.4303	0.5513	0.1375	0.0497	-0.0713	0.3425
1963..........	0.4325	0.4514	0.5513	0.4800	-0.0189	-0.1188	-0.0475
1964..........	0.5000	0.3498	0.5513	0.4325	0.1502	-0.0513	0.0675
Root Mean Square of Deviations of Observed from Predicted (D)					0.09995	0.2197	0.1924

iii. *The interaction of the wage and price change relationships*

Next, we wish to combine the wage and price level relationships of the Reuber model, in order to see how well the model behaves in combination. In this way, one can evaluate directly the predictive accuracy of the final trade-off relationship (between changes in the price level and the rate of unemployment).

For the period 1949-60, we have calculated the following wage change and price change relationships:

$$(4.1a) \qquad \dot{w}_t = -0.227 + 4.445\, U_t^{-1} + 0.6826\, \dot{P}_t\ .$$

$$(4.4a) \qquad \dot{P}_t = -0.131 + 0.2005\, \dot{F}_t + 0.2348\, \dot{w}_t + 0.5145\, \dot{P}_{t-1}\ .$$

Substituting equation (4.1a) into (4.4a) one can solve for the rate of change of consumer prices as a linear function of the rate of change of import prices, the reciprocal of the rate of unemployment, and the previous quarter's value of the price change variable.[1] After performing these algebraic manipulations, one obtains:

$$(4.5a) \qquad \dot{P}_t = -0.220 + 0.2388\, \dot{F}_t + 1.243\, U_t^{-1} + 0.6127\, \dot{P}_{t-1}\ .$$

One can now ask how well equation (4.5a), which represents an estimate, over the earlier sample period, of the manner in which the wage adjustment and the price change equations interact, predicts changes in the consumer price level. As before, we examine average quarterly changes for the four years 1961, 1962, 1963, and 1964. The results are presented in Table 4.5 below and also in Figure 4.4. In order to plot the predicted changes in the price level against the unemployment rate, both the actual and the predicted rates of change of prices were adjusted for changes in import prices and past changes in the consumer price level. (Actual changes in the consumer price level were adjusted by subtracting the effects, estimated by equation (4.5a), of the other two explanatory variables.) In Table 4.5 the deviations obtained by forecasting with our two "naive" models are also reproduced from Table 4.4, in order to provide a basis of comparison.

---

[1] One could reduce equation (4.5a) further, as was done in Chapter 2 above and also later in this section, by setting the lagged value of consumer price level changes equal to the current value and thus getting the price change variable as a function of the reciprocal of the unemployment rate and of the rate of change of foreign prices. However, such a procedure seemed inappropriate as a forecasting device; one would expect such a derived equation to predict accurately only if the two explanatory variables (the unemployment rate and the rate of change of foreign prices) remained fairly stable over a moderately long period of time, so that the rate of change in the consumer price level had time to "settle down" to its new "steady state" value. In fact, of course, both explanatory variables change continually over time, and so one should not expect such a convergence in the real world. This does not mean that the derived constant-rate-of-change trade-off relationship is not of interest, because, like the long-run equilibrium position of traditional price theory, it does represent (under certain assumptions) the tendency towards which the economic mechanism is continually moving.

Table 4.5

Predictive Accuracy of a Derived Trade-Off Equation from the Reuber Study and of Two Comparison "Naive" Models, over the Period 1961-64

Year	Actual Average Changes in the Consumer Price Level, Corrected ($=\dot{P}_t - 0.2388\dot{F}_t - 0.6127\dot{P}_{t-1}$)	Changes in Consumer Price Level Predicted by Equation (4.5a) ($=-0.220 + 1.234U_t^{-1}$)	Deviation, Actual from Predicted, Equation (4.5a)	Deviation, Actual from Predicted, "Naive" Model (a)	Deviation, Actual from Predicted, "Naive" Model (b)
1961	-0.1736	-0.0436	-0.1300	-0.4138	-0.1550
1962	0.0507	0.0092	0.0559	-0.0713	0.3425
1963	0.0018	0.0056	-0.0038	-0.1188	-0.0475
1964	0.2482	0.0436	0.2046	-0.0513	0.0675
Root Mean Square of Deviations of Observed from Predicted (D)			0.1249	0.2197	0.1924

A comparison of Figures 4.3 and 4.4 (or of Tables 4.4 and 4.5) suggests that equation (4.5a) forecasts somewhat less accurately than equation (4.4a). This is not particularly surprising, because in combining two statistical relationships like (4.1a) and (4.3a), one also combines their error terms (or their random disturbances), and hence it is quite possible for the resulting random disturbance (of the derived relationship) to have a larger variance than either of the original disturbances. Nevertheless, one can still argue that equation (4.5a) forecasts reasonably well; it still outperforms, in three years out of four and also on average as measured by the D statistic, both of the two "naive" models under consideration.

Finally, we may conclude our reconsideration of the earlier Reuber study by asking how the best estimate of the trade-off relationship for the combined sample period (running from the second quarter of 1949 through the second quarter of 1965) compares with that of the earlier study. For the total period 1949-I (or 1949-II, in the case of the price change equation) through 1965-II, the following relationships have already been estimated:

$$(4.1c) \qquad \dot{w}_t = -0.190 + 4.314\ U_t^{-1} + 0.6740\ \dot{P}_t\ .$$

$$(4.4c) \qquad \dot{P}_t = -0.110 + 0.1924\ \dot{F}_t + 0.2192\ \dot{w}_t + 0.5343\ \dot{P}_{t-1}\ .$$

By substituting the first relationship into the second and by setting the lagged value of the price level change variable equal to the current value,[1] one can derive a trade-off relationship between the "steady state" rate of change of the consumer price level and the reciprocal of the unemployment rate and the rate of change of import prices, as explanatory variables. The result is:

$$(4.6) \qquad \dot{P}_t = -0.477 + 0.60497\ \dot{F}_t + 2.974\ U_t^{-1}\ .$$

As in Chapter 3, this derived trade-off relationship may alternatively be presented either graphically (Figure 4.5) or in tabular form (Table 4.6). In Figure 4.5, the estimated trade-off curve is presented, under the assumption of a zero rate of change of import prices. For purposes of comparison, the trade-off curve for the earlier period is also sketched in on the same graph.[2] In this manner, one can observe the extent of the modification in one's picture of the trade-off curve when one is able to incorporate the information drawn from the entire sample period. Table 4.6 is directly comparable to Table 3.16 above: we have converted the predicted quarterly rates of change from equation (4.6) into annual rates of change,

---

[1] The entire procedure was outlined in the Appendix to Chapter 3 above. The first part of the technique is identical to that described earlier in this Section and very similar to that described abstractly in Section 4 of Chapter 2.

[2] The curve for the 1949-60 period is calculated from the equilibrium form of equation (4.5a). It differs somewhat from the original Reuber curve presented in Figure 3.18 above, for two reasons: (1) There is a difference of one year in the size of the sample periods, as noted in the figures; and (2) the original Reuber equation contained a very slight copying error (which we discovered when re-running the original relationships).

making a similar conversion for the rate of change of import prices, which is used as an explanatory variable for this relationship.

Table 4.6

Estimated Trade-Off Relationship for Canada, Based on Reuber-Type Equations for the Combined Sample Period (1949-I through 1965-II)

Unemployment Rate (Per Cent of Labour Force)	Annual Percentage Change in the Consumer Price Index Associated with an Annual Percentage Increase in Import Prices of:		
	0	1	3
2.0	4.04	4.64	5.86
2.5	2.85	3.45	4.67
3.0	2.06	2.66	3.87
4.0	1.07	1.67	2.88
5.0	0.47	1.08	2.29
6.0	0.08	0.68	1.89
7.0	-0.21	0.40	1.61
8.0	-0.42	0.18	1.40

Although the component relationships underlying the derived trade-off relationship have apparently not shifted significantly, Figure 4.5 suggests that there is slight evidence that the trade-off relationship has shifted outward if the experience of the last four years is taken into account—at least for higher rates of unemployment. Thus, for a zero rate of change of import prices, the earlier trade-off relationship suggests a rate of unemployment of approximately $5\frac{2}{3}$ per cent of the labour force consistent with stable prices, while the corresponding rate of unemployment for our full-period trade-off relationship is $6\frac{1}{4}$ per cent.[1] However, in the lower ranges of unemployment rates, the two relationships are very similar, as Figure 4.5 suggests. (This implies that the full-period relationship rises at a slower rate than the earlier one, and so at very low rates of unemployment less inflation would be expected with the full-period trade-off relationship.) In addition, both relationships show virtually the same steady state response to a given rate of foreign inflation. As equation (4.6) indicates, a sustained increase in the rate of change of import prices of one percentage point per year ultimately leads to an increase in the rate of domestic inflation of 0.605 of a percentage point—other things (particularly the unemployment rate) remaining unchanged. The corresponding figure for the earlier trade-off relationship was a marginal response of 0.617 of a percentage point, which is very close to the full-period estimate.

---

[1] We should not like to push this interpretation very far; in view of the lack of evidence of a shift in either of the regressions underlying the trade-off relationship, the apparent shift in the rate of unemployment associated with complete price stability may be largely statistical illusion. More precisely, it may indicate the sampling variability to which the estimated parameters of a derived relationship, like the trade-off equation, are subject. Our results in Chapters 5 and 6 below do not suggest that the earlier estimate (some $5\frac{2}{3}$ per cent) of the rate of unemployment associated with complete price stability, with a zero rate of change of import prices, is an underestimate.

Figure 4.1

WAGE ADJUSTMENT CURVES, G. L. REUBER RELATIONSHIPS, FOR EARLIER SUBPERIOD AND FOR COMBINED DATA

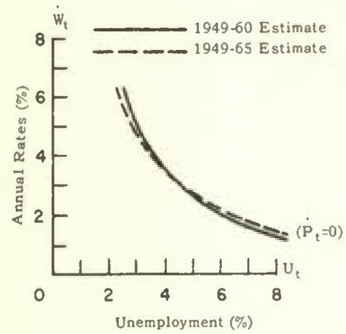
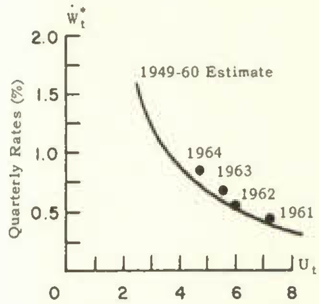


Figure 4.2

ACTUAL WAGE CHANGES, 1961-64, AND PREDICTIONS BASED ON G. L. REUBER'S WAGE ADJUSTMENT EQUATION FOR 1949-60



*Adjusted, per footnote 5, page 94.

Figure 4.3

ACTUAL RATES OF CHANGE OF THE CONSUMER PRICE INDEX, 1961-64, AND PREDICTIONS BASED ON G. L. REUBER'S PRICE CHANGE EQUATION FOR 1949-60

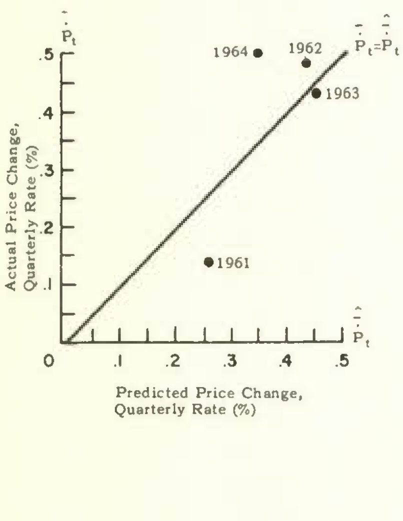
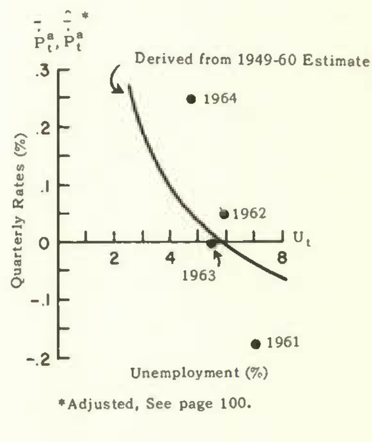


Figure 4.4

A TRADE-OFF CURVE FROM THE REUBER STUDY AND PREDICTED AND ACTUAL RATES OF PRICE CHANGE, 1961-64



*Adjusted, See page 100.

Figure 4.5

TWO ESTIMATED "STEADY STATE" TRADE-OFF CURVES, BASED ON REUBER-TYPE RELATIONSHIPS

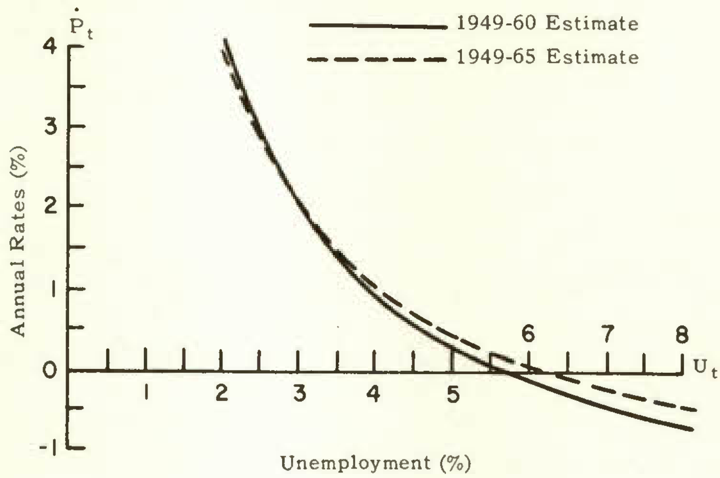
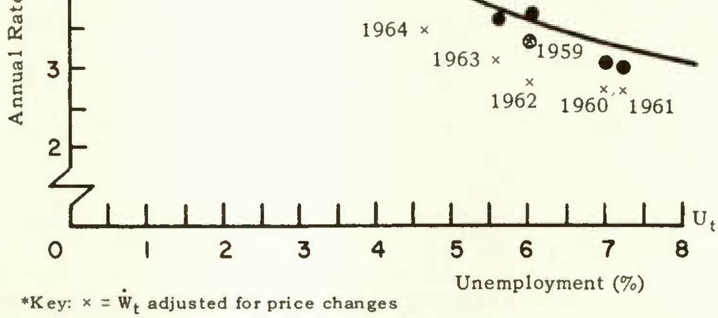


Figure 4.6

ACTUAL WAGE CHANGES, 1959-64,* AND PREDICTIONS BASED ON S.F. KALISKI'S WAGE ADJUSTMENT EQUATION FOR 1947-58



*Key: × = $\dot{W}_t$ adjusted for price changes

● = $\dot{W}_t$ unadjusted.

3. Re-examination of a Wage Adjustment Relationship, Fitted by S. F. Kaliski

In "The Relation between Unemployment and the Rate of Change of Money Wages in Canada," S. F. Kaliski fitted a relationship of the form:

$$(4.7) \qquad \dot{w}_t = \gamma_0 + \gamma_1 U_t^{-1} + \gamma_2 \dot{U}_t + \gamma_3 \dot{P}_t + v_{2_t} ,$$

where the γ's are parameters, w is an annual average of average weekly wages and salaries for an industrial composite, U_t is the percentage of the labour force unemployed, P_t is the consumer price index, and v_{2_t} is a stochastic disturbance. Kaliski used relative first central differences, and so the "dot" symbol will be given that meaning in this section; for example,

$$(4.8) \qquad \dot{P}_t = \frac{P_{t+1} - P_{t-1}}{2P_t} \ (100).$$

(As before, the 't' subscript denotes a time-date to which the variable in question belongs.) Kaliski fitted this relationship to the period 1946-58. As with the Reuber wage adjustment relationship, we have refitted this relationship to (approximately) the same span of data (the years 1947-58), to a later subperiod (1959-65), and to the two subperiods combined (1947-64).[1] In this manner, we intended to test the stability of the Kaliski wage adjustment relationship. The results are presented in Table 4.7, which is comparable to Table 4.1.[2]

Scanning Table 4.7, one's first impression is that this wage adjustment relationship has shifted in a pronounced fashion from the first subperiod to the second. When one takes the standard errors into account, the presence of such a shift is less obvious. The second subperiod relationship has very unreliable parameter estimates, possibly due to the very short run of data in the subperiod under examination. The relationships for the full period and for the earlier, longer subperiod resemble each other much more closely. However, the question can be put to more objective tests. In the column headed $\hat{\gamma}_4$, we have computed the regression coefficient of a dummy variable which always takes on a value of zero during the first subperiod (1947-58) and a value of unity during the second subperiod (1959-64), in a regression for the full period in which all the other explanatory variables are the same as in row (3) of this Table. As one can easily verify from the information available in Table 4.7, the t-ratio for the dummy variable (the ratio of the estimated coefficient to its standard error) is 1.58, which is not significant, even at the 10 per cent level, with 13 degrees of freedom. Thus, one cannot reject the null hypothesis that the intercept term of this wage adjustment relationship has not shifted from the first to the second subperiod under examination.

---

[1] The first central difference method requires data one year beyond the period in which one is interested. Our 1965 observations (used in calculating first central differences for 1964) are, in general, based upon the first 10 months of 1965.

[2] A comparison of the first row of Table 4.7 with a corresponding regression run by Kaliski (equation 134 of Kaliski's Table 3) shows a close agreement, although the numbers are not identical. This is probably explainable in terms of data revisions, in addition to the fact that Kaliski's wage adjustment regressions appear to be based on one more year of data.

Table 4.7

Re-estimates of the Parameters of S.F. Kaliski's
Wage Adjustment Relationship

Period	$\hat{\gamma}_0$	$\hat{\gamma}_1$	$\hat{\gamma}_2$	$\hat{\gamma}_3$	$\hat{\gamma}_4$	$R^2/\bar{S}_u$
1947-58	1.818	10.76	-0.0259	0.326	—	0.9203
(1)		(3.24)	(0.0150)	(0.0995)		0.7967
1959-64	0.642	20.69	-0.0002	-0.472	—	0.9252
(2)		(7.86)	(0.0132)	(0.537)		0.1766
1947-64	0.958	12.66	-0.0136	+0.347	—	0.9300
(3)		(2.33)	(0.0105)	(0.084)		0.6847
1947-64	1.836	10.50	-0.0228	0.337	-0.797	0.9413
(4)		(2.60)	(0.0116)	(0.0798)	(0.504)	0.6506

One can also apply the Chow test in order to test whether there is any evidence of a shift in any of the (true) parameter values of this relationship. The computed value of the F statistic is, in this case, 0.692. Since this number falls short of unity, it is not statistically significant. Accordingly, one can conclude that the sum of the squared residuals for the combined period does not significantly exceed the total of the sum of the squared residuals for each subperiod separately; hence, there is no evidence of a significant shift in the Kaliski wage adjustment relationship between the two subperiods.

Finally, one can ask how well the Kaliski wage adjustment relationship, fitted to the earlier subperiod, predicts wage changes in the later subperiod. As before, one can plot the predicted values against the actual experience on a graph (see Figure 4.6), but one gets a more objective feel of the forecasting performance of the regression equation by comparing its predictions against those of a "naive" model. Again, we employ two "naive" models: for the first "naive" model, the predicted wage change is simply the mean value of wage change variable during the first subperiod, while for the second, the predicted value of the wage change is that experienced during the preceding year. For the regression model, the predicted wage change is taken as the sum of the constant term, the unemployment effect, and the effect of the actual rate of increase in prices experienced during the year in question; however, the nonsignificant effect of percentage changes in the unemployment rate was not included in calculating the predicted wage change.[1] The comparison of the predictions of the regression model against those of the two "naive" models is presented in Table 4.8.

From Figure 4.6 one is likely to conclude that, although the Kaliski wage adjustment equation generates predictions that are not extremely out of line with actual experience, neither are they extremely close. Moreover, the relationship consistently predicts with an upward bias–in all six years, the actual wage change was less than the rate of wage change forecasted by the wage adjustment relationship. (In this connection, the relevant plot points are the small crosses; the large dots should be given relatively little weight and are discussed in footnote 1, page 110.) The same impression emerges from Table 4.8. It is true that the regression model gives a better prediction in every year than "naive" model (a), in which one forecasts the wage change as simply the mean (percentage) wage change experienced in the earlier subperiod. In addition, the root mean square error of the forecasting deviations (0.644) is slightly smaller than the estimated standard deviation (0.797) of the residuals, during the sample subperiod. This suggests that the predictive accuracy of this earlier subperiod relationship did not deteriorate during the later subperiod. However, in each of the six years, "naive" model (b) yields a better forecast than the regression model; the previous year's wage change is a better predictor than one based on the unemployment rate and changes

[1] We have also made some calculations in which the predicted wage change included a term measuring the effect of percentage changes in the unemployment rate. The result of adding this term to the regression model was, in general, to reduce the predictive accuracy considerably. Thus, the predicted wage changes were further away from the actual (in comparison with the regression model discussed in the text) in five years out of the six; moreover, the root mean square of the forecasting deviations was much larger, at 0.875.

Table 4.8

Predictive Accuracy of the Kaliski Wage Adjustment Relationship and Two Comparison "Naive" Models, over the Period 1959-64

Year	Observed Wage Change	Wage Change Predicted by Regression Model= (9) + $0.326\dot{P}_t$	Wage Change Predicted by "Naive" Model (a) $= \overline{\dot{w}}_t$	Wage Change Predicted by "Naive" Model (b) = $\dot{w}_{t-1}$	Deviation, Regression Model = (2) - (3)	Deviation, "Naive" Model (a) = (2) - (4)	Deviation, "Naive" Model (b) = (2) - (5)	$1.8181 + 10.756\frac{1}{U_t}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1959	3.67	3.989	6.159	3.93	-0.319	-2.49	-0.26	3.614
1960	3.06	3.699	6.159	3.67	-0.639	-3.10	-0.61	3.356
1961	3.02	3.653	6.159	3.06	-0.633	-3.14	-0.04	3.313
1962	3.27	4.087	6.159	3.02	-0.817	-2.89	0.25	3.614
1963	3.66	4.321	6.159	3.27	-0.661	-2.50	0.39	3.743
1964	4.06	4.749	6.159	3.66	-0.689	-2.10	0.40	4.109
Root Mean Squared Deviation (D)					0.6442	2.729	0.3688	

in the consumer price level, with coefficients obtained from a regression for the earlier subperiod. Consequently, one might conclude that the Kaliski wage adjustment relationship, while it passes a formal statistical test that indicates no evidence of a significant shift in its parameters between the two subperiods examined, is not very successful as a forecasting device. In turn, this would imply that this wage adjustment relationship, in particular, is subject to some limitations in providing guidance for public policy.[1]

4. Re-examination of the Klein-Bodkin Wage Adjustment Relationship

For Canada, L. R. Klein and R. G. Bodkin fitted the following relationship to quarterly data over the period between the first quarter of 1952 and the fourth quarter of 1959:

$$(4.9) \qquad \dot{w}_t = \eta_0 + \eta_1\left[\frac{1}{4}\left\{U_t + U_{t-1} + U_{t-2} + U_{t-3}\right\}\right] + \eta_2\left[\frac{1}{4}\left\{\dot{P}_t + \dot{P}_{t-1} + \dot{P}_{t-2} + \dot{P}_{t-3}\right\}\right] + \eta_3 t + v_{3t} \, ,$$

where the η's denote parameters of the relationship, the t subscript dates the observation on the variable in question by the relevant quarter, and v_{3t} is a stochastic disturbance. As before, w represents average hourly earnings, U the percentage of the labour force unemployed, P the Consumer Price Index, and t is a time trend variable. (The variable t is equal to unity in the first quarter of 1952 and increases by one unit for each quarter elapsed since that date.) The "dot" operator is defined to be the percentage change between the current quarter and the same quarter of the preceding year; for example, $\dot{P}_t$ is defined as:

$$(4.10) \qquad \dot{P}_t = \frac{P_t - P_{t-4}}{P_{t-4}} (100).$$

We have recalculated this relationship for the original sample period (1952-I through 1959-IV), for a later subperiod (1960-I through 1965-II), and for the two subperiods combined. The results are presented in Table 4.9 below.[2] The same format is followed in this Table as in Tables 4.1 and 4.7.

[1] One interesting by-product of these comparisons is that the constant term and the unemployment effect alone yield a very good set of predictions for the rate of change of money wages, over the six years 1959-64. This is apparent from Figure 4.6 in which the large dots, which represent the unadjusted wage changes, are very close to the hypothetical line of a perfect fit. Moreover, the deviations of the observed wage changes from the column (9) values of Table 4.8 are smaller (in numerical value) than the "naive" model (b) deviations, for four out of the six years. Moreover, the root mean square of the former deviations is smaller than that of the latter (0.225 versus 0.369, respectively). Since the regression model asserts that changes in the consumer price level are an appropriate explanatory variable, the above set of results must be regarded principally as a curiosum. Still, this intriguing group of results does provide a very mild confirmation of the importance of the unemployment variable.

[2] A comparison of the first row of Table 4.9 with the corresponding regression parameters reproduced in the Appendix to Chapter 3 indicates a close but not perfect correspondence to the earlier set of estimates. Once again, it seems likely that the discrepancies can be explained on the basis of revisions of the underlying data.

Table 4.9

Re-estimates of the Parameters of the Klein-Bodkin Wage Adjustment Equation

Period	$\hat{\eta}_0$	$\hat{\eta}_1$	$\hat{\eta}_2$	$\hat{\eta}_3$	$\hat{\eta}_4$	$R^2/\bar{S}_u$
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1952-I	8.11	-1.24	0.788	0.0453	–	0.8724
-1959-IV		(0.232)	(0.0716)	(0.0343)		0.981
1960-I	7.54	-0.548	0.724	-0.0438	–	0.7371
-1965-II		(0.148)	(0.270)	(0.0230)		0.353
1952-I	6.88	-0.724	0.762	-0.0085	–	0.8469
-1965-II		(0.109)	(0.063)	(0.0100)		0.874
1952-I	7.14	-0.721	0.763	-0.0307	0.8208	0.8566
-1965-II		(0.106)	(0.062)	(0.0156)	(0.4507)	0.854

Turning to the Table itself, one can observe that the constant terms and the coefficients of the average price change variable (column (2) and (4), respectively) are rather similar, from regression to regression. On the other hand, the coefficients of the average unemployment rate variable do vary widely from regression to regression, even when one takes the accompanying standard errors into account. Also, there is some suggestion of instability in the estimated effect of a time trend. Consequently, it appears doubtful whether one can maintain the hypothesis of no shift in the parameters of the Klein-Bodkin wage adjustment relationship.

One can proceed to the formal statistical tests. For the dummy variable formed by splitting the constant term according to the subperiod during which it occurs, the t-ratio of the estimated regression coefficient to its associated standard error is 1.82. With 49 degrees of freedom, this t-ratio is significant at the 10 per cent level, but not at the 5 per cent level.[1] Thus, performance of this test leaves us with a suspicion that the relationship has shifted, although the evidence of a shift is hardly conclusive.

The Chow test seems more appropriate in these circumstances because, if there have been shifts in the parameters of the Klein-Bodkin relationship, it seems likely that the coefficient of the unemployment rate (and also, possibly, that of the time trend variable) has (have) shifted, rather than the constant term. Accordingly, the F ratio appropriate to the Chow test was calculated to be 3.54. This indicates that the sum of the squared residuals of the full-period relationship considerably exceeds, in a comparative sense, the total of the sum of the squared residuals for each period separately. According to the null hypothesis (equality of the regression coefficients between the subperiods, in conjunction with the assumptions of the classical regression model), this Chow ratio has an F distribution with 4 and 46 degrees of freedom in the numerator and denominator, respectively. The 5 and 1 per cent values for the F distribution (with the same number of

[1] With 49 degrees of freedom, the 10 and 5 per cent values of the t distribution are 1.68 and 2.01 respectively.

degrees of freedom in the numerator and the denominator) are 2.57 and 3.76 respectively. Consequently, the computed F ratio is quite significant, and one may reasonably conclude that the Klein-Bodkin wage adjustment relationship has not remained unchanged from the earlier to the later subperiod, and that at least some of the parameters of this relationship shifted over the total period from the first quarter of 1952 to the second quarter of 1965. From our previous examination of the individual regression coefficients, it seems likely that the coefficient of the average unemployment rate and possibly that of the time trend variable were the ones that actually shifted over the total period under examination.[1]

5. Conclusions

In this Chapter, we have re-examined three wage adjustment relationships in the light of additional evidence accumulated since the relationships were first estimated. The Reuber wage adjustment relationship gave no evidence of a shift between the two subperiods examined. In addition, the Reuber wage adjustment regression fitted to the earlier subperiod predicted wage changes during the later subperiod better than either of the two "naive" models for forecasting wage changes, which were used as a standard of comparison. The Kaliski wage adjustment relationship also gave no evidence of a significant shift between the subperiods examined, but its forecasting performance was less satisfactory. In particular, this relationship did not predict as accurately as the "naive" model in which the forecasted wage change was taken to be the wage change experienced during the preceding period. Finally, the Klein-Bodkin wage adjustment relationship fitted to the original subperiod predicted wage changes very badly beyond this period; a related conclusion was that this relationship exhibited evidence of a shift in some of its parameters over the entire period examined. Accordingly, on the grounds of forecasting accuracy and the related criterion of the absence of significant shifts in the estimated parameters of the relationship, the Reuber wage adjustment relationship would appear to be the most satisfactory of the three examined.

The instability of the fitted parameters of the Klein-Bodkin relationship deserves further comment. It will be recalled that this relationship is linear in the unemployment variable utilized (instead of employing the reciprocal formulation, like the Reuber and the Kaliski relationships). Moreover, the coefficient of this unemployment variable was one of the two coefficients which displayed the strongest evidence of a shift between the two subperiods examined. During the earlier subperiod, the unemployment rate averaged 4.38 per cent of the labour force, while during the later subperiod the mean of this variable was 6.00 per cent. Moreover, the coefficient of the unemployment variable was much larger during the earlier subperiod, which suggests a nonlinear relationship much like that

[1] With the evidence that this wage adjustment relationship shifted from the earlier to the later subperiod, there would appear to be little point in seeing how well the earlier subperiod relationship forecasts wage changes in the later subperiod. Nevertheless, some preliminary calculations that were made suggest that the forecasting performance of this relationship is very bad, as could have been anticipated. In particular, the predicted wage changes generated by the earlier subperiod relationship were further (by the root mean squared deviations criterion) from the observed changes than even those of "naive" model (a), in which the predicted wage changes were the mean of those experienced in the earlier subperiod.

generated by the hyperbolic (reciprocal) formulation. Hence, it would appear that the linear formulation of the influence of the unemployment rate is a less satisfactory description of reality than the hyperbolic formulation employed by Reuber and Kaliski. If this conclusion is correct, there is some merit (aside from making use of the additional evidence provided by more recent data) in re-estimating the West European wage adjustment relationships studied by Klein and Bodkin, utilizing a nonlinear formulation of the influence of the rate of unemployment. In Chapter 8, we present the results of a limited investigation of these questions.

In our re-examination of the Reuber study, the Reuber price change equation was also scrutinized. Although its forecasting accuracy was less spectacular than the Reuber wage adjustment equation, it, too, was considerably more accurate than either of the two "naive" model against which it was compared. Moreover, there was no evidence that the parameters of this relationship had shifted between the separate subperiods examined. Not surprisingly, therefore, the derived trade-off curve (the two-dimensional relationship between the rate of increase of the price level and the rate of unemployment for a zero rate of change of import prices) for the total period looks very much like that calculated in the original Reuber study, which was based on (approximately) the data from the earlier subperiod alone. If there has been any change in our best estimate of this relationship, the suggestion is that the rate of unemployment required for stability of the consumer price level is somewhat higher than was previously estimated. Given the margin of error to which these derived measures are subject, one should not place much confidence in this conclusion, particularly in view of the evidence of Chapters 5 and 6 below.

APPENDIX

An Outline of the Chow Test

In this Appendix, we outline the mechanics of the Chow test. In this manner, the assertions in the test concerning this test of significance will be explained more fully. For a detailed statement and proofs of the assertions, the reader should consult other sources.[1]

Suppose that we originally have a sample of n observations, to which we fit the hypothesized population relationship:

$$(4.11) \qquad Y_t = \alpha_1 + \alpha_2 X_{2t} + \alpha_2 X_{3t} + \cdots + \alpha_k X_{k_t} + u_{1t}\ ,\ t = 1, 2, \ldots n\ ,$$

where the α's are the parameters of the relationship, Y_t is the dependent variable. $X_2, X_3, \ldots, X_k$ are the independent or explanatory variables of this relationship, u_{1_t} is a stochastic disturbance, and the t subscript denotes the individual observation under consideration. Suppose that, with the passage of time or with diligent pursuit of survey data, we obtain an additional m observations on our variables, where m is presumed to exceed k, the number of parameters to be estimated. If we are uncertain that the relationship (4.11) still holds for this new set of data, we can fit the relationship:

$$(4.12) \quad Y_t = \beta_1 + \beta_2 X_{2t} + \beta_3 X_{3t} + \cdots + \beta_k X_{k_t} + u_{2_t}\ , t = n + 1, n + 2, \ldots, n + m\ ,$$

where the β's are the parameters of this relationship and u_{2_t} is a stochastic disturbance, for the second set of observations. On the other hand, if we are certain that the same relationship (as for the first set of data) continues to characterize the new set of data, we might fit the following relationship, for all n + m observations:

$$(4.13) \qquad Y_t = \gamma_1 + \gamma_2 X_{2t} + \gamma_3 X_{3t} + \cdots + \gamma_k X_{k_t} + u_{3t}\ ,\ t = 1, 2, \ldots, n + m$$

(Here, as before, the Greek letter symbols are parameters and u_{3_t} is a stochastic disturbance.) The Chow test is constructed to test the composite null hypothesis that the parameters of relationships (4.11), (4.12), and hence (4.13) are identical. In symbols, the null hypothesis is:

$$(4.14) \qquad \alpha_1 = \beta_1 = \gamma_1\ ;\ \alpha_2 = \beta_2 = \gamma_2\ ;\ \ldots\ ;\ \alpha_k = \beta_k = \gamma_k\ .$$

To perform this test, we make all of the assumptions of the classical linear regression model and in addition assume that the (universe) variance of the random

[1] The original statement of this test, along with a statement of the assumptions postulated and proofs of the relevant propositions required for the statistical test, may be found in Gregory C. Chow, "Tests of Equality between Sets of Coefficients in Two Linear Regressions," *Econometrica*, Volume 28, No. 3 (July 1960), pp. 591 -605. A shortened statement of the Chow test, on which this Appendix is based, appears in J. Johnston, *Econometric Methods* (New York: McGraw Hill Book Company, Inc., 1963), pp. 136 -138.

disturbance u_{1_t} is the same as that of u_{2_t}. One can then obtain the least squares estimates of the parameters of all three of these relationships. (As in the text, these least squares estimates are denoted by the same symbol as the corresponding population parameter which is being estimated, with one small difference: the sample estimators have the circumflex or "cap" symbol appearing above the other symbols. Thus $\hat{\gamma}_1$, is the least squares estimator of γ_1.) The point estimates of the "true" regression coefficients will almost certainly differ, but the real issue is whether these differences can reasonably be attributed to the chance fluctuations associated with sampling. After these least squares estimates have been computed, one can compute the following sums of squares of the sample residuals:

$$(4.15) \qquad Q_1 = \sum_{t=1}^{n+m} \hat{u}_{3t}^2 = \sum_{t=1}^{n+m} \left(Y_t - \hat{\gamma}_1 - \hat{\gamma}_2 X_{2t} - \ldots - \hat{\gamma}_k X_{k_t}\right)^2 \text{, and}$$

$$(4.16) \qquad Q_2 = \sum_{t=1}^{n} \hat{u}_{1_t}^2 + \sum_{t=n+1}^{n+m} \hat{u}_{2_t}^2 = \sum_{t=1}^{n} \left(Y_t - \hat{\alpha}_1 - \hat{\alpha}_2 X_{2_t} - \ldots - \hat{\alpha}_k X_{k_t}\right)^2 + \sum_{t=n+1}^{n+m} \left(Y_t - \hat{\beta}_1 - \hat{\beta}_2 X_{2_t} - \ldots - \hat{\beta}_k X_{k_t}\right)^2 .$$

(Here, the "cap" symbol over the u_{i_t}'s denotes a sample residual, rather than the corresponding population disturbance, which in general is not observable.) In words, Q_1 is the sum of the squared sample residuals for the relationship based on the two sets of data combined, while Q_2 is the total of the sum of the squares of the sample residuals for the two relationships estimated from the two sets of data separately. It is a property of least squares regression estimates that Q_1 can never be less than Q_2: in general, Q_1 will exceed Q_2 because one can generally obtain a smaller sum of squared deviations, which after all is the criterion for the least squares regression procedure, if one is allowed to go to work on the two sets of data separately.

One can define another sum of squares, which is related to the size of the discrepancies between the least squares estimators of the relationship for the combined sets of data and those of the relationships for the two sets of data individually. Let Q_3 be defined by the expression:

$$(4.17) \qquad Q_3 = \sum_{t=1}^{n} \left[(\hat{\alpha}_1 - \hat{\gamma}_1) + X_{2t}(\hat{\alpha}_2 - \hat{\gamma}_2) + \ldots + X_{k_t}(\hat{\alpha}_k - \hat{\gamma}_k)\right]^2 + \sum_{t=n+1}^{n+m} \left[(\hat{\beta}_1 - \hat{\gamma}_1) + X_{2t}(\hat{\beta}_2 - \hat{\gamma}_2) + \ldots + X_{k_t}(\hat{\beta}_k - \hat{\gamma}_k)\right]^2 .$$

Using the properties of least squares regression estimators, one can prove that Q_2 and Q_3 add up to Q_1; in symbols we have:

$$(4.18) \qquad Q_1 = Q_2 + Q_3 \ .$$

Hence, the closer is the sum of the squared residuals of the relationship based on both sets of data combined to the total of the separate sums of squared residuals Q_2, the smaller is the "parameter-estimates-discrepancy" sum of squares Q_3. This is certainly a reasonable result.

Now let σ^2 be the common (universe) variance of the disturbances u_{1_t} and u_{2_t}. Under the null hypothesis, Q_2/σ^2 and Q_3/σ^2 have independent X^2 distributions with $m + n - 2k$ and k degrees of freedom, respectively. It thus follows that the ratio of the means of these sums of squares will have the F probability distribution. We thus compute the ratio:

$$(4.19) \qquad F = \frac{Q_3/k}{Q_2/(m+n-2k)} \ ,$$

which of course has k degrees of freedom in the numerator and $(m + n - 2k)$ degrees of freedom in the denominator.[1] If the computed F statistic is above the critical value, this indicates that the "parameter-estimates-discrepancy" sum of squares is relatively large, in a significant manner. One would then reject the null hypothesis (4.14). On the other hand, if the computed F value is below the critical value, this suggests that the amount by which the Q_1 sum of squared residuals for the total period relationship exceeds the total of the separate sums of squared residuals Q_2 can reasonably be attributed to the chance fluctuations inherent in the sampling process. In this case, we would accept the null hypothesis and would conclude that the same relationship (4.13) characterized both sets of data under examination.

[1] In practice, of course, one would not compute Q_3 directly, for that would involve a great deal of unnecessary computational effort. Instead, one would make use of the identity (4.18), computing Q_3 as the excess of Q_1 over Q_2.

CHAPTER 5

RE-ESTIMATION OF THE RELATIONSHIPS UNDERLYING TRADE-OFF EQUATIONS FOR THE CANADIAN ECONOMY

1. Purposes and Basis of Re-estimation

In the preceding Chapter, three earlier estimates of the wage adjustment relationship were evaluated, as was an estimate of the direct relationship between price and wage changes. The most recent of these estimates was based on data to the end of 1961 and reflected the approaches in common use at that time. There are several compelling reasons for re-estimating these relationships for the purposes of this study. First, additional data have become available since 1961. These data might simply be used to refit the earlier estimates—which in fact have been done in Chapter 4—but the availability of data reflecting a wider range of experience makes it worth exploring other relationships to see whether estimates which in some sense are "better" can be derived. A second reason for re-estimating the structure of the relationships is that a number of studies in this area have become available since this earlier work was completed. Moreover, various suggestions have emerged from the discussions of the earlier Canadian relationships. These developments have suggested the desirability of testing several variables, formulations of the influence of particular variables, and estimating procedures which were not employed in the three earlier wage adjustment relationships for Canada. In the concluding section of this Chapter, we give some attention to technical problems arising from autocorrelated residuals and from the presence of simultaneity between the wage and price change relationships.

One of the most important of the recent studies is the work done by Schultze and Tryon as part of *The Brookings Quarterly Econometric Model of the United States.*[1] In re-estimating the relationships for Canada, we have followed closely, where feasible, the approach employed by Schultze and Tryon, experimenting as well with several modifications of their techniques. The principal modifications are designed to take into account more adequately the relative openness of the Canadian economy in comparison to the U.S. economy, and the widely recognized influences of U.S. prices and wages on Canadian prices and wages.

In general, the work in this and the following Chapter is implicitly based on the assumption that we are principally dealing with the industrial sector of the economy. This assumption is dictated, in part, by the statistics available for estimating the relationships in question. Indirectly, data on average hourly earnings in manufacturing, the Consumer Price Index, the unemployment rate and so forth, may reflect relationships in the agricultural and other primary sectors, but it is

[1] Charles L. Schultze and Joseph L. Tryon, "Prices and Wages", Chapter 9 of *The Brookings Quarterly Econometric Model of the United States, op. cit.*

highly debatable whether these relationships are adequately described by statistics on developments in the other sectors of the economy. This *caveat* applies with particular force to our wage series, which is based on the manufacturing sector alone. As pointed out in our discussion in Chapter 3 above, there are limitations on the extent to which average hourly earnings in manufacturing can serve as a proxy for average wages in the economy as a whole, particularly in the Canadian context. On the other hand, one might possibly attempt to make a virtue out of these limitations by arguing that the trade-off analysis pursued in the following Chapter is not readily applicable to agriculture and other primary sectors.

In this Chapter the new estimates of the relationships from which a trade-off equation can be derived are presented. The surrounding discussion will explain their derivation, and tests applied to evaluate their reliability will be reported. These tests are the same sort as those applied to the three earlier estimates exammined in the preceding Chapter. The concluding section summarizes the results of the preceding three sections, in conjunction with the technical material reported in the Appendix to this Chapter. In Chapter 6, the policy implications of the new estimates will be explored.

2. Wage Adjustment Relationships

As in the earlier Reuber and Kaliski studies and in the Brookings model, the dependent variable of the wage equations which we have fitted is the percentage rate of change of wages—not the *level* of wages. The wage variable is average hourly earnings of production workers in the manufacturing sector. These figures do not take into account fringe benefits as do the "compensation" data employed in the Brookings model. Average hourly earnings reflect bonuses and other premium payments; in addition, they reflect the cyclical movement in the proportion of regular to overtime wages and in the industrial composition of wage payments. Consequently, what is termed "wages" in the following discussion is not a pure and simple wage rate. Average hourly earnings figures were used because these figures were considered to be the best approximation to wage rates available on a quarterly basis. These average hourly earnings exclude the salaries of nonproduction employees, again in contrast to the data utilized in the Brookings study.

In re-estimating the wage adjustment relationships, regressions were fitted to quarterly data, by ordinary least squares methods,[1] as was done for the earlier Reuber estimates for Canada and in the Brookings model. The main differences from these earlier estimates for Canada are: (i) the selection of the variables used to explain the rate of change in wages; (ii) the form in which the variables were included in the fitted equations; (iii) the time span covered by the estimates; and (iv) the use of dummy variables to take account of seasonal influences instead of seasonally adjusting the quarterly data employed prior to their use in the regressions.

[1] Some limitations of this technique are discussed in Section 5 of this Chapter. Two-stage least squares estimates of the parameters of the tentatively selected wage and price equations are presented in the Appendix to this Chapter.

In the Reuber, Kaliski, Klein-Bodkin, and Vanderkamp studies, the most significant variables explaining the rate of change in wages were the rate of change in the Consumer Price Index and the unemployment rate. None of the estimated relationships from these studies assigned a significant role to either profits or to U.S. wages. In popular discussions (such as those found in the daily press), profits are usually pointed up as a significant determinant of wages. Larger profits, for example, are said to enable firms to "afford" to pay higher wages; it might be argued that high profits reduce the resistance to wage demands by making the opportunity cost of a strike or work stoppage unacceptably high. At the same time, higher profits strengthen the political position of unions pressing for higher wages and large oligopolistic firms are likely to find it advantageous to share some of their gains in profits with their labour force. Several empirical studies published in recent years, including the Brookings model, have tended to confirm the importance of profits as a determinant of wage changes in the United States.[1] The selection of a statistical variable to represent satisfactorily the influence of profits as a determinant of wages leaves considerable room for uncertainty. In Reuber's earlier study, the quarterly percentage rate of change in manufacturing corporate profits and in profits per unit of manufacturing output were included in several experiments; neither proved to be significant. Vanderkamp tried corporate profits as a fraction of Gross National Product in explaining wage changes in his organized sector; this variable was also not statistically significant. After considering the profit variables utilized in other studies and the availability of data for Canada, it was decided to experiment further with two specifications of a profits variable: profits per unit of manufacturing output and the ratio of corporate profits in manufacturing to the wage bill in the manufacturing sector. In these experiments, these variables entered the regressions in two forms: as a *level* indicating the amount of the profit margins; and in the rate of change form, indicating the percentage change in profit margins.

As far as the influence of U.S. wages is concerned, it is frequently suggested that trade union policies in this country are influenced by the policies followed by U.S. unions, with which many Canadian unions are affiliated and have close connections.[2] Furthermore, in wage negotiations in Canada, labour unions have sometimes explicitly expressed their demands in relation to the U.S. wage levels. Most frequently, this has taken the form of demanding parity with U.S. wage levels either immediately, or over a period of time. In addition to these considerations, which suggest a rather special relationship between Canadian and U.S. wages, one might expect Canadian wages to be influenced by U.S. wages in much the same way that wages in many U.S. industries are influenced by wages in a "key group" of industries. The importance of the spillover effects of wage changes in a "key

---

[1] See the references given in Chapter 3 above, in connection with the discussion of the study by G. L. Perry. For a more detailed discussion of the role of profits in a wage adjustment equation, see Schultze and Tryon, *op. cit.*, pp. 314-316, and William G. Bowen, *The Wage-Price Issue*, pp. 113-124.

[2] As an example of this type of trade union policy, one might cite a recent pamphlet by Harry J. Waisglass, *Toward Equitable Income Distribution* (Toronto: National Office for Canada of the United Steelworkers of America, 1966). Fourteen pages out of fifty-five in this pamphlet focus explicitly on the issue of parity with U.S. wages.

group" of industries on wages in other industries has been especially emphasized by Professors Eckstein and Wilson in their study of wage determination in the United States.[1] As an extension of their findings, one would not be surprised to find a closely analogous relationship between wages in the United States and Canada, with the U.S. economy serving as the "key group" to which Canadian wages are geared. As with most econometric findings, of course, it is possible to put forward alternative interpretations of these results.

The form in which each variable was included in the equations generally corresponds to the form followed in the Brookings model and, in some cases, in the Klein-Bodkin study. In fitting equations to quarterly data, the question of lag relationships between variables becomes particularly important since the time span between observations, during which the variables can interact, is very short, and the reaction time between variables can be expected to differ. Consequently, unless lag relationships are taken into account satisfactorily, one may easily derive estimates of the structural relationships which are spurious or badly inaccurate. Kaliski's study was based on annual data and no explicit attempt was made to allow for lags. Reuber's earlier wage adjustment equation, which was based on quarterly data, allowed for lags by including lagged values of the dependent variable (which proved to be statistically insignificant), following a procedure developed by L. M. Koyck and extended by R. M. Solow.[2] In the Brookings model, lags are taken into account by including a distributed lag effect in the form of the variables and also by including a lagged value of the dependent variable (a Koyck-type distributed lag term). With a few exceptions, the distributed lag effect was built into the explanatory variables by calculating a four-quarter moving average of the values of each explanatory variable for the current and preceding three quarters,[3] these transformed data provided the inputs, in some cases after the raw data themselves had been previously manipulated, to which the equations were fitted.

These variables were used to explain the percentage rate of change in wages between any quarter and the same quarter a year earlier. By putting the dependent variable in this form, the problem of allowing for seasonality is very largely

---

[1] Otto Eckstein and Thomas A. Wilson, "The Determination of Money Wages in American Industry", *op. cit.*

[2] L. M. Koyck, *Distributed Lags and Investment Analysis* (Amsterdam: North Holland Publishing Company, 1954); R. M. Solow, "On a Family of Lag Distributions", *Econometrica*, Vol. 29, No. 1 (January 1961), pp. 65-73.

[3] The use of this technique originated with Dicks-Mireaux and Dow, "The Determinants of Wage Inflation: United Kingdom, 1946-1956", *op. cit.* The method is based on the assumption of an annual wage round, with wage settlements uniformly distributed throughout the year. In this case, the change in wages from the corresponding quarter of the previous year to the current quarter will reflect equally the state of the determinants of wage changes for the present quarter and each of the preceding three quarters; hence, the use of the four-quarter moving average, centred on a time date 1½ quarters prior to the present, is appropriate. In a North American context (where the "wage round" concept is much more amorphous and, in many cases, does not refer to a one-year period), the use of such a technique is less natural; nevertheless, on pragmatic grounds, the technique may be applied if it has been found to give good results, which is generally the case.

eliminated.[1] At the same time, the use of the percentage change on a year-to-year basis recongizes a certain stickiness in wage adjustments and allows sufficient time for important wage changes to manifest themselves in the statistics. The wage changes reflected in any four-quarter change will, of course, reflect adjustments made towards the beginning of the period as well as towards the end of the period; in turn, adjustments made earlier in the period may reflect the state of the determinants of wage changes during the preceding four-quarter period as well as during the current one. The state of the determinants of wage changes during the current period is presumably captured in the moving averages of these variables during the current period, while the lagged effects of the state of the determinants during the preceding period is hopefully taken into account by including the value of the dependent variable of four quarters prior to the current date.

The following list of variables indicates the exact form in which these variables were used in the experiments undertaken in developing our estimates; the sources of the underlying data are given, in parentheses, after the definitions of the variables. (The t subscript, which time-dates the variables, denotes a specific quarter of the year to which the observation belongs.)

$\dot{W}_t = \frac{W_t - W_{t-4}}{W_{t-4}} \cdot 100 =$ percentage change in average hourly earnings of production workers in manufacturing between a given quarter and the corresponding quarter one year earlier. (Dominion Bureau of Statistics.)

$\dot{W}^*_{us_t} = \frac{1}{4} \sum_{i=0}^{3} \dot{W}_{us_{t-i}}$, where $\dot{W}_{us_t} = \frac{W_{us_t} - W_{us_{t-4}}}{W_{us_{t-4}}} \cdot 100$ and W_{us} is average hourly earnings in manufacturing, in U.S. dollars. ([U.S.] Department of Labor.)

$W^*_{gap_t} = \sum_{i=0}^{3} W_{gap_{t-i}}$, where $W_{gap_t} = \frac{W_{us_t} - W_t}{W_t}$.

(It should be noted that the wage gap variable is defined without taking fluctuations in the exchange rate into account. In other words, an exchange rate at par is implicity assumed.)

[1] In our initial experiments, seasonal dummies, which take the value of unity during a particular quarter and zero at other times, were introduced explicitly into the estimated wage adjustment relationships. (The procedure is outlined in more detail in Section 3 below on relationships describing labour productivity.) These dummy variables were always insignificant, with the regression coefficients generally a small fraction of the associated standard errors. However, the definitions of the variables are such that little scope is left for seasonal factors to have an influence. Thus, taking the percentage change over a four-quarter period (as with the wage change dependent variable) will eliminate a multiplicative seasonal influence, while taking an arithmetic average in which each of the four calendar quarters of the year appear with an equal weight (as with the unemployment rate) will annihilate an additive seasonal influence. Accordingly, it is not surprising that seasonal variables fail to be statistically significant in the wage adjustment regressions.

$\dot{P}_t^* = \frac{1}{4} \sum_{i=0}^{3} \dot{P}_{t-i}$ where $\dot{P}_t = \frac{P_t - P_{t-4}}{P_{t-4}} . 100$ and P is the Consumer Price Index. (Dominion Bureau of Statistics.)

$(U_t^*)^{-1}$ = Reciprocal of U_t^*, where $U_t^* = \frac{1}{8} U_t + \frac{1}{4} \sum_{i=1}^{3} U_{t-i} + \frac{1}{8} U_{t-4}$ and U_t is the unemployment rate in the t–th quarter. (Dominion Bureau of Statistics.)

$(U_t^*)^{-2} = \frac{1}{(U_t^*)^2} = (U_t^{*-1})^2$.

Z_t = Corporate profits in manufacturing before tax, either in millions of dollars or as an index (1949=100), as indicated. (Dominion Bureau of Statistics.)

Q_t = Revised index of manufacturing production (1949=100). (Dominion Bureau of Statistics.)

$(Z/Q)_t^* = \frac{1}{4} \sum_{i=0}^{3} (Z/Q)_{t-i} . 100$ = four-quarter moving average of the profit markup on output (i.e., profits per unit of output in manufacturing), as an index (1949=100) (Z and Q are both indexes).

WN = total wage and salary income in manufacturing, in millions of dollars. (Dominion Bureau of Statistics.)

$(Z/WN)_t^* = \frac{1}{4} \sum_{i=0}^{3} (Z/WN)_{t-i} . 100$ = four-quarter moving average of the percentage profit markup on the wage bill in manufacturing (Z in this case is in millions of dollars, as is WN).

$(\dot{Z}/Q)_t = \frac{(Z/Q)_t - (Z/Q)_{t-4}}{(Z/Q)_{t-4}} . 100$ = percentage change in the profit markup on output in manufacturing between one quarter and the corresponding quarter a year earlier (Z an index).

$\Delta(Z/WN)_t = [\,(Z/WN)_t - (Z/WN)_{t-4}\,] . 100$ = absolute change in the percentage markup of profits on the bill for wages and salaries in manufacturing between one quarter and the corresponding quarter a year earlier (Z and WN both in millions of dollars).

$\dot{A}_t^* = \frac{1}{4} \sum_{i=0}^{3} \dot{A}_{t-i}$, where $\dot{A}_t = \frac{A_t - A_{t-4}}{A_{t-4}} . 100$

$A_t = \left(\frac{Q}{MH_t}\right) . 100$ = index of output per man-hour (MH) of labour input in manufacturing (1949=100). (Economic Council of Canada.)

DUM = 0 , first quarter of 1953 to fourth quarter of 1960 inclusive;
= 1 , first quarter of 1961 to second quarter of 1965 inclusive.

In defining our variables, we have deliberately conformed as closely as possible to the definitions in the Brookings model, which in turn closely follow the variable definitions adopted by Dicks-Mireaux and Dow. It is recognized, of course, that one might choose different definitions for these variables—e.g., by averaging the data over a different number of quarters and by assigning different weights to each quarter. The definitions of the variables in the Brookings model seemed reasonably satisfactory to us. Moreover, by conforming to the Brookings definitions, we gain the additional advantage that our results are more closely comparable with the Brookings estimates for the United States.

The unemployment rate, which, as indicated in the foregoing list, has been transformed into a weighted, five-quarter moving average centred on a date six months prior to the current period, was used in two forms. As in the Reuber, Kaliski, and Brookings studies (along with a number of others), the reciprocal of the unemployment rate was used as an explanatory variable. As outlined in the preceding Chapter, there is some evidence to suggest that this form of the variable, which implies a nonlinear relationship, is more appropriate for the Canadian economy than the use of the untransformed unemployment rate itself in a linear relationship. In addition, the square of the reciprocal of the unemployment rate was also utilized. Kaliski, in his study, experimented with this variable and found that it did not add significantly to his explanation of wage changes. Nevertheless, it seemed worth experimenting further with this variable as a check on the simple reciprocal form. The square of the reciprocal implies a wage-change-unemployment curve which is steeper in the very low range of unemployment and flatter in the higher range of the unemployment rate than is the straight reciprocal. In other words, the formulation utilizing the square of the reciprocal implies a wage adjustment curve with greater curvature in the observed range of the unemployment rate than does the simple reciprocal.

In the equations that follow, t-ratios (which are the regression coefficients divided by their associated standard errors) are shown in square brackets below these regression coefficients. (In this manner, we distinguish these statistics from the standard errors, which are sometimes shown in parentheses below the estimated regression coefficients.) These t-ratios indicate the degree of confidence to be associated with any particular coefficient. Following the usual convention, we have assumed that t-ratios of 2.02 or more indicate a significant coefficient at the 95 per cent confidence level and a t-ratio of less than 2.02 indicates an insignificant coefficient.[1] R^2, which is the coefficient of multiple determination (unadjusted for degrees of freedom), indicates the percentage of the variation in the dependent variables explained by variation in the explanatory variables.

---

[1] The critical value is based on approximately 45 degrees of freedom and a two-tailed test. Strictly speaking, the test is applicable only if all the assumptions of the classical regression model, including nonautocorrelated disturbances, are satisfied.

Table 5.1

Regressions Explaining $\dot{W}_t$, the Rate of Change in Wages, over the Period 1953-65

Equation Number	Constant Term	Coefficients of Explanatory Variables:						R^2	D.W.
		$\dot{P}^*_t$	$(U^*_t)^{-2}$	$(U^*_t)^{-1}$	$(Z/Q)^*_{t-2}$	$\dot{W}^*_{us_t}$	$\dot{W}_{t-4}$		
(5.1)	-4.32	0.487 [6.42]	18.4 [2.96]	–	0.0618 [3.16]	0.291 [2.51]	-0.116 [3.02]	0.847	1.62
(5.2)	-5.45	0.440 [6.06]	–	6.31 [2.45]	0.0658 [3.25]	0.351 [3.11]	-0.0890 [2.46]	0.839	1.57
(5.3)	-5.05	0.537 [6.95]	25.6 [4.35]	–	0.0775 [3.96]	–	-0.140 [3.54]	0.825	1.42
(5.4)	-7.13	0.479 [6.13]	–	9.07 [3.44]	0.0910 [4.50]	–	-0.104 [2.66]	0.803	1.30
(5.5)	0.761	0.512 [6.20]	29.2 [5.09]	–	–	0.409 [3.40]	-0.122 [2.91]	0.812	1.40
(5.6)	-0.573	0.446 [5.59]	–	10.9 [4.64]	–	0.499 [4.38]	-0.0829 [2.08]	0.800	1.35
(5.7)	1.65	0.602 [6.94]	44.5 [11.5]	–	–	–	-0.161 [3.61]	0.764	1.12
(5.8)	-0.265	0.516 [5.59]	–	18.6 [10.0]	–	–	-0.105 [2.25]	0.714	0.948
(5.9)	1.42	0.556 [5.78]	36.1 [10.4]	–	–	–	–	0.697	1.01

Finally, D.W., the Durbin-Watson statistic, may be used to test for significant autocorrelation in the computed residuals of the regression equation.[1]

In all our experiments concerned with estimating the determinants of $\dot{W}$, $\dot{P}^*$ and one of the variants of U^* were included as explanatory variables, and almost all included $\dot{W}_{t-4}$– the distributed lag term–as well. Most of our experimentation concentrated on testing for the role of profit margins and for that of U.S. wages, for the most appropriate form in which to include the U^* variable in our estimates, and for any evidence of a shift in the wage-change-unemployment relationship.

Initially, our work focused on the period from 1949 to 1965. It was suggested that the period from 1949 to the end of 1952 was highly abnormal because of the Korean War and its aftermath and that inclusion of these years might distort our estimates.[2] We tested this suggestion statistically by including a dummy variable in some of our estimates which had a value of zero from 1949 to the second quarter of 1952 and a value of unity thereafter. The regression coefficient of this dummy variable was statistically significant, thus supporting the view that a shift had occurred after 1952. In addition, we noted that the Brookings estimates of the U.S. wage and price relationships generally improved when the Korean period was excluded and the regressions were rerun, though this improvement may have reflected other factors as well as omission of this period.[3] On the basis of this evidence, it was decided to eliminate the 1949 to 1952 period and form the estimated relationships for the period beginning in 1953 and ending with the second quarter of 1965–the latest date for which data were available at the time the computations were made. Thus, our estimates are based on 50 observations.

The "best" equations explaining $\dot{W}_t$ are shown in Table 5.1. In our judgment, these equations are "best", with the criteria being the magnitude of R^2, the size of the t-ratios, the appropriateness of the signs of the parameters and the reasonableness of the parameters themselves. All equations include $\dot{P}_t^*$ and a variant of the unemployment rate U^*, and all but one include $\dot{W}_{t-4}$. Equations (5.1) and (5.2) include both profits and U.S. wage changes; equations (5.3) and (5.4) include profits but omit the U.S. variable; equations (5.5) and (5.6) include U.S. wage changes but omit profits; equations (5.7) and (5.8) omit both profits and U.S. wage changes; and equation (5.9) includes only the consumer price change variable and one of the two unemployment variables. In these equations all regression coefficients are significant (by the conventional tests) at the 5 per cent level and

[1] Tables for evaluating the Durbin-Watson test statistic may be found in J. Durbin and G. S. Watson, "Testing for Serial Correlation in Least Squares Regression, II", *Biometrika*, Vol. LXXVI (1951), pp. 159-178, and in H. Theil and A. L. Nagar, "Testing the Independence of Regression Disturbances", *Journal of the American Statistical Association*, Vol. LVI (1961), pp. 793-806. Ordinarily, the presence of a lagged dependent variable vitiates such tests, but since the lagged dependent variable is dated four quarters previously to the current quarter, presumably the reasoning underlying these tests will continue to go through, provided one can assume that the autoregressive structure for the disturbances does not extend backward for more than three quarters.

[2] This suggestion was first advanced to us by J. J. Deutsch and later reiterated by D. L. McQueen.

[3] Schultze and Tryon, *op. cit.*, pp. 331-332.

each variable has the expected sign. At first blush one might question the sign of the coefficient on the lagged wage change variable, $\dot{W}_{t-4}$. On further consideration, however, this sign seems quite plausible: one might expect a fluctuating path of wage adjustments over time, a year of rapid increase being followed by a year of less rapid increase, and vice versa. Moreover, wage bargains frequently extend over more than one year with a large increase in one year being accompanied by an agreement on a more modest increase in the succeeding year.[1]

Several experiments were conducted using $(Z/Q)^*_t$ and $(Z/Q)^*_{t-1}$ in place of $(Z/Q)^*_{t-2}$. In each of these "alternative" cases the relevant coefficient was not significant, and the value of R^2 for the equation as a whole was reduced. It seems plausible that the level of profit margins affects the rate of change in wages with a slight lag. Presumably, it takes some time for information on profit margins to become available and for employees and employers to react to this information. Each of the above profit variables has a lag built in, and of course the $(Z/Q)^*_{t-2}$ form—the only one to register a significant coefficient—involves a longer lag than do the other two. The implication here is that it takes still longer for profits (compared with price changes, for example) to affect wages.[2]

Various experiments were made, employing both the level and the absolute change forms of $(Z/_{WN})$ and utilizing the rate of change form of $(Z/_Q)$, in a fitted regression. In each case, the regression coefficient of this profits variable was insignificant, and the magnitude of R^2 was less than with the formulation adopted. Another set of experiments attempted to test the (partial) relationship between $\dot{W}_t$ and the productivity change $\dot{A}^*_t$. The regression coefficient for this variable was highly insignificant consistently, and in one case it had an inappropriate sign as well.

The optimum method of incorporating the influence of U.S. wages on Canadian wage changes was an open question, when we began our experiments on this issue. From the arguments in popular discussion,[3] one might expect the relative gap between U.S. and Canadian wage levels to be a more important determinant of (Canadian) wage changes than the rate of change of U.S. wages. But the former variable, W^*_{gap}, is never statistically significant, whereas we have seen in Table 5.1 that the $\dot{W}^*_{us_t}$ variable is a rather strong influence, at conventional levels of statistical significance. This outcome is perhaps explicable in terms of the near constancy of the W^*_{gap} variable, which fluctuates very little over the sample period. Hence, if there are any errors of measurement in the variable (which seems likely, in view of the arbitrariness of the exchange rate conversion factor employed), such errors might swamp any genuine "signal" coming from this variable. Thus it is

---

[1] It is interesting to note that Schultze and Tryon obtained similar results, with even larger quantitative impacts of the lagged wage changes in five out of the six subsectors investigated.

[2] Published information on profits may involve a considerable lag, while changes in consumer prices (and changes in the availability of unemployed labour as well) are likely to be recognized rather quickly. In this sense, then, it should not be too surprising to find evidence of a longer "reaction time" in the case of the profits variable.

[3] Cf. footnote 2, p. 119.

quite possible that the four-quarter average of U.S. wage changes is a better indicator of pressures for parity than the wage gap variable itself.

All but one of the combinations of explanatory variables in Table 5.1 were tested in conjunction with both $(U^*)^{-1}$ and $(U^*)^{-2}$. In every equation shown, $(U^*)^{-2}$ emerges as the better form of the variable, judged in terms of its higher t-ratio and a higher value of the coefficient of multiple determination. The Durbin-Watson statistic is consistently higher for the formulation employing the square of the reciprocal of the unemployment rate, and with the Theil-Nagar test, the residuals of equation (5.1) are significantly nonautocorrelated at the 1 per cent (but not the 5 per cent) level, while this is not true for equation (5.2). Moreover, in an experiment in which both $(U^*)^{-1}$ and $(U^*)^{-2}$ were included in the same regression, $(U^*)^{-2}$ was statistically significant while $(U^*)^{-1}$ was not.

Finally, various tests were run on the equations shown in Table 5.1 in order to check the regressions for evidence that they may have shifted over time and to assess their predictive power. The tests applied were the same as those employed in Chapter 4 in evaluating the previous relationships estimated for the Canadian economy.

Table 5.2 shows the coefficients for the first four regressions in Table 5.1 in which $(U^*)^{-2}$ appears as an explanatory variable. In each case, the Table presents the regression coefficients for the equations estimated for the period as a whole, for two subperiods – 1953-60 and 1961-65 – and for the entire period with an added dummy variable which takes a value of zero during the first subperiod and a value of unity during the second subperiod. Table 5.2 also shows the standard errors of the regression coefficients, the values of the coefficients of multiple determination, and the estimated standard deviation of the residuals, $\bar{S}_u$, which has been corrected for degrees of freedom.

The first point to be noted is that, in every case, the regression coefficient for the dummy variable is statistically insignificant, thus providing no evidence of a shift in the constant term of the relationship after 1960. The same conclusion held when these tests were made for the regressions with the $(U^*)^{-1}$ variable; the dummy variable was insignificant, although the t-ratios were slightly higher than those with the $(U^*)^{-2}$ form.

A somewhat different picture results when one examines the slope coefficients of individual explanatory variables. There is no evidence of a significant shift in any of the four price change coefficients, nor for any of the four coefficients of the lagged wage change variables. On the other hand, in both cases the coefficient of the U.S. wage change variable appears to shift significantly from the earlier to the later subperiod. As intermediate cases, one of the two coefficients of the profits variables appears to shift significantly between the subperiods (while the other does not), and the unemployment variable displays stability in its influence on wage changes, over the two subperiods examined, in only two out of four instances.

Table 5.2

Wage Change Regressions Estimated for 1953–65 and for Subperiods

Group	Equation Number	Period Estimated	Constant	Coefficients of Explanatory Variables:						R^2	$\overline{S}_u$
				$\dot{P}^*_t$	$(Z/Q)^*_{t-2}$	$\dot{W}^*_{us_t}$	$(U^*_t)^{-2}$	$\dot{W}_{t-4}$	$D^{\#}$		
A	(5.1)	1953–65	–4.32	0.487 (0.0758)	0.0618 (0.0195)	0.291 (0.116)	18.4 (6.23)	–0.116 (0.0384)	–	0.847	0.456
	(5.10)	1953–60	–6.59	0.482 (0.0878)	0.0828 (0.0240)	0.388 (0.149)	12.0 (6.76)	–0.0978 (0.0405)	–	0.886	0.451
	(5.11)	1961–65	2.84	0.433 (0.400)	0.0110 (0.0464)	–0.433 (0.301)	53.2 (14.2)	–0.434 (0.274)	–	0.830	0.333
	(5.12)	1953–65	–4.52	0.485 (0.0757)	0.0616 (0.0195)	0.326 (0.120)	18.2 (6.23)	–0.107 (0.0393)	0.165 (0.157)	0.851	0.455
B	(5.3)	1953–65	–5.05	0.537 (0.0773)	0.0775 (0.0196)	–	25.6 (5.87)	–0.140 (0.0394)	–	0.825	0.482
	(5.13)	1953–60	–8.33	0.587 (0.0859)	0.112 (0.0233)	–	20.4 (6.53)	–0.134 (0.0419)	–	0.856	0.497
	(5.14)	1961–65	4.16	0.732 (0.360)	–0.0291 (0.0392)	–	45.5 (13.8)	–0.161 (0.211)	–	0.800	0.348
	(5.15)	1953–65	–5.13	0.539 (0.0782)	0.0780 (0.0198)	–	25.7 (5.96)	–0.138 (0.0402)	0.0494 (0.161)	0.825	0.487

Table 5.2 (Continued)

Wage Change Regressions Estimated for 1953–65 and for Subperiods

Group	Equation Number	Period Estimated	Constant	Coefficients of Explanatory Variables:						R^2	$\bar{S}_u$
				$\dot{P}^*_t$	$(Z/Q)^*_{t-2}$	$\dot{W}^*_{us_t}$	$(U^*_t)^{-2}$	$\dot{W}_{t-4}$	$D^{\#}$		
C	(5.5)	1953–65	0.761	0.512 (0.0826)	–	0.409 (0.120)	29.2 (5.73)	–0.122 (0.0420)	–	0.812	0.499
	(5.16)	1953–60	0.193	0.435 (0.103)	–	0.629 (0.155)	21.0 (7.38)	–0.0922 (0.0479)	–	0.834	0.534
	(5.17)	1961–65	3.53	0.500 (0.271)	–	–0.401 (0.235)	53.7 (13.5)	–0.401 (0.230)	–	0.830	0.321
	(5.18)	1953–65	0.542	0.511 (0.0826)	–	0.444 (0.125)	28.9 (5.74)	–0.113 (0.0430)	0.170 (0.172)	0.816	0.499
D	(5.7)	1953–65	1.65	0.602 (0.0868)	–	–	44.5 (3.89)	–0.161 (0.0448)	–	0.764	0.553
	(5.19)	1953–60	1.60	0.620 (0.115)	–	–	45.4 (5.33)	–0.164 (0.0554)	–	0.733	0.665
	(5.20)	1961–65	1.89	0.574 (0.285)	–	–	40.5 (11.8)	–0.186 (0.205)	–	0.791	0.342
	(5.21)	1953–65	1.65	0.602 (0.0880)	–	–	44.5 (4.10)	–0.162 (0.0457)	–0.00173 (0.185)	0.764	0.560

#The shift variable "D" has a value of 0 up to the end of 1960 and 1 thereafter.

Finally, the results of applying the Chow test to these four equations are summarized in Table 5.3. Equation (5.1) fails the Chow test at the 5 per cent level of statistical significance, but does manage to pass it at the 1 per cent level. The strict interpretation of this result is that the test provides some evidence of a shift in the relationship, over the entire period under examination. The other equations all pass this test, although equations (5.3) and (5.5) do so barely; this outcome implies that there is no evidence of a shift in the parameters of these relationships.[1] Equation (5.1) includes both profit margins and U.S. wage changes as explanatory variables, while the other regressions exclude either or both of these variables. Hence, given the results regarding the stability of the individual regression coefficients, it is not surprising that equations (5.3) and (5.5) are marginally more stable than equation (5.1) and that the equation which warrants the greatest confidence with regard to stability over the total period is equation (5.7), which omits both profit margins and U.S. wage changes as explanatory variables. As indicated in Table 5.3, the F-ratio for equation (5.7) is extremely small (0.05), both in comparison to the critical values for the F statistic and to the F-ratios associated with the other three regressions.[2]

Table 5.3

Tests for Shifts in the Regression Coefficients of the Wage Change Equations, 1953-65

Equation Number	F-ratio from Equation	Critical Values for F-ratio, at Significance Level of: 5%	1%	Conclusion#
	F	F_ϵ	F_ϵ	
(5.1)	2.42	2.35	3.32	Shift (at 5% level)
(5.3)	2.15	2.45	3.51	No shift
(5.5)	1.93	2.45	3.51	No shift
(5.7)	0.05	2.59	3.80	No shift

#If $F > F_\epsilon$ we reject the hypothesis that the parameters have not shifted.

In addition to these two tests, the predictive power of the estimated wages equations was tested against the predictive power of several "naive" models, again employing the procedure used in Chapter 4. Since the form of the variables included in the equations here differs from the form of the variables considered in that Chapter, the naive models used here differ slightly from those used earlier,

[1] The Chow test was performed on equations (5.2) and (5.4), which are comparable to (5.1) and (5.3), except that the unemployment rate is expressed as a simple reciprocal. The F-ratios were 2.77 and 2.68, respectively, suggesting unstable relationships. On these grounds, also, it appears that the regressions utilizing $(U^*)^{-2}$ appear to be somewhat better.

[2] The level of statistical significance of the regression coefficients for a number of the explanatory variables is well below the 5 per cent level, for the 1961-65 subperiod. The possibility that the relationship disintegrates, in some sense, during this later subperiod has been considered in footnote 3, page 94 above. On the other hand, the unemployment effect seems, if anything, to be stronger during the later subperiod.

although they have the same general form. The following naive models were employed for the present purpose:

$$\hat{\dot{W}}_t = \bar{\dot{W}} \text{ (1953–60)}, \tag{5.22}$$

$$\hat{\dot{W}}_t = \dot{W}_{t-1} , \tag{5.23}$$

$$\hat{\dot{W}}_t = \dot{W}_{t-4} , \text{ and} \tag{5.24}$$

$$\hat{\dot{W}}_t = \dot{W}^*_{t-1} , \tag{5.25}$$

where (as before) $\dot{W}_t$ is defined as $\frac{W_t - W_{t-4}}{W_{t-4}} \cdot 100$, $\hat{\dot{W}}_t$ is the predicted value of $\dot{W}_t$, $\dot{W}^*_t = \frac{1}{4} \sum_{i=0}^{3} \dot{W}_{t-i}$ and $\bar{\dot{W}}$ (1953–60) is the mean value of $\dot{W}_t$ from 1953 through 1960.

Naive model (5.22) predicts that the percentage change in wages in the current quarter will equal the average of the quarterly percentage changes in wages from 1953 to 1960. Model (5.23) predicts that the percentage change in wages in the current quarter will be the same as for the previous quarter. Model (5.24) predicts that the percentage change in wages for the current quarter will be the same as for the corresponding quarter a year earlier. Finally, naive model (5.25) predicts that the percentage change in wages for the current quarter will equal the average of the quarterly percentage changes in wages during the preceding four quarters. In each of these cases, it is important to remember that the percentage change in wages is consistently defined as the percentage change between any particular quarter and the corresponding calendar quarter one year earlier.

The predicted wage changes ($\hat{\dot{W}}_t$) for these four naive models, together with those based on the four regression equations utilizing the $(U^*)^{-2}$ formulation are shown in Table 5.4, as are the deviations between predicted and actual wage changes ($\dot{W}_t - \hat{\dot{W}}_t$). For each predictive model, the value of the D statistic, as defined in Chapter 4, is shown in the last line of Table 5.4. If one judges on the basis of this statistic, equation (5.19), which explains $\dot{W}_t$ as a function of unemployment $(U^*_t)^{-2}$, prices ($\dot{P}^*_t$) and lagged wages ($\dot{W}_{t-4}$), outperforms all other regression equations and all the naive models by a substantial margin. Where U.S. wage changes ($\dot{W}^*_{us_t}$) are added as an explanatory variable in equation (5.16), the value of the D statistic increases and is very slightly greater than the value of the D statistic for naive model (5.25). On this basis, one can say that regression equation (5.16) does not predict any better than a model which simply assumes that the percentage changes in wages for the current quarter will equal the average of the quarterly percentage changes in wages during the preceding four quarters. However, equation (5.16) is a better predictor than all the other naive models. The same conclusions hold for equations (5.10) and (5.13), the results for which are only marginally different from (5.16) and from each other. Thus equation (5.10), which

Table 5.4

Predictive Power of Regression and Naive Models of Wage Changes, 1961-65

Quarter		Actual Wage Change	Predicted Wage Change ($\hat{\dot{W}}_t$)								Deviation of Actual from Predicted Wage Change ($\dot{W}_t - \hat{\dot{W}}_t$)							
			Regression Equations				Naive Models				Regression Equations				Naive Models			
		$\dot{W}_t$	(5.10)	(5.13)	(5.16)	(5.19)	(5.22)	(5.23)	(5.24)	(5.25)	(5.10)	(5.13)	(5.16)	(5.19)	(5.22)	(5.23)	(5.24)	(5.25)
1961	I	2.65	2.80	3.01	2.47	2.68	4.05	2.68	3.68	3.35	-0.15	-0.36	0.18	-0.03	-1.40	-0.03	-1.03	-0.70
	II	2.80	2.35	2.41	2.39	2.56	4.05	2.65	3.71	3.09	0.45	0.39	0.41	0.24	-1.25	0.15	-0.91	-0.29
	III . . .	2.83	1.89	1.92	2.24	2.58	4.05	2.80	3.33	2.87	0.94	0.91	0.59	0.25	-1.22	0.03	-0.50	-0.04
	IV . . .	2.94	1.89	1.90	2.26	2.57	4.05	2.83	2.68	2.74	1.05	1.04	0.68	0.37	-1.11	0.11	0.26	-0.20
1962	I	2.36	2.00	1.74	2.62	2.52	4.05	2.94	2.65	2.81	0.36	0.62	-0.26	-0.10	-1.69	-0.58	-0.29	-0.45
	II	2.72	2.43	2.17	2.85	2.63	4.05	2.36	2.80	2.73	0.29	0.55	-0.13	0.09	-1.33	0.36	-0.08	-0.01
	III . . .	2.92	2.79	2.67	2.96	2.84	4.05	2.72	2.83	2.71	0.13	0.12	-0.04	0.08	-1.13	0.20	0.09	0.21
	IV . . .	3.08	3.34	3.02	3.60	3.11	4.05	2.92	2.94	2.74	-0.26	0.06	-0.52	-0.03	-0.97	0.16	0.14	0.34
1963	I	3.44	3.48	3.46	3.53	3.46	4.05	3.08	2.36	2.77	-0.04	-0.02	-0.09	-0.02	-0.61	0.38	1.08	0.67
	II	3.18	3.63	3.54	3.43	3.53	4.05	3.44	2.72	3.04	-0.45	-0.36	-0.25	-0.35	-0.87	-0.28	0.46	0.14
	III . . .	3.37	3.36	3.70	3.51	3.57	4.05	3.18	2.92	3.16	0.01	-0.33	-0.14	-0.20	-0.68	0.19	0.45	0.21
	IV . . .	4.03	3.46	3.74	3.04	3.59	4.05	3.37	3.08	3.27	0.57	0.29	0.99	0.44	-0.02	0.66	0.95	0.76
1964	I	3.63	3.71	3.73	3.25	3.66	4.05	4.03	3.44	3.51	-0.08	-0.10	0.38	-0.03	-0.42	-0.40	0.19	0.12
	II	3.60	3.71	3.99	3.51	3.93	4.05	3.63	3.18	3.55	-0.11	-0.39	0.09	-0.33	-0.45	-0.03	0.42	0.05
	III . . .	4.35	3.98	4.27	3.65	4.01	4.05	3.60	3.37	3.66	0.37	-0.08	0.70	0.34	0.30	0.75	0.98	0.69
	IV . . .	3.17	3.97	4.33	3.56	4.02	4.05	4.35	4.03	3.90	-0.80	-1.16	-0.39	-0.85	-0.88	-1.18	-0.86	-0.73
1965	I	4.66	4.01	4.42	3.71	4.32	4.05	3.17	3.63	3.69	0.65	0.24	0.95	0.34	0.61	1.49	1.03	0.97
	II	4.61	3.88	4.27	3.83	4.59	4.05	4.66	3.60	3.95	0.73	0.34	0.78	0.02	0.56	-0.05	1.01	0.66
Sum of Squared Deviations											4.79	4.91	4.74	1.66	16.61	5.58	8.80	4.47
Root Mean Square Deviation (D)											0.52	0.52	0.51	0.30	0.96	0.56	0.70	0.50

includes both the profit and U.S. wage variables, performs (essentially) as well as the two equations containing only one of these variables, in spite of the marginal evidence (from the Chow tests) that these latter two equation forms revealed slightly more stable relationships.[1]

As a further check on the relevance of the equations containing $(U^*)^{-2}$, estimates were made of the predictive powers of the "alternative" regressions (with $(U^*)^{-1}$). In all four cases the D statistic was higher for the $(U^*)^{-1}$ formulation than for that with $(U^*)^{-2}$, thereby contributing further support for the superiority of the latter.[2]

In connection with all of these tests, it can be argued that "naive" models (5.25) and (5.23) pose fairly stiff tests against which to measure the predictive power of the regression equations. This is primarily because of the very high serial correlation in the wage change series. The simple correlation coefficient between $\dot{W}_t$ and $\dot{W}_{t-1}$ is 0.95. As already emphasized, the regression equations predict the percentage change in wages in a particular quarter from the same quarter of one year earlier. As pointed out earlier, this gap of four quarters allows some time for the lags to work themselves out and frees the series to some extent from the constraints of the past. This can be regarded as a virtue of utilizing this form of the wage change variable: variations in this series will not be so strongly dominated by events beyond the period under examination, and hence, more scope is provided for evaluating the relative importance of independent determinants of wage changes. At the same time, however, the regression model selected may be a poorer predictor, because it does not make full use of the serial correlation properties

---

[1] The size of the D statistic is not the only criterion by which one can measure the accuracy of a forecasting model. H. Theil has suggested, in *Economic Forecasts and Policy*, Second Revised Edition (Amsterdam: North Holland Publishing Company, 1961), pp. 31-42, the use of an "inequality coefficient"; the numerator of Theil's inequality coefficient is the D statistic, while the denominator is the sum of the root mean squares of the separate actual and the predicted series. It can be shown that the measure varies from 0 to 1, with low values indicating a relatively good fit. For regression model (5.10), the value of the Theil inequality coefficient is 0.078; for regression model (5.19), it is 0.044; and for naive model (5.25), it is 0.075. These values would be generally considered to be indicative of a reasonably high degree of forecasting accuracy.

As Theil's discussion shows, the inequality coefficient can be decomposed into partial coefficients of inequality due to unequal central tendency, due to unequal variation, and due to imperfect covariation. One can then express these three partial coefficients as percentages of the over-all coefficient; Theil's view appears to be that, for a good forecasting model, most of the inequality coefficient can be attributed to imperfect covariation. It is interesting to note that all three of the forecasting models discussed in this footnote conform to this criterion. For regression model (5.10), the proportion of the inequality coefficient due to imperfect covariation is 83 per cent, while for naive model (5.25), this proportion is 73 per cent. For regression model (5.19), the proportion of the inequality coefficient due to imperfect covariation is a fantastic 99.8 per cent.

[2] The root mean square of the deviations for the four "$(U^*)^{-1}$ regressions" comparable to those for (5.10), (5.13), (5.16), and (5.19), respectively, are: 0.55, 0.59, 0.55, and 0.36. It seems reasonable that the $(U^*)^{-1}$ forms should be poorer predictors, given the greater evidence of instability in the relationships suggested by the Chow tests.

entailed in forming overlapping four-quarter rates of change. With these considerations in mind, one can argue that the fitted equations do reasonably satisfactorily in comparison with the naive models. The first three come fairly close to the most accurate naive model (while outperforming the other three), and the fourth regression equation is a better predictor than any of the alternatives.

When the bulk of the evidence is accumulated, it becomes difficult to claim that any particular one of the four basic equations is "best". Equation (5.7) is apparently more stable and a better predictor than the others, at least over the period being considered. However, it may be that the 1961-65 experience, which involved a major adjustment in the exchange rate and a long, slow recovery from a pronounced recession (with the attendant slack in the labour market, and perhaps a resulting insensitivity to profit levels and U.S. wage changes), will not be entirely relevant for wage changes in the future. Moreover, the other equations, especially (5.1), do take more influences into account and provide a superior statistical explanation, in terms of a higher coefficient of determination and a relative freedom from autocorrelation of the residuals. On these criteria, equation (5.1) might be considered the most satisfactory, although all four are carried forward so that their implications for the policy issue of the trade-offs can be compared.[1]

3. Productivity Growth Relationships

As outlined in Chapter 2, the level of productivity may serve as a link between the levels of wages and of prices and consequently the rate of change of productivity may serve as an intervening variable between the rate of change of wages and that of prices. Because of this link, it is evident that a study of the trade-off relationship may necessitate a consideration of productivity trends. However, a complete study of the determinants of productivity and technical change during the period under examination is well beyond the terms of reference for this study. Accordingly, our work on productivity has essentially been designed to obtain an estimate of the trend of output per man-hour in manufacturing, taking into account seasonal influences and the level of resource utilization. The period to which our relationships were fitted was the 68 quarters running from the first quarter of 1949 through the fourth quarter of 1965, although, as will become apparent shortly, this total period is implicitly divided into two subperiods with different predicted rates of productivity growth for each subperiod. No attempt was made to go beyond this analysis to examine the basic determinants of productivity by fitting production functions or by using other types of more advanced techniques.

Our "best" productivity equations, which are based on the full set of 68 observations, are contained in Table 5.5, which presents the regression coefficients, their standard errors and t-ratios, and the coefficients of multiple determination for each equation. The variables are defined as follows:

$\log_{10}A_t$ = logarithm to the base 10 of an index of output per man-hour in the manufacturing sector, where the base value of the A_t index is equal to 100 in 1949;

[1] Estimates of the coefficients of the wage adjustment equations, after the variables have been subject to an autoregressive transformation, and two-stage least squares estimates of the parameters of equation (5.1), are presented in the Appendix to this Chapter.

Table 5.5

Productivity Equations, Fitted to the Period 1949–65#

Equation Number	Constant	Coefficients of Explanatory Variables:								R^2	D.W.
		t	DUM	DUM.t	Q_{dev}/Q_{tr}	$\log_{10}(Q_a/Q_p)_t$	S_1	S_2	S_3		
(5.26)	1.99667	0.0043269 (0.0000947) [45.71]	0.01591 (0.00754) [2.11]	-0.000404 (0.000151) [2.68]	0.0391 (0.0212) [1.84]	–	-0.00989 (0.00194) [5.11]	0.000057 (0.00193) [0.03]	-0.01892 (0.00192) [9.86]	0.9959	1.01
(5.27)	1.82702	0.0044719 (0.0001054) [42.41]	0.01908 (0.00915) [2.09]	-0.000513 (0.000189) [2.71]	–	0.0838 (0.0499) [1.68]	-0.00985 (0.00194) [5.07]	0.000075 (0.00193) [0.04]	-0.01891 (0.00193) [9.81]	0.9959	1.00
(5.28)	1.99607	0.0043808 (0.0000917) [47.75]	0.00757 (0.00614) [1.23]	-0.000300 (0.000142) [2.11]	–	–	-0.00962 (0.00197) [4.89]	0.000235 (0.00196) [0.12]	-0.01886 (0.00196) [9.64]	0.9957	1.03
(5.29)	1.99675	0.0043503 (0.0000887) [49.05]	–	-0.000144 (0.0000645) [2.23]	–	–	-0.00949 (0.00197) [4.81]	0.000321 (0.00197) [0.16]	-0.01881 (0.00196) [9.58]	0.9956	1.01

The dependent variable is $\log_{10}A_t$, where A is an index of output per man-hour in manufacturing.

t	=	time trend, equal to unity in the first quarter of 1949 and increasing consecutively by one unit each quarter;
DUM	=	dummy variable, which takes on a value of zero from the first quarter of 1949 through the fourth quarter of 1957 and a value of unity from the first quarter of 1958 through the fourth quarter of 1965;
S_i	=	three dummy variables (where $i = 1, 2,$ or 3) which correct for the influence of seasonality within the regression itself: S_i is equal to unity in the i–th quarter and zero in the other three quarters. Accordingly, the fourth quarter is designated as the base quarter;
Q_{dev}/Q_{tr}	=	the deviation (Q_{dev}) between actual manufacturing output (seasonally adjusted) and its trend value, as a proportion of the trend value. The trend value (Q_{tr}) is based on a simple logarithmic trend fitted to actual manufacturing output (seasonally adjusted), over the entire period 1949–65;
$\log_{10}(Q_a/Q_p)$	=	logarithm to the base 10 of the index of actual output in manufacturing (again seasonally adjusted) expressed as a percentage of potential output in manufacturing (Q_p). Q_p was calculated by fitting a logarithmic trend between seasonally adjusted values of Q_a when the seasonally adjusted unemployment rate was approximately $3\frac{1}{2}$ per cent.

The equations reported were developed after a fairly extensive series of experiments. The main problem was to develop an equation which satisfactorily took account of the effect of the level of resource utilization on productivity and at the same time allowed for variations in the secular trend in productivity over the period in question. Changes in productivity reflecting secular and resource-utilization effects are likely, on occasion, to be interrelated; in addition, the secular trend in productivity may shift over time. All four equations make an explicit allowance for a shift in the secular trend in productivity beginning in the first quarter of 1958,[1] through the inclusion as explanatory variables in the regressions of DUM (in all but equation 5.29) and DUM.t, which is the product of the time trend and the DUM variables. The DUM variable allows for a shift in the intercept of the equation, while DUM.t allows for a change in the slope coefficient on time and hence, it permits the secular rate of growth of productivity to take on a separate value in each of the two "subperiods".

The difference between equations (5.26) and (5.27) is in the variable employed to take account of the effect of the level of resource utilization: equation (5.26) employs Q_{dev}/Q_{tr} for this purpose, while equation (5.27) uses $\log(Q_a/Q_p)$. It may be observed that, while the value of the coefficient of multiple determination (R^2) is virtually the same for the two equations, the significance of the utilization or "cyclical" variable is slightly higher in the first equation. In neither case does the utilization variable's coefficient satisfy the requirement that the t-ratio be at least 2; nevertheless, the equations are still presented as our most comprehensive, and

[1] The rationale for this break is discussed briefly below.

in some sense "best", estimates, since they do allow for a utilization effect.[1] As a check on these estimates, the regression was run without the utilization variable (equation (5.28)). The omission had only small effects on the remaining coefficients, although it did eliminate the significance of DUM as an explanatory variable. In equation (5.28), then, there is no evidence that the productivity relationship shifted (in terms of the intercept) in 1958, although the evidence still suggests that the rate of change of productivity fell (as indicated by the negative and significant coefficient of the DUM.t variable). Finally, equation (5.28) was rerun with the insignificant DUM variable omitted, which yielded equation (5.29). In the discussion below of the implied rates of growth of productivity derived from these relationships, the effects resulting from this successive deletion of variables can be observed.

In all the attempts to estimate the secular trend in productivity, the dependent variable was expressed in logarithmic form, which follows conventional practice. The rationale for this form is that it is desired to estimate the rate of growth of productivity over time, which can be easily obtained from the logarithmic form. The use of this type of relationship means that the equations estimated by regressions (5.26) and (5.27) can be transformed into the following relationships:

(5.26a) $A_t = \alpha_0 \alpha_1^{DUM} \, 10^{(\beta_1 + \beta_2 . DUM)t} \text{ antilog } (\gamma_1 S_1 + \gamma_2 S_2 + \gamma_3 S_3 + \gamma_4 \, Q_{dev}/Q_{tr})$,

and

(5.27a) $A_t = \alpha'_0 \alpha'^{DUM}_1 \, 10^{(\beta'_1 + \beta'_2 . DUM)t} \text{ antilog } [\gamma'_1 S_1 + \gamma'_2 S_2 + \gamma'_3 S_3] (Q_a/Q_p)^{\gamma'_4}$,

where the α's, the α''s, the β's, the β''s, the γ's, and the γ''s are the parameters estimated in the regressions. Showing the relationships in this form indicates the underlying assumption of a multiplicative interaction among the independent variables. With unchanged values of the seasonal and resource utilization variables, A_{t+1} is 10^{β_1} times as large as A_t during the period 1949-57, and $10^{\beta_1+\beta_2}$ times as large during the later subperiod 1958-65. Accordingly, the deseasonalized, constant resource-utilization rate of growth of productivity is $(10^{\beta_1} - 1)$ during the earlier subperiod and $(10^{\beta_1+\beta_2} - 1)$ during the later subperiod.

In all our experiments, seasonal variations in productivity were taken into account by use of dummy variables, as outlined above. Every test consistently shows the first- and third-quarter dummies as highly significant in the negative direction and the second-quarter dummy as highly insignificant. This suggests that, due to seasonal influences by themselves, productivity tends to be lower in the first and third quarters than in the second and fourth.

A variety of empirical studies for a number of industrialized countries have pointed to the conclusion that productivity may be sensitive, at least in the short

---

[1] If one were to employ a one-tailed rather than a two-tailed test of significance, the utilization variables would "pass" (i.e., be accepted as significant), since the required t-ratio, at the 5 per cent level, would then be only 1.67. Since there is room for argument as to which is in fact the appropriate test in this case, the retention and presentation of these two equations was felt justified. On the other hand, the presence of autocorrelated residuals (as indicated by the relatively low values of the Durbin-Watson (D.W.) statistic) would, in general, bias the estimated standard errors downward, thus tending to overstate the t-ratios. As it turns out, the implication of the equation is that the degree of utilization has a very small effect on the level of productivity; most of the explanation of productivity emanates from the influence of the other variables.

run, to the level of resource utilization.[1] What is not so obvious is how this influence on productivity can best be taken into account in a quantitative analysis, as there is no unique or generally accepted method of measuring excess capacity. In addition to the variables included in equations (5.26) and (5.27) in order to take variations in capacity utilization into account, experiments were made employing the following variables: U, the rate of unemployment of the labour force; Q_{gap}, the absolute difference between actual and potential real output in manufacturing (as defined above); and Q_{dev}, the numerator of the Q_{dev}/Q_{tr} variable. The unemployment variable was consistently insignificant in every test (including some utilizing lags and leads), while Q_{gap} and Q_{dev} were barely significant in a few experiments, but not in others. In any case, it was felt that the form of the variables used in equations (5.26) and (5.27) were superior on the grounds that in ratio form the numerical value of these variables is independent of the *level* of the indices from which they are derived. The logarithmic form of (Q_a/Q_p) is suggested by a theoretical model of a long-run production function, based on the Cobb-Douglas form.[2]

---

[1] See, for example, B. J. Drabble, *Potential Output, 1946 to 1970*, Staff Study No. 2, Economic Council of Canada (Ottawa: Queen's Printer, 1964) and the evidence cited there. One of the most intensive recent investigations of this question, together with an extensive bibliography, is provided in Professor Edwin Kuh's paper, "Cyclical and Secular Labor Productivity in United States Manufacturing," *The Review of Economics and Statistics*, Vol. XLVII, No. 1 (February 1965), pp. 1-12.

[2] Let the long-run production function be given by:

(i) $$Q_p = \alpha 10^{\lambda t} L_p^{1-\beta} K^{\beta},$$

where Q_p is potential output, L_p is the potential labour input, K is the available stock of capital, and t is a time trend.

Let the following short-run relationship hold when the actual labour input falls short of the potential input and so actual output is below its potential level:

(ii) $$\frac{Q_a}{Q_p} = \left(\frac{L_a}{L_p}\right)^{\gamma},$$

where L_a is the actual labour input and Q_a is the actual level of output. The fact that relationship (ii) is a short-run relationship means that it is presumed to be valid only as an expression of short-term deviations from full-employment or full-capacity levels.

Now we may derive an expression for the ratio of Q_a to L_a, which can be interpreted as a productivity measure. From equation (ii), it follows that

(iii) $$Q_a = \left(\frac{L_a}{L_p}\right)^{\gamma} Q_p \text{, and hence}$$

(iv) $$\frac{Q_a}{L_a} = L_a^{\gamma-1} L_p^{-\gamma} Q_p.$$

Combining equations (iv) and (i), we have:

(v) $$\frac{Q_a}{L_a} = L_a^{\gamma-1} L_p^{1-\beta-\gamma} K^{\beta} \alpha 10^{\lambda t} = \left(\frac{L_a}{L_p}\right)^{\gamma-1} \left(\frac{K}{L_p}\right)^{\beta} \alpha 10^{\lambda t}.$$

Substitution of equation (ii) into this result yields:

(vi) $$\frac{Q_a}{L_a} = \left(\frac{Q_a}{Q_p}\right)^{\frac{\gamma-1}{\gamma}} \left(\frac{K}{L_p}\right)^{\beta} \alpha 10^{\lambda t}$$

Finally, taking common logarithms of both sides of this relationship, we obtain:

(vii) $$\log\left(\frac{Q_a}{L_a}\right) \frac{\gamma-1}{\gamma} \log\left(\frac{Q_a}{Q_p}\right) + \beta \log\left(\frac{K}{L_p}\right) + \lambda t + \text{constant}$$

Relationship (vii) suggests the possibility that the ratio of the available capital stock to the potential labour input may be a relevant variable in the productivity regressions. Although a modification of this variable was entered in several trial regressions, its influence never appeared to be statistically significant.

Q_{dev}/Q_{tr} might have been modified so that an analogous logarithmic variable would have appeared in equation (5.26) instead. However, the two forms approximate each other very closely and it was not considered worth-while to re-run the regression with this form of the utilization variable.[1]

The secular trend in productivity is represented in equations (5.26), (5.27), (5.28) and (5.29), by the regression coefficients of t and DUM.t. (The inclusion of the DUM variable as well permits a shift in the constant term, but does not enter into the estimate of the growth rate itself.) Thus, the inclusion of both a time trend variable and an interaction term between the time trend and the dummy variable allows not only for a secular trend in productivity but also for a shift in that trend. From other evidence and from the time diagram of the productivity series (Figure 5.1), it seemed likely that a shift in the secular trend of productivity occurred around the end of 1957; hence the value of DUM was defined to change from zero to unity at the beginning of 1958. The regression results confirm this expectation: the DUM.t variable is significant in every case, and is negative, indicating a lower rate of productivity growth from the late 1950's onward.[2]

Before reporting the actual rates implied by the equations, it may be mentioned in passing that some other experiments with time trend variables also picked up the decline in the productivity growth rate. Experiments were conducted in which

---

[1] Let y be a mathematical variable and let ln denote the natural logarithm function (logarithm to the base e). Whenever y is small, we shall have the following approximation:

(i) $\ln(1+y) \approx y$.

Hence the statistical variable Q_{dev}/Q_{tr} is approximately equal to:

(ii) $\ln(1+Q_{dev}/Q_{tr}) = \ln(1+\frac{Q_a-Q_{tr}}{Q_{tr}}) = \ln(1+Q_a/Q_{tr}-1) = \ln(Q_a/Q_{tr})$,

where Q_a is the actual (seasonally adjusted) level of output. Since the natural logarithm function is always a constant multiple of the common logarithm function, the two forms of the resource utilization variable are much more analogous than would appear at a casual glance.

It is of some interest to quantify the effects of a varying degree of resource utilization on labour productivity. Computations with equation (5.26) indicate that a 1 per cent rise in manufacturing output relative to its trend value is associated with a 0.090 per cent rise in the A_t variable, at a given point in time and with the seasonal factors held constant. For equation (5.27), one can calculate that a one percentage point rise in the ratio of Q_a to Q_p is associated with a 0.086 per cent rise in the A_t dependent variable. Hence, for both productivity relationships, the calculated effects of variations in the degree of resource utilization on the dependent variable are both quite close and quite small.

[2] A "kink" in the series was much more apparent when productivity was calculated on the basis of the unrevised manufacturing output data. The recent revision resulted in faster rising output (and thus faster rising productivity) over the whole period, with more pronounced adjustments in the more recent years. Nevertheless, the expectations of a slowdown in productivity growth in the late 1950's can still be justified on *a priori* grounds and this expectation is confirmed by our equations (which are based on the revised data). It is quite possible, of course, that further revisions of the data will refute these *a priori* arguments by showing no slowdown at all after 1957.

It might also be mentioned that the productivity series plotted in Figure 5.1 are not seasonally adjusted, while the productivity trend plotted has implicitly been seasonally adjusted by the multiple regression at the fourth-quarter level. Since productivity reaches a seasonal peak in the fourth quarter, the dashed trend lines generally lie above the productivity series.

the trend variable included, in addition to the straight linear t variable, some nonlinear variables: t^2 and t^{-1}. The t^{-1} form suggests a gradually diminishing rate of productivity change, approaching some (asymptotic) steady rate of growth. The t^{-1} variable was significant in versions using the old output data, but was not significant with the revised data. The t^2 form is significant (and the coefficient negative) with either set of data, but the implications are considered unrealistic: the equation captures the gradual decline in the rate of productivity growth, but implies a continuous degeneration whereby the change in productivity would eventually become negative, which of course means that the level of productivity itself would fall.[1]

Table 5.6

Estimates of the Secular Rates of Growth of Productivity, 1949-65

Period	Estimates from Equation: (5.26)	(5.27)	(5.28)	(5.29)
	(Annual percentage rates)			
1949-57	4.06	4.20	4.12	4.09
1958-65	3.68	3.71	3.83	3.95

To return, finally, to our equations in Table 5.5, estimates have been made of the implied rates of growth of productivity, which are presented in Table 5.6. Equation (5.26) implies a compound growth rate in manufacturing productivity of 4.06 per cent per year during the period 1949 through 1957, and of 3.68 per cent per year during the later period 1958 through 1965. The actual productivity levels and the trend values estimates from equation (5.26) (with the cyclical variable and the seasonal variables set equal to zero) have been shown in Figure 5.1. The rates evolving from the four equations are basically similar, although one interesting phenomenon is the progressive increase in the second period's growth rate as variables were deleted from the regression equations. From Table 5.5, it is reasonable that the shift in the constant term (captured by the coefficient of DUM) is positive and significant in equation (5.26) and in equation (5.27), is insignificant in (5.28), and is absent from (5.29). With less upward shift (and finally no shift) in the function at the "kink" point, one might expect a slightly larger slope in the later period; in other words, the estimated growth rate might be expected to become progressively larger from the second equation onward. In any case, the main con-

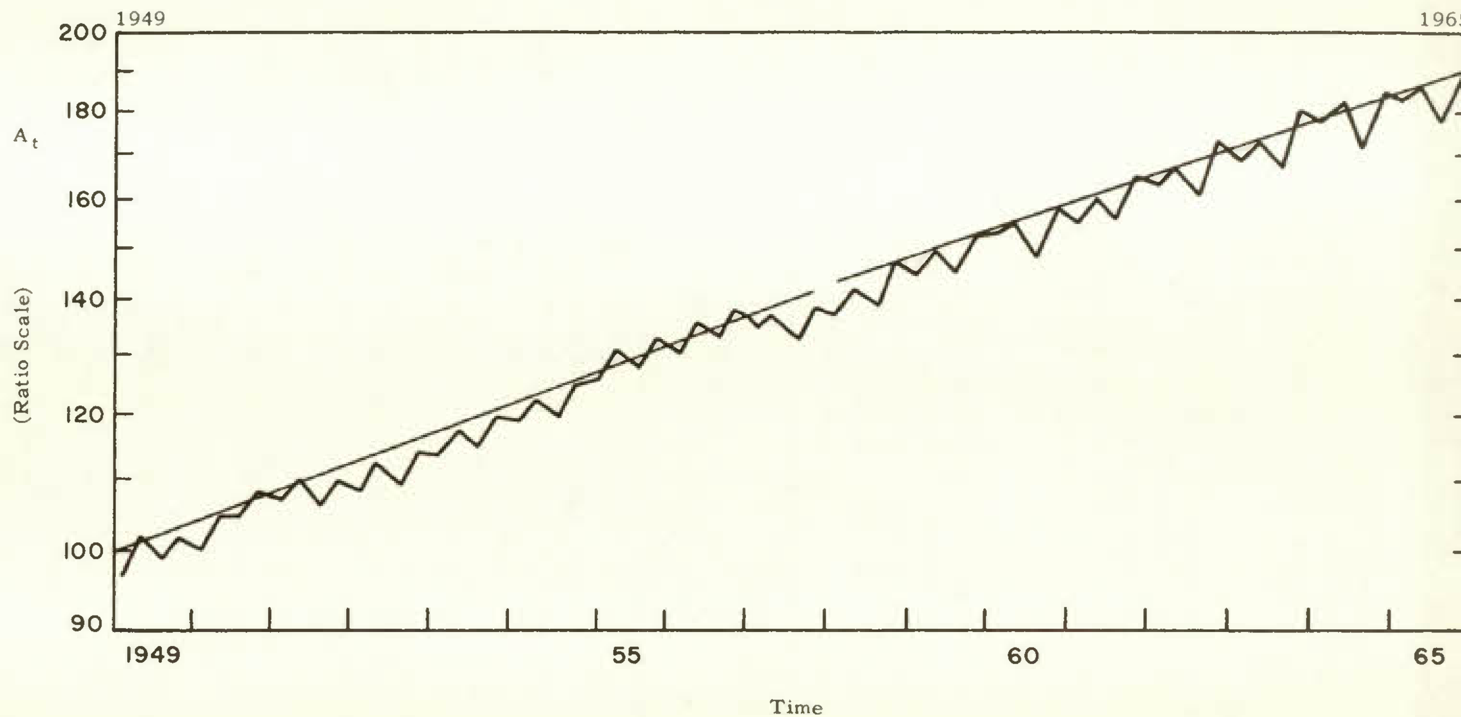
[1]The most statistically satisfactory of these equations is:

$$\log A_t = \underset{[32.33]}{1.99488 + 0.004573t} - \underset{[2.94]}{0.00000586t^2} + \underset{[2.28]}{0.0353 Q_{dev}/Q_{tr}} - \underset{[5.18]}{0.00980S_1} + \underset{[0.06]}{0.00011S_2} - \underset{[10.01]}{0.01891S_3}$$

The coefficient of multiple determination is 0.9960, and the equation is fitted for the complete period based on the revised output data. The implied (trend) rates of productivity growth in 1950, 1955, 1960, and 1965, respectively, are: 4.23%, 4.01%, 3.78%, and 3.56% (annual rates). It is also interesting to note that the cyclical or capacity utilization variable is unambiguously significant (by conventional standards) in this regression.

Figure 5.1

LEVEL OF PRODUCTIVITY (OUTPUT PER MAN-HOUR IN THE MANUFACTURING SECTOR) AND COMPUTED TREND VALUES, 1949-65*



*Irregular line indicates actual productivity levels. Straight lines indicate trend values, derived from Equation (5.26).

clusion is that the equations show a secular growth in productivity between about 3.7 and 4.0 per cent for the late 1950's and early 1960's, and that these rates are between 0.1 to 0.5 of a percentage point lower than those enjoyed in the early post-war period.[1]

Assuming that it is not entirely statistical illusion, how might one explain the shift in the rate of growth of labour productivity which appears to have occurred around the end of 1957? Although a full explanation is considerably beyond the scope of this study, several factors that seem relevant can at least be indicated. The year 1957 marked the end of the immediate post-war era; post-war reconstruction, cold-war readjustment, and the catching up on a variety of plans that had been long delayed because of the war and its aftermath, were largely completed. There was also the Korean War boom, and the intensified investment programmes of 1955 and 1956. On the international scene, new developments included much tougher international competition, increasing industrialization abroad, and the development of new trade and payments relationships.[2] At home, related development included a lower proportion of the national product going into capital formation, along with generally higher unemployment rates and generally greater excess capacity. It seems quite possible that labour productivity no longer grew so rapidly because the growth in the complementary factor, capital, also slowed down, both absolutely and relatively to the labour input.[3] Each of these developments may have played some role in the apparent slowdown in productivity growth after 1957, although a complete explanation may be more complex and may involve additional explanatory factors.

4. Direct Relationships between Price and Wage Changes

Our work on the relationship between prices and wages has proceeded along two approaches. One approach has been to consider the relationship between the Consumer Price Index and labour costs per unit of output in manufacturing. The second approach has been to examine the relationship between the Consumer Price Index and wages (average hourly earnings in manufacturing). In the first approach, the link through productivity between wages and prices is recognized by combining wages and productivity to derive labour costs per unit of output (wages divided by output per man-hour). In this form, the relationship shows how prices are affected by wage changes adjusted for productivity changes. In the second approach, the productivity link between wages and prices is recognized by attempting

[1] The rates are, of course, lower for the earlier estimates based on the unrevised output data. For example, equation (5.26) yielded estimated growth rates of 3.32 per cent and 2.56 per cent for the two subperiods respectively when the old data was employed.

[2] For an extensive review of these developments, see G. L. Reuber, "International Trade Trends and Policies," *Business Quarterly*, Volume 29, No. 4 (Winter 1964), pp. 40-50.

[3] In this connection, we may recall that the capital-labour ratio, which was included as an explanatory variable in some trial productivity regressions in an attempt to explain away the apparent retardation in productivity growth, did not have a significant influence in these regressions. Nevertheless, in view of the poor quality of the capital data employed in this experiment, it seems permissible to reject the data instead of the hypothesis and to argue that the deceleration of productivity growth (if really present) was at least somewhat related to the slowdown in capital formation.

to relate wages and productivity separately to prices in order to ascertain their independent effects on prices. With both approaches, other variables in addition to wages and productivity have also been introduced to explain price changes.

Initially, our estimates were based on the period from 1949 to the second quarter of 1965. As already indicated, significant evidence was found of a shift in the wage adjustment relationship after 1952. This conclusion was reinforced by the evidence which emerged from various experiments on the price level relationship. The results of most of these experiments suggested a shift in the relationship after 1952. Accordingly, unless otherwise indicated, all of the estimated relationships discussed in this section are based on quarterly data for the period from the first quarter of 1953 to the second quarter of 1965, which encompasses 50 observations. Our first set of trial regressions explaining the consumer price level utilized the absolute values of the price, wage, productivity, and unit labour cost variables. However, it was felt that the very high coefficients of multiple determination and t-ratios which were obtained were misleading, especially in view of the fact that, in general, the computed residuals appeared to be significantly autocorrelated. Consequently, we focused on explaining the percentage change (between corresponding calendar quarters of adjacent years) in the Consumer Price Index, thus posing a somewhat stiffer hurdle (in terms of statistical significance) for prospective explanatory variables. Moreover, the formulation in terms of percentage rates of change enables one to derive the trade-off relationship from the underlying relationships in a reasonably straightforward manner, without resort to some simplifying approximations.

i. *The unit labour cost approach*

Some features of the price level regressions in the Brookings model were incorporated into our work on the relationship between prices and unit labour costs. In several respects, however, our approach differed substantially.

As in the Brookings model, unit labour costs were incorporated in the estimated relationships in two forms: as *normal* unit labour costs (ULC^n) and as (straight) unit labour costs (ULC), where:

$$(5.30) \qquad ULC_t^n = \frac{W_t}{A_t^*/100} = \frac{W_t}{\frac{1}{8}\sum_{i=0}^{7}\left(\frac{Q}{MH}\right)_{t-i}},^{[1]} \quad \text{and}$$

$$(5.31) \qquad ULC_t = \frac{W_t}{A_t/100} = \frac{W_t}{\left(\frac{Q}{MH}\right)_t}.$$

[1] The Brookings model variable uses a twelve-quarter moving average of productivity in the denominator instead of the eight-quarter moving average used in our work.

Here, the symbols on the right-hand side of equations (5.30) and (5.31) are defined as follows, with the data sources given, where appropriate, in parentheses:

Q_t = index of output in manufacturing (1949 = 100) (Dominion Bureau of Statistics);

MH_t = index of man-hours in manufacturing (1949 = 100) (Dominion Bureau of Statistics);

W_t = average hourly earnings in manufacturing (Dominion Bureau of Statistics);

A_t = level of labour productivity (1949 = 100); and

A_t^* = index of normal labour productivity.

The hypotheses underlying the use of (ULC^n) and (ULC) are summarized in the Brookings volume.[1] Stated briefly, these hypotheses are: (i) prices are set by a mark-up on standard costs – i.e., costs at *normal levels* of operation; (ii) temporary changes in costs (i.e., deviations of actual costs from standard costs) affect prices but less than permanent changes; (iii) changes in wage rates are considered permanent whereas temporary changes in productivity are not and, consequently, normal ULC is defined as the current level of wages relative to productivity averaged over several periods, which serves to abstract from temporary fluctuations in productivity.

In most other respects, our relationships differed from those of the Brookings model. One major difference was that our estimates are concerned only with aggregate price changes as reflected by the Consumer Price Index. The Brookings relationships, on the other hand, attempt to explain directly variation in various broad components of the Wholesale Price Index, which are subsequently drawn together and related to the level of retail prices. Secondly, as noted above, we have attempted to explain the percentage rate of change in consumer prices, while the Brookings equations explain the *level* of components of the Wholesale Price Index.

A long series of experiments was undertaken to explain the percentage change in prices, $\dot{P}_t$, in terms of the percentage change in normal units labour costs ($U\dot{L}C^n$), the deviation between the percentage change in current unit labour costs and normal unit labour costs ($U\dot{L}C_t$ - $U\dot{L}C_t^n$), together with the percentage change in U.S. prices, in Canadian import and export prices, and in lagged prices. For this purpose, the unit labour cost variables were defined as follows:

$$(5.32) \qquad (U\dot{L}C^n)_t = \frac{(ULC_t^n) - (ULC_{t-4}^n)}{(ULC_{t-4}^n)} \cdot 100 \text{ , and}$$

$$(5.33) \qquad (U\dot{L}C_t) = \frac{ULC_t - ULC_{t-4}}{ULC_{t-4}} \cdot 100 \text{ .}$$

---

[1] Schultze and Tryon, *op. cit.*, pp. 284-288.

Although we experimented very extensively with these variables for the period 1953-65, we were unable to estimate a completely satisfactory statistical relationship between price changes and these explanatory variables in combination with the other explanatory variables mentioned. In the experiments, the unit labour cost variables were statistically insignificant in almost every instance.[1] Our "best" estimate which employs these variables is equation (5.34), in which the unit labour cost variable is statistically significant with a one-tailed test but barely misses statistical significance with the more conventional two-tailed test.

$$(5.34) \qquad \dot{P}_t = 0.205 + \underset{[1.97]}{0.0996}(\dot{ULC}^n)_t + \underset{[2.29]}{0.0827}\dot{F}_t + \underset{[8.77]}{1.014}\dot{P}_{t-1} - \underset{[1.99]}{0.226}\dot{P}_{t-2}, \quad R^2 = 0.854, \quad D.W. = 2.22 .$$

$\dot{P}_t$ and $(\dot{ULC}_t^n)$ have already been defined. $\dot{F}_t$ is the percentage change in the implicit deflator for imports of goods and services in the National Accounts (the source of the underlying data on this variable is the Dominion Bureau of Statistics); in symbols, $\dot{F}_t$ is equivalent to:

$$\frac{F_t - F_{t-4}}{F_{t-4}} \cdot 100$$

As before, the numbers in square brackets below the estimated regression coefficients are computed t-ratios, R^2 is the unadjusted coefficient of multiple determination, and D. W. is the Durbin-Watson statistic.[2] However, when the percentage change in U.S. prices was added as an explanatory variable, both $\dot{F}_t$ and $(\dot{ULC}^n)_t$ became insignificant. Also, leaving the $\dot{P}_{t-2}$ variable out of equation (5.34) increased the t-ratios for $\dot{F}_t$ and $\dot{P}_{t-1}$, but reduced slightly the coefficient of determination and brought about a marginal reduction (to 1.96) in the t-ratio for $(\dot{ULC}^n)_t$.[3]

---

[1] It is perhaps worth reporting that, in the earlier experiments with the level form of the variables, normal unit labour costs were always highly significant, while the deviation between actual and normal labour costs was significant in some (but not all) of the cases, with a coefficient considerably smaller than that of normal unit labour costs.

[2] As is well known (see, e.g., Marc Nerlove and Kenneth F. Wallis, "Use of the Durbin-Watson Statistic in Inappropriate Situations," *Econometrica*, Vol. 34, No. 1 (January 1966), pp. 235-238), the Durbin-Watson statistic does not provide a very strong test of possible autocorrelation in the residuals of a regression equation. This is so because the Durbin-Watson statistic is asymptotically biased toward the null value of 2.0 with autocorrelation present (in the universe), and so the test lacks power. The formulation in terms of percentage rates of change was in part chosen to obviate this complication; for what evidence they provide, the computed Durbin-Watson statistics presented in this section are consistent with the view that this transformation of the variables does actually succeed in eliminating autocorrelation in the regression residuals.

[3] The equation became:

$$(5.35) \qquad \dot{P}_t = 0.158 + \underset{[1.96]}{0.102}(\dot{ULC}^n)_t + \underset{[2.64]}{0.0965}\dot{F}_t + \underset{[13.97]}{0.813}\dot{P}_{t-1}, \quad R^2 = 0.841 .$$

It is interesting to note that, with the use of revised output and productivity data, the influence of the normal unit labour cost variable did gain somewhat in statistical significance. An alternative trade-off relationship, based on the price change equation (5.35), is computed and presented in the Appendix to the following Chapter.

ii. *The use of current wage changes as an explanatory variable*

As indicated at the outset of this section, in our second set of experiments wage and productivity changes were initially included as separate explanatory variables in the price change regressions. Our "best" estimated relationship, for data based on the period from the first quarter of 1953 through the second quarter of 1965, is equation (5.36), in which the variables and the "dot" operator have the definitions already given:

$$(5.36) \qquad \dot{P}_t = -0.622 + \underset{[3.53]}{0.199\dot{W}_t} + \underset{[2.97]}{0.0998\dot{F}_t} + \underset{[15.6]}{0.817\dot{P}_{t-1}}, \; R^2 = 0.865, \; D.W. = 2.04.$$

In deriving this estimated equation, we made a number of trials regarding the relationship between productivity and prices. Productivity changes were included as an explanatory variable in several forms. One form was a four-quarter or an eight-quarter average of (annual) percentage rates of change in productivity; the explanatory variables were $\dot{A}_t^{*} = \frac{1}{4}\sum_{i=o}^{3} \dot{A}_{t-i}$ and $\dot{A}_t^{**} = \frac{1}{8}\sum_{i=o}^{7} \dot{A}_{t-i}$, where $\dot{A}_t = \frac{A_t - A_{t-4}}{A_{t-4}} \cdot 100$. Another form employed an estimate of the percentage rate of increase in normal productivity as generated by a preliminary version of equation (5.27) above. In this case, the productivity variable which was entered in the regression was $\dot{\hat{A}}_t = \frac{\hat{A}_t - \hat{A}_{t-4}}{\hat{A}_{t-4}}$, where $\hat{A}_t$ is the predicted value of the dependent variable from equation (5.27) above. In none of our experiments were any of these productivity variables statistically significant and in some regressions they entered the equation with an inappropriate sign, implying the implausible conclusion that an increase in the rate of productivity growth adds to the upward pressure on prices. In short, our experiments failed to establish directly a significant relationship between the percentage rate of change in prices and the percentage rate of change in productivity for the period from 1953 to 1965, and the same conclusion applies to the longer period from 1949 through 1965.

One could argue that the effects of productivity growth have implicitly been subsumed in the estimated constant term of the fitted regression. As pointed out in Chapter 2 above, if productivity (especially the relevant conceptualization of labour productivity) grows along a rather smooth trend, there may not be enough variation in this determinant to allow the variable to appear as a significant influence in a regression explaining rates of change, and so the productivity effects may merely appear in the constant term of the regression.[1] The constant term of equation (5.36), which is both negative and significant (with a t-ratio of 2.6), is consistent with this interpretation. Moreover, as the discussion of Chapter 6 will substantiate, the "steady state" value of the constant term (approximately -3.4) is

[1] It is interesting to note that, in the level form of the price equations, the absolute level of "normal" productivity (an eight-quarter average) had a regression coefficient that was always negative and generally statistically significant, by conventional tests.

also consistent with this view of the influence of productivity growth. Thus, after the price change variables have settled down to a continuing rate of change, the Consumer Price Index might be expected to fall by 3.4 per cent per year in the hypothetical situation in which money wages and import prices experienced a (continuing) zero rate of change. This is at least the right order of magnitude for the interpretation of the constant term as a reflection (primarily) of the expected rate of growth of productivity during the sample period.

In order to take account of the influence of foreign prices, a number of tests were made with changes in three foreign price variables: the implicit deflator, from the GNP accounts, of the imports of goods and services, F; the implicit GNP deflator for the exports of goods and services, X; and U.S. prices, P_{us}. As indicated in Chapter 2, foreign prices influence Canadian prices because imports account for a high proportion, on average, of the total value of final output. In addition, domestic prices of many Canadian products are set to meet import competition. Similarly, the domestic prices of Canadian products which are readily exported, such as beef and some other meats, are influenced by the world prices for these products. Aside from these direct influences, it seems likely that the trend of foreign prices has an important effect on expectations regarding Canadian prices – particularly when the country maintains a fixed exchange rate. Thus, a general upward drift in world prices – especially U.S. prices – is likely to lead to a similar drift in Canada; the reactions which these expectations induce are, in turn, likely to reinforce the tendency for Canadian prices to follow foreign price trends. The influence of U.S. prices – both directly and indirectly – is, of course, likely to be the predominant foreign influence affecting Canadian prices.

When the percentage change in export prices ($\dot{X}_t$) was added to equation (5.36), it was not statistically significant. ($\dot{X}_t$) was entered in the regression in the following form: $\frac{X_t - X_{t-4}}{X_{t-4}} \cdot 100$, where X_t is the export price index mentioned above.

The use of U.S. consumer prices to explain Canadian consumer prices was suggested by the observation that movements of the Consumer Price Indexes in the two countries have been very similar. This observation is confirmed by equation (5.37), in which the percentage rate of change in the U.S. Consumer Price Index is the only variable used to explain the rate of change of the Canadian Consumer Price Index:

$$(5.37) \qquad \dot{P}_t = 0.537 + \underset{[10.3]}{1.008\dot{P}_{us_t}}, \qquad R^2 = .623,$$

where $\dot{P}_{us_t} = \frac{P_{us_t} - P_{us_{t-4}}}{P_{us_{t-4}}} \cdot 100$ and P_{us_t} is the U.S. Consumer Price Index. (The source of the data for this variable is the U.S. Department of Labor.) This equation explains 62 per cent of the variation in the percentage change in Canadian prices. In addition, it implies that Canadian consumer prices tend to rise by uniformly one-half a percentage point more than U.S. consumer prices, with an additional percentage point increase in U.S. consumer prices being associated with almost precisely one additional percentage point increase in Canadian consumer prices.[1] When U.S. consumer prices ($\dot{P}_{us_t}$) were added to equation (5.36), the regression coefficient for this variable was not significantly different from zero, with a t-ratio of 0.99. The coefficients of the other explanatory variables remained statistically significant and the value of the coefficient of multiple determination increased only very slightly.[2]

As noted earlier, the statistical series used for import and export price indexes (F_t and X_t) are the implicit price deflators for goods and services from the GNP account. Both series pose a number of technical problems which will not be discussed here. For the purpose of explaining changes in the Consumer Price Index, we considered these series, which incorporate the prices of both goods and services, to be slightly preferable to a series relating to foreign trade in goods only.

In arriving at equation (5.36), we also added another lagged value of the dependent variable as an explanatory variable – $\dot{P}_{t-2}$. The regression coefficient for $\dot{P}_{t-2}$ was not statistically significant:[3] the coefficients for the other explanatory variables in the regression remained statistically significant.

Various experiments were also made to test for the influence of seasonal factors in equation (5.36) by adding seasonal dummies in the manner described earlier. None of these seasonal variables proved to be statistically significant. In view of the fact that we are dealing with percentage rates of change over corresponding quarters of the calendar year, this outcome is hardly surprising.

In addition, a number of experiments were undertaken in which we attempted to assess the direct influence on consumer prices of excess demand in the product markets of the economy. As outlined in Chapter 2, this sort of influence might be expected to play a role if the markets for final goods and services are "reasonably" competitive. The following four variables were utilized as proxies for excess demand in the final goods markets (sources of the underlying given in parentheses where appropriate):

Q_{gap} , as defined in Section 3;

---

[1] One can explain most of the variations in P_t over the 1953–65 sample period as a function of lagged price changes and changes in the U.S. consumer price level. Thus, we have computed:

(5.38) $$\dot{P}_t = 0.120 + \underset{[3.74]}{0.287}\, \dot{P}_{us_t} + \underset{[8.42]}{0.947}\, \dot{P}_{t-1} - \underset{[2.75]}{0.289}\, P_{t-2},\ R^2 = 0.868.$$

It may be observed that the coefficient of determination for this regression is even higher than for equation (5.36) above. As we shall see in Chapter 6, the steady state properties of this equation are quite similar to, though not identical with, equation (5.37), in which the effects of lagged price changes are not explicitly estimated.

[2] $$\dot{P}_t = -0.494 + \underset{[2.12]}{0.154}\, \dot{W}_t + \underset{[2.27]}{0.0842}\, \dot{F}_t + \underset{[10.4]}{0.766}\, \dot{P}_{t-1} + \underset{[0.99]}{0.104}\, \dot{P}_{us_t},\ R^2 = 0.868$$

[3] $$\dot{P}_t = -0.519 + \underset{[3.02]}{0.178}\, \dot{W}_t + \underset{[2.64]}{0.0910}\, \dot{F}_t + \underset{[8.06]}{0.930}\, \dot{P}_{t-1} - \underset{[1.10]}{0.125}\, \dot{P}_{t-2},\ R^2 = 0.868$$

$\log(Q_a/Q_p) \cdot 100$, as defined in the previous Section;

Q_{dev}/Q_{tr} , as defined in Section 3;

$(I/S)_t^{dev} = \frac{I}{S} - (\frac{I}{S})_t^*$, the deviation of the ratio of manufacturing inventories to shipments in period t from an eight-quarter average of the ratio, i.e.

$$(\frac{I}{S})_t^* = \frac{1}{8} \sum_{i=0}^{7} (\frac{I}{S})_{t-i}$$, (Dominion Bureau of Statistics);

UO unfilled orders in manufacturing (seasonally adjusted), (Dominion Bureau of Statistics).

The direct influence of demand factors on price formation would appear to be of decidedly secondary importance. None of the regression coefficients of these proxies for excess demand was significantly different from zero, with the rate of change formulation of the price and wage variables.[1]

Finally, a quick experiment based on an alternative dependent variable for the price change regression was made. P_t^{exf} denotes the Consumer Price Index Excluding Food Products during the t-th quarter; the source of this series is the Dominion Bureau of Statistics. Using the rate of change in this variable for the dependent variable (and a one-quarter lag of this rate of change as one of the explanatory variables), one obtains:

$$(5.36a) \qquad \dot{P}_t^{exf} = -0.413 + \underset{[3.11]}{0.101}\,\dot{W}_t + \underset{[4.67]}{0.0893}\,\dot{F}_t + \underset{[19.1]}{0.934}\,\dot{P}_{t-1}^{exf} ,$$

$$R^2 = 0.907 , \; D.W. = 1.75 .$$

These results are quite consistent with those of equation (5.36), although the steady state properties seem to be less in agreement with our expectations. In any case, it would appear correct to assert that the behaviour of the over-all Consumer Price Index is not influenced unduly by peculiarities in the movements of the food component.

---

[1] It is interesting to note that, in our calculations with the levels of prices, wages and unit labour costs, several of the demand variables were statistically significant, with theoretically appropriate signs. One possible interpretation of this outcome might be that the level, but not the rate of change, of prices in general is sensitive to the direct influence of demand in the product markets. In this view, the pressure of high demand would have a once-and-for-all effect, raising the mark-up factor to a level that was permanently higher so long as demand remained high. However, we should not like to push this interpretation very far; even our calculations in the levels of the variables, which probably overstate the true levels of statistical significance for reasons outlined above, show a majority of the coefficients on the demand variables to be statistically insignificant and a few with perverse signs. The impression persists of a high degree of insensitivity to the direct influence of demand pressures.

From the set of experiments leading to equation (5.36), one set of regression results obtained which warrants further consideration was:

$$(5.39) \qquad \dot{P}_t = -0.213 + \underset{[2.02]}{0.0816}\ \dot{W}_t + \underset{[6.99]}{0.129}\ \dot{F}_t + \underset{[4.21]}{0.195}\ \dot{P}_{us_t}$$

$$+ \underset{[10.87]}{0.951}\ \dot{P}_{t-1} - \underset{[5.18]}{0.327}\ \dot{P}_{t-2}\,, \qquad R^2 = .972\,.$$

All the variables in this equation have already been defined and all are statistically significant. The value of the coefficient of multiple determination indicates that, in combination, changes in wages, import prices, U.S. prices and lagged domestic prices explain 97 per cent of the variation in current Canadian prices. This equation was fitted to the period from 1949 to 1965. When a dummy variable was added to take account of the Korean War and its aftermath, with a value of zero from 1949 to the end of the second quarter of 1952 and a value of unity thereafter, the regression coefficient of the dummy variable was statistically significant, indicating a shift in the relationship.[1] In addition, with the dummy variable in the equation, the coefficient for $\dot{W}_t$ was no longer significant. When the equation was re-estimated for the period from 1953 to 1965, none of the explanatory variables, except price changes lagged one quarter, was significant.[2]

The stability and predictive power of equation (5.36) were examined by employing the three tests which have already been introduced. The equations for the subperiods 1953-60 and 1961-65 are shown in Table 5.7, together with the equations for the full period 1953-65 with and without a dummy variable. As before, the value of the dummy variable is zero from 1953 to 1960 and unity from 1961 to 1965. Table 5.7 indicates the regression coefficient for the dummy variable is not significantly different from zero. When one applies the Chow test, the value of the F statistic reported in Table 5.8 does not provide any evidence of a shift in the relationship at the 5 per cent level of significance. Both tests therefore suggest a stable relationship.[3]

---

[1] $$\dot{P}_t = 0.631 + \underset{[0.43]}{0.0198}\ \dot{W}_t + \underset{[4.35]}{0.0965}\ \dot{F}_t + \underset{[5.03]}{0.2518}\ \dot{P}_{us_t} + \underset{[11.5]}{0.973}\ \dot{P}_{t-1}$$
$$-\underset{[5.82]}{0.3634}\ \dot{P}_{t-2} - \underset{[2.47]}{6.51}\ DUM_{52\frac{1}{2}}\,, \quad R^2 = 0.975.$$

[2] $$P_t = -0.241 + \underset{[1.11]}{0.0898}\ \dot{W}_t + \underset{[1.50]}{0.0593}\ \dot{F}_t + \underset{[1.57]}{0.175}\ \dot{P}_{us_t} + \underset{[7.99]}{0.912}\ \dot{P}_{t-1}$$
$$- \underset{[1.64]}{0.200}\ \dot{P}_{t-2}\,, \quad R^2 = 0.875\,.$$

[3] There does appear to be some evidence that the coefficient of the import price change variable shifted over the total period under consideration. However, performing a formal statistical test results in a t-ratio of 1.9, which is somewhat below the traditional 5 per cent level of statistical significance. Hence, even for this parameter, one can reasonably maintain the hypothesis of a stable relationship over the period under consideration.

Table 5.7

Coefficients of Price Change Equation Estimated for 1953-65 and for Subperiods

Equation Number	Period Estimated	Constant Term	Coefficients of Explanatory Variables: $\dot{W}_t$	$\dot{F}_t$	$\dot{P}_{t-1}$	R^2	$\bar{S}_u$
(5.36)	1953-65	−0.622	0.199 (0.0564)	0.0998 (0.0336)	0.817 (0.0525)	0.865	0.430
(5.40)	1953-60	−0.606	0.188 (0.0695)	0.136 (0.0490)	0.798 (0.0599)	0.893	0.461
(5.41)	1961-65	0.239	0.190 (0.198)	−0.0516 (0.0834)	0.528 (0.284)	0.650	0.367
(5.42)	1953-65 with shift variable	−0.652 + 0.0484 D (0.146)	0.205 (0.0598)	0.0955 (0.0363)	0.815 (0.0535)	0.865	0.434

Table 5.8

Test for Shift of Coefficients in Price Change Equation, over the Period 1953-65

Equation	F-ratio	Critical Values for F-ratio, at Significance Level of: 5%	1%	Conclusion
(5.36)	0.86	2.59	3.80	No Shift

The predictive power of equation (5.36) was tested against the following four "naive" models, which correspond to the four "naive" models against which the predictive power of our wage equations were tested.

$$\hat{\dot{P}}_t = \bar{\dot{P}}\ (1953\text{–}60)\ , \qquad (5.43)$$

$$\hat{\dot{P}}_t = \dot{P}_{t-1}\ , \qquad (5.44)$$

$$\hat{\dot{P}}_t = \dot{P}_{t-4}\ , \qquad (5.45)$$

$$\hat{\dot{P}}_t = \dot{P}^*_{t-1}\ , \qquad (5.46)$$

where $\dot{P}_t$ is defined as $\frac{P_t - P_{t-4}}{P_{t-4}} \cdot 100$, $\hat{\dot{P}}_t$ is the predicted value of $\dot{P}_t$, $\dot{P}^*_t = \frac{1}{4} \sum_{i=0}^{3} \dot{P}_{t-i}$, and $\bar{\dot{P}}$ (1953–60) is the mean value of $\dot{P}_t$ from 1953 through 1960.

Table 5.9 shows the predicted price changes ($\hat{\dot{P}}_t$) for these four naive models and for the regression model (5.40), which is the estimate of the parameters of equation (5.36) over the period 1953-60. If one judges in terms of the D statistic defined earlier, equation (5.40) is a substantially better predictor of the percentage change in consumer prices than any of the naive models except for model (5.44), which assumes that the percentage change in prices in the current quarter will be the same as for the previous quarter. As a predictor, the regression model performs almost as well as this naive model and the value of the D statistic is not much lower for the naive model.

In one view, this outcome is quite discouraging; the "sophisticated" regression model not only fails to predict better than one of the naive models but actually does a slightly poorer job of prediction. This failure is all the more remarkable when one recalls that the $\dot{P}_{t-1}$ variable is also one of the inputs in the regression model, so that the regression model could be viewed as a method of improving upon the autoregressive properties of price changes by taking into account the "structural" variables of changes in wages and in import prices. However, as we have seen, this anticipated improvement fails to materialize, at least for data beyond the period for which the predicting equation (5.40) was fitted. Nevertheless, such pessimism should probably not be overdone. It could have been anticipated that, due to the autoregressive properties of the overlapping price changes, naive model (5.44) would set a very difficult standard to equal, and a calculation of the Theil inequality coefficient confirms this expectation.[1] By this same criterion, regression equation (5.40) performs creditably, and so one should not scrap it on these grounds alone. Moreover, the fitted regression does reveal something about the determinants of price changes and does aid, if this approach has any merit, in the analysis of policy problems.

5. Qualifications and Conclusions

Before launching into the conclusions of the empirical analysis of this Chapter, some methodological qualifications regarding our results may be presented. Some of these difficulties can be circumvented with the use of more advanced techniques; others are very difficult to handle adequately and, for this study at least, must simply be accepted as factors limiting the precision of the results obtained.

Among the first class of difficulties, we have the famous simultaneous equations problem: wage changes influence price changes, which in turn influence wage changes (with, however, a lag, which somewhat reduces the severity of the problem). We have, however, estimated each relationship in isolation, assuming

[1] For the naive model (5.44), the Theil inequality coefficient was 0.116; for the regression equation (5.40), this measure was 0.124; both values indicate a reasonably high degree of forecasting accuracy. It is interesting to observe both forecasting models obey the criterion that the bulk of the forecasting error measured by the inequality coefficient is due to less than perfect correlation between the actual and the predicted series. For the regression model, the proportion of the inequality coefficient due to imperfect covariation is 80 per cent, while naive model (5.44) does even better on this score, as with the measures of forecasting accuracy themselves. For this naive model, the proportion of the inequality coefficient due to imperfect covariation is 96 per cent.

Table 5.9

Predictive Power of the Fitted Regression and of Naive Models of Price Change over the Period 1961–65

Quarter		Actual Price Change ($\dot{P}_t$)	Predicted Price Change ($\hat{\dot{P}}_t$)					Deviation of Actual from Predicted Price Change ($\dot{P}_t - \hat{\dot{P}}_t$)				
			Regression Model:	Naive Model:				Regression Model:	Naive Model:			
			Equation (5.40)	Equations (5.43)	(5.44)	(5.45)	(5.46)	Equation (5.40)	Equations (5.43)	(5.44)	(5.45)	(5.46)
1961	I....	1.49	1.11	1.20	1.09	1.11	1.20	0.38	0.39	0.40	0.38	0.29
	II....	1.18	1.29	1.20	1.49	1.51	1.30	-0.11	-0.02	-0.31	-0.33	-0.12
	III....	0.94	1.38	1.20	1.18	1.11	1.22	-0.44	-0.26	-0.24	-0.17	-0.28
	IV....	0.08	1.28	1.20	0.94	1.09	1.18	-1.20	-1.12	-0.86	-1.01	-1.10
1962	I....	0.46	0.52	1.20	0.08	1.49	0.92	0.06	-0.74	0.38	-1.03	-0.46
	II....	1.01	1.08	1.20	0.46	1.18	0.66	-0.07	-0.19	0.55	-0.17	0.35
	III....	1.55	1.23	1.20	1.01	0.94	0.62	0.32	0.35	0.54	0.61	0.93
	IV....	1.70	1.54	1.20	1.55	0.08	0.78	0.16	0.50	0.15	1.62	0.92
1963	I....	1.85	1.73	1.20	1.70	0.46	1.18	0.12	0.65	0.15	1.39	0.67
	II....	1.69	1.74	1.20	1.85	1.01	1.53	-0.05	0.49	-0.16	0.68	0.16
	III....	1.91	1.78	1.20	1.69	1.55	1.70	0.13	0.71	0.22	0.36	0.21
	IV....	1.59	2.17	1.20	1.91	1.70	1.79	-0.58	0.39	-0.32	-0.11	-0.20
1964	I....	1.74	1.77	1.20	1.59	1.85	1.76	-0.03	0.54	0.15	-0.11	-0.02
	II....	1.96	1.81	1.20	1.74	1.69	1.73	0.15	0.76	0.22	0.27	0.23
	III....	1.80	1.88	1.20	1.96	1.91	1.80	-0.08	0.60	-0.16	-0.11	0.00
	IV....	1.64	1.51	1.20	1.80	1.59	1.77	0.13	0.44	-0.16	0.05	-0.13
1965	I....	2.01	1.61	1.20	1.64	1.74	1.78	0.40	0.81	0.37	0.27	0.23
	II....	2.29	1.80	1.20	2.01	1.96	1.85	0.49	0.09	0.28	0.33	0.44
			Sum of Squared Deviations....................					2.74	7.02	2.35	8.21	4.31
			Root Mean Square Deviation (D)..............					0.39	0.62	0.36	0.68	0.49

that all of the explanatory variables were given or "predetermined", when we calculated the least squares estimates of these parameters. As is well known, such a procedure can lead to biased parameter estimates. Fortunately, there is an easy way around this difficulty; some simultaneous estimation procedure, such as the method of two-stage least squares, can be employed to re-estimate the parameters of the wage and price change relationships. In the Appendix, two sets of two-stage least squares estimates of the parameters of equations (5.1) and (5.36) are presented. (The two sets presented correspond to two different views regarding the endogeneity of U_t^*, the employment variable.) Numerically, the results are very close (especially for the first set of results, which are based on the assumption that the unemployment rate is "really" exogenous); what single equation bias is present appears to be quantitatively unimportant. The use of the two-stage least squares estimating procedure generally reduces the t-ratios, although there is only one instance in which a formerly significant variable loses statistical significance: for the second two-stage least squares estimate of the wage adjustment equation, the t-ratio of the U.S. wage change variable drops to 1.91, which is significant at the 5 per cent level with a one-tailed test, but not at that level with the more conventional two-tailed test. In all other cases, however, the explanatory variables retain their statistical significance, by conventional standards.

Another difficulty, which was encountered in the wage adjustment equations, is the problem of autocorrelated residuals. (On the basis of an intuitive feeling and some limited evidence, we concluded – perhaps heroically – that autocorrelation of the estimated residuals was not a complicating factor in the case of the price change regressions.) Although this phenomenon does not, in the usual case, lead to biased parameter estimates, it does usually entail an understatement of the standard errors (computed according to the usual formulas) of the sample regression coefficients; consequently, the level of statistical significance of the explanatory variables will, in the usual case, be overstated. Fortunately, this difficulty can be handled in a number of ways: in the Appendix, we form autoregressive transformations for all of the variables and then run the wage adjustment regressions with these transformed variables (Table 5.10). In general, this transformation of the variables succeeds in eliminating the observed autocorrelation in the sample residuals, as judged by the Durbin-Watson statistic. The picture of the economic structure of the wage adjustment relationships remains largely unchanged, although the coefficient of the lagged wage change tends to be appreciably higher and the coefficient of the U.S. wage change variable somewhat lower. As expected, this estimating procedure tends to reduce the estimated t-ratios, although in most cases the variables retain statistical significance, by conventional criteria. Of the four estimated coefficients of the U.S. wage change variable, two are unambiguously significant at the 5 per cent level, one is significant at that level with a one-tailed test (but not a two-tailed test), and one is unambiguously insignificant at that level.

Another difficulty, which is more difficult to deal with, particularly in conjunction with simultaneous equations bias and possible autocorrelation in the residuals of the fitted regressions, is the problem of observational errors. In view of the magnitude of the revisions to which some of the variables employed in our statistical analyses have been subjected over the course of this study, it would appear ridiculous to claim that our variables have been measured exactly (that is, free from errors of observation). There are certain techniques available for dealing with observational error,[1] but they generally require that one know something about the ratios of the variances of the errors of observation. In general, the effect of having errors of observation present is to bias the estimated regression coefficients towards zero, making variables appear insignificant when they may in fact have a significant influence. Thus, the ignoring of this problem will, in general, merely lead one to be more conservative than necessary – one may reject an influence that, under perfect measurement, might have been included. For this reason and for that given above, we have not done anything further with this problem.

Two other qualifications deserve some mention. As the reader has probably noticed, we often employ variables relating to the manufacturing sector (wages, productivity, profits) in the fitted regressions, while our derived trade-off relationships in the following Chapter primarily relate to the economy as a whole. As our discussion in Chapter 3 pointed out, there are definite limitations in using manufacturing data and relationships in the manufacturing sector as indicative of those to be expected for the economy as a whole; nevertheless, if only in view of the absolute size of the manufacturing sector, one might argue that manufacturing variables and relationships provide a reasonable "first approximation" to those characterizing the economy as a whole.[2] Nevertheless, we should not like to deny that this consideration is a possible limitation on the generality of our conclusions. Finally, it must be admitted that there exists an additional limitation on the precision of the formal tests of statistical significance, apart from those stemming from the earlier qualifications. As our exposition has stated explicitly, many of our tentatively final relationships were obtained after a long series of experiments. In these circumstances, it is questionable whether one should accept at face value the t-ratios computed on the basis of the classical linear regression model; after all, a certain number of statistically "significant" results can be expected from the operation of chance forces if one undertakes a large number of trials. On the other hand, many of these trials were simply to ascertain the best formulation and combinations of the variables, and in many cases a particular variable consistently had a statistically significant influence. Hence, this difficulty also should not be exaggerated, although the reader should take the computed t-ratios with a medium grain of salt, for this and other reasons.

Subject to the above qualifications, some tentative conclusions of the empirical analyses of this Chapter may be presented. With regard to the determinants of wage changes, we have found that the traditional explanatory variables, the level of unemployment and the rate of change of consumer prices, have a statistically significant influence. The formulation employed in this Chapter was based on a

---

[1] See J. Johnston, *Econometric Methods (op.cit.)*, Chapter 6.

[2] Our survey in Chapter 3 of the literature on wage adjustment relationships indicated that, broadly speaking, one could conclude that a similar view of the process of wage adjustment was obtained regardless of whether the wage change variable was based on manufacturing wages or on an economy-wide wage series.

4½ months' lag for the price change variable and a 6 months' lag for the unemployment rate. As expected, the rate of unemployment appears to exert its influence in a nonlinear fashion, and there is some suggestion that employing the square of the reciprocal of the unemployment variable is a better method of incorporating the effects of variations in the level of unemployment than the use of the straight reciprocal of this variable. In addition, some nontraditional variables appeared to play a significant role as well in explaining wage changes. The level of profit margins (the ratio of profits to output, in the manufacturing sector) was a significant variable with a theoretically appropriate coefficient; high profits appear to induce, with an estimated lag of almost a year (10½ months), wage changes that are higher than they would be in the absence of this factor. The importance of such a profits variable in a wage adjustment regression would suggest that there is a role for incomes policies with regard to profits as well as wages. Wage changes also appear sensitive to the wage change of four quarters previously; a high wage change in the same quarter of the preceding year appears to be associated with a *low* wage change in the current quarter, at given values of the other determinants of wage changes. This result may reflect either the presence of contracts longer than one year or the tendency of the labour market to "hunt" an appropriate solution; in any case, this effect is also found in our international sample as well (see Chapter 8 below). There is some suggestion that Canadian wage changes are affected by U.S. wage changes, providing some confirmation to a "key group" theory of wage determination, although the existence of this effect is partially called into question by our more intricate estimation techniques in the Appendix. Finally, there was no direct evidence of a significant effect of the rate of change of labour productivity on the rate of change of (money) wages.

With regard to the productivity variable (output per man-hour in the manufacturing sector), the trend variable was the most important determinant in our fairly superficial analysis. There was some evidence of a break in the trend at the end of 1957, although this break was far less obvious with the revised than the unrevised data; moreover, it is conceivable that a further revision of the data could eliminate the apparent retardation of productivity growth during the 1958-65 subperiod. There was some suggestion that this productivity series was mildly sensitive to a cyclical utilization variable, although the effect is quantitatively small in any case. As expected, the seasonal dummy variables had a statistically significant influence, indicating seasonal peaks in the level of productivity during the second and fourth quarters of the year. The observed rate of growth of this productivity series, based on revised output data, was of the order of 3.7 to 4.0 per cent per year.

The third building-block of a derived trade-off relationship is a structural explanation of the rate of change of the consumer price level. We tried two different approaches to this relationship, one based on a (normal) unit labour cost variable and one which entailed attempting to estimate the separate influence of wage and (normal) productivity changes. The first approach was not entirely successful; consequently, we followed the second approach although we were also unsuccessful in obtaining a significant and theoretically appropriate effect of productivity growth on price changes. We have argued, however, that the effects of productivity growth may be largely picked up by the constant term, which is of the right order of magnitude to support this interpretation. Import price changes, but not export price changes, appeared to be a significant influence on the rate of change of domestic consumer prices. There was some suggestion that the rate of change of the U.S. consumer price level had a direct influence (additional to the effect of the change in import prices) on Canadian consumer prices, although this variable was not statistically significant in our final price change regression. Also insignificant were several proxies for the direct influence of excess demand in the product markets of the economy. While a more appropriate variable might indicate a significant effect of demand pressures in the final goods markets, it seems justifiable to form the tentative impression of the insensitivity of price changes to direct demand influences. Finally, the rate of change of consumer prices, lagged one quarter, has a significant and positive effect on the rate of change of consumer prices in the current quarter; one interpretation of this result is that it takes into account the influence on price changes of the state of short-term expectations, which was briefly discussed in Chapter 2.

APPENDIX

Two-Stage Least Squares Estimates of Wage and Price Change Equations, and an Autoregressive Transformation of the Wage Adjustment Equations

A. As outlined in the text, we have two sets of two-stage least squares estimates of the parameters of equations (5.1) and (5.36). In the first set (denoted by the single primes attached to the equation number), only the wage and price change variables are considered endogenous. In the second set (indicated by the double primes), the unemployment variable is considered endogenous. In all cases, U.S. wage changes, lagged wage changes, the ratio of profits to output (which was included with a two-quarter lag in addition to that entailed by the moving average procedure), and the rate of change of import prices were taken as predetermined. The results are:

(5.1') $$\dot{W}_t = -4.32 + \underset{[6.32]}{0.487}\,\dot{P}_t^{*} + \underset{[2.94]}{18.5}\,U_t^{*-2} + \underset{[3.14]}{0.0618}\,(Z/Q)^{*}_{t-2}$$
$$+ \underset{[2.49]}{0.291}\,\dot{W}^{*}_{us_t} - \underset{[3.00]}{0.116}\,\dot{W}_{t-4}, \quad R^2 = 0.845, \quad D.W. = 1.60,$$

(5.36') $$\dot{P}_t = -0.658 + \underset{[3.37]}{0.209}\,\dot{W}_t + \underset{[2.96]}{0.101}\,\dot{F}_t + \underset{[15.3]}{0.815}\,\dot{P}_{t-1},$$
$$R^2 = 0.862, \quad D.W. = 1.99,$$

(5.1") $$\dot{W}_t = -3.88 + \underset{[5.38]}{0.507}\,\dot{P}_t^{*} + \underset{[2.17]}{21.5}\,U_t^{*-2} + \underset{[2.38]}{0.0570}\,(Z/Q)^{*}_{t-2}$$
$$+ \underset{[1.91]}{0.263}\,\dot{W}^{*}_{us_t} - \underset{[2.69]}{0.126}\,\dot{W}_{t-4}, \quad R^2 = 0.830, \quad D.W. = 1.63, \text{ and}$$

(5.36") $$\dot{P}_t = -0.657 + \underset{[3.31]}{0.208}\,\dot{W}_t + \underset{[2.94]}{0.100}\,\dot{F}_t + \underset{[15.4]}{0.818}\,\dot{P}_{t-1},$$
$$R^2 = 0.861, \quad D.W. = 2.00 .$$

B. Suppose the following relationship characterizes a sample of statistical data:

(5.47) $$Y_t = \alpha_0 + \alpha_1 X_{1_t} + \ldots + \alpha_k X_{k_t} + v_t, \quad t = 1,2,\ldots, N$$

where Y_t is the dependent variable, the α's are parameters, the X_{i_t}'s (i = 1,2, . . . , k) are the independent variables, the t subscript refers to the particular observation (out of a total of N) to which the value of a variable belongs, and v_t is a disturbance term. Suppose that v_t obeys a simple autoregressive law so that:

(5.48) $v_t = \rho v_{t-1} + v'_t$, where ρ is the coefficient of first order autocorrelation, v_{t-1} is the value of v_t in the preceding period, and v'_t is another disturbance term which is presumed to be "truly random" (i.e., obey the assumptions of the classical linear regression model). Since (5.47) holds during the period t-1, we have:

$$(5.49) \qquad Y_{t-1} = \alpha_0 + \alpha_1 X_{1_{t-1}} + \ldots + \alpha_k X_{k_{t-1}} + v_{t-1}\,, \; t = 2,3,\ldots, N.$$

Multiplying equation (5.49) by ρ and subtracting from (5.47), one obtains:

$$(5.47a) \qquad (Y_t - \rho Y_{t-1}) = \alpha_0(1-\rho) + \alpha_1 (X_{1_t} - \rho X_{1_{t-1}}) + \ldots + \alpha_k (X_{k_t} - \rho X_{k_{t-1}}) + v_t' \,, \; t = 2,3, \ldots , N.$$

since $v_t' = v_t - \rho v_{t-1}$.

The parameters of equation (5.47a) can be estimated by ordinary regression techniques, and the properties of the Markov theorem on least squares regression will apply. The dependent variable and the independent variables may be said to have undergone an "autoregressive transformation". It should be pointed out that this method of estimating the parameters reduces the number of observations on which the regression is based (and hence the apparent number of degrees of freedom) by one.

Table 5.10

Regressions with Autoregressive Transformations of the Variables, Explaining $\dot{W}_t$, the Rate of Change in Wages, over the Period 1953-65

Equation Number	Constant Term	Coefficients of Explanatory Variables:						R^2	D.W.
		$\dot{P}_t^*$	$(U_t^*)^{-2}$	$(U_t^*)^{-1}$	$(Z/Q)_{t-2}^*$	$\dot{W}_{us_t}^*$	$\dot{W}_{t-4}$		
(5.1a)	-3.97	0.524 [4.64]	22.2 [2.54]	–	0.0619 [2.30]	0.227 [1.46]	-0.204 [2.54]	0.713	2.18
(5.2a)	-5.21	0.474 [4.35]	–	8.10 [2.17]	0.0651 [2.35]	0.286 [1.89]	-0.176 [2.23]	0.702	2.12
(5.3a)	-4.46	0.555 [4.95]	27.8 [3.52]	–	0.0737 [2.84]	–	-0.228 [2.87]	0.698	2.06
(5.4a)	-6.42	0.496 [4.45]	–	10.6 [2.96]	0.0840 [3.16]	–	-0.198 [2.47]	0.678	1.84
(5.5a)	1.16	0.551 [4.68]	33.1 [4.33]	–	–	0.335 [2.16]	-0.212 [2.53]	0.677	2.05
(5.6a)	-0.369	0.484 [4.24]	–	13.0 [4.03]	–	0.414 [2.79]	-0.177 [2.13]	0.664	2.00
(5.7a)	1.94	0.611 [5.14]	45.8 [8.91]	–	–	–	-0.255 [3.00]	0.643	1.86
(5.8a)	-0.0578	0.526 [4.33]	–	19.6 [8.20]	–	–	-0.213 [2.43]	0.605	1.66

In Table 5.10, the results of a re-estimation, by this technique, of wage adjustment equations (5.1) through (5.8), are presented. Each equation is given the same number as in the text, except that the "a" letter follows the text equation number. (Hence, equation (5.1a) is the result of re-estimating the parameters of equation (5.1), through the method of forming autoregressive transformations of the dependent and explanatory variables.) The period of the estimation is the second quarter of 1953 through the second quarter of 1965; as indicated above, one observation is used up in the process of forming autoregressive transformations. Two numerical values of ρ, the coefficient of first order autocorrelation of the disturbances, were tried; ρ was set equal to 0.375 in one set of computations and equal to 0.75 in a second set of computations. The second trial value (0.75) apparently "overcorrected", in the sense of inducing negative first-order autocorrelation in the new error terms. These results are not presented here. Table 5.10 is based on the first trial value (0.375) of the parameter ρ.

CHAPTER 6

DERIVATION OF THE ESTIMATED TRADE-OFF RELATIONSHIPS

1. Introduction

In this Chapter, we calculate steady state relationships for some of the estimated wage adjustment and price level change equations which were presented in Chapter 5. In each case, we present two or more variants of the relationship under examination. Some of the reasons for not committing ourselves to one definitive relationship were indicated in the preceding Chapter. In addition, in both the wage and price change relationships, U.S. wage and price changes respectively may enter as an explanatory variable, but we wish also to consider some alternative relationships in which these variables do not enter explicitly. On the one hand, it is desirable to have prototype relationships which can be fitted to West European and U.S. data, thus enabling us (in Chapter 8) to place the issue of a conflict between the goals of full employment and price level stability in the framework of a comparative setting. On the other hand, it is interesting to see in what manner and to what extent the inclusion of changes in U.S. wages or prices modifies our picture of the structure of the Canadian economy.

Section 2 discusses the derivation and properties of several steady state wage change equations for the Canadian economy, and in Section 3 a similar discussion of the price level change relationships is presented. The productivity growth relationships are not analyzed further in this Chapter, since these equations do not entail the calculation of any steady state properties and since these relationships have already been analyzed in some detail, in Section 3 of the preceding Chapter. Section 4 below presents several numerical estimates of the trade-off relationship, based on several versions of the wage adjustment equation and our best price level change relationship, equation (5.36) of the preceding Chapter. In our discussion, we calculate trade-off estimates on the basis of alternative estimates of the wage adjustment relationship in order to indicate how much difference the alternative assumptions underlying our wage adjustment models make in terms of the trade-off relationship. In addition, we indicate the degree to which the estimated trade-off curve shifts if foreign price and wage trends change or if profit margins shift. A few general implications of the analysis are briefly noted in Section 5. In the Appendix, we discuss several alternative trade-off relationships based on our less-preferred price level change relationships, one of which is based on the unit labour cost approach and one of which explicitly incorporates changes in the U.S. Consumer Price Index into the Canadian price level change equation. In addition, the trade-off relationship implied by the two-stage least squares estimates of the wage and price change equations, which were presented in the Appendix of the previous Chapter, is also discussed.

2. Steady State Wage Adjustment Relationships

Equation (5.1) of Chapter 5 can be explicitly presented in the following manner:[1]

$$(5.1) \qquad \dot{W}_t = -4.3243 + 0.48659\dot{P}_t^* + 0.06178\ (^Z/Q)^*_{t-2} + 0.29125\dot{W}^*_{us_t} + 18.446\,(U_t^*)^{-2} - 0.11595\dot{W}_{t-4}\,.$$

As pointed out in the preceding Chapter, the fact that the current change in wages is negatively related to its own lagged value of four quarters ago, $\dot{W}_{t-4}$, imparts an oscillatory pattern to the expected wage change. The current wage change, $\dot{W}_t$, is predicted by equation (5.1) to be low if the wage change of the corresponding quarter of the previous year was high, and to be high (relatively) if the wage change of four quarters ago was low. Thus, one might ask whether the rate of change of money wages converges, in a sort of dynamic "equilibrium", to a particular rate of change related to the other explanatory variables, and if so, how is the steady state rate of change of money wages related to the first four explanatory variables of equation (5.1).

It will soon become apparent that such an "equilibrium" relationship always exists for a wage adjustment equation of the same form as (5.1). Moreover, it can be shown that the "equilibrium" is a stable one, in the sense that the actual rate of change of money wages will converge to the steady state rate of change, whenever the coefficient of lagged wage changes is numerically smaller than unity.[2] To find the steady state relationship, we merely assume that the actual rate of change of wages has settled down to its "equilibrium" value. In this case,

$$(6.1) \qquad \dot{W}_t = \dot{W}_{t-4} = \dot{W}_t^e\,,$$

where $\dot{W}_t^e$ is the steady state rate of change of money wages at time t. Substituting into equation (5.1) and rearranging terms, we have:

$$(6.2) \quad \dot{W}_t^e + 0.11595\dot{W}_t^e = -4.3243 + 0.4859\dot{P}^*_t + 0.06178\ (^Z/Q)^*_{t-2} + 0.29125\dot{W}^*_{us_t} + 18.446(U_t^*)^{-2}$$

In turn, equation (6.2) simplifies to the following steady state wage adjustment relationship:

$$(5.1e) \qquad \dot{W}_t^e = -3.8749 + 0.43603\dot{P}^*_t + 0.05536\ (^Z/Q)^*_{t-2} + 0.26099\dot{W}^*_{us_t} + 16.529\,(U^*)^{-2}$$

---

[1] In Chapter 5, we rounded the parameter estimates to three significant figures, so as not to present a spurious impression of extreme precision. In the computations of this Chapter, we carry a larger number of significant figures (generally the five significant figures available from the electronic computer print-outs), so as to make the final computations as accurate numerically as possible.

[2] This point is discussed in some detail in the previously cited article by Schultze and Tryon in the volume describing the Brookings econometric model of the U.S. economy, on pp. 328-329 of that work. The mathematical form is that of a first order, linear difference equation with constant coefficients; for equation (5.1) (and, in addition, all of the relationships of Table 5.1), the interim time path of the solution for $\dot{W}_t$ is one of damped, short oscillations about the steady state rate of change of wages.

In Table 6.1, the results of calculating, by similar methods, steady state wage adjustment relationships corresponding to those shown in Table 5.1 are presented. The steady state relationship is indicated by the same number as the original equation, with the letter "e" added as a suffix to this equation number – e.g., the steady state equation for equation (5.1) is shown as (5.1e).

Table 6.1

Coefficients of Steady State Wage Adjustment Relationships (Relationships Explaining $\dot{W}_t^e$), 1953-65

Equation Number	Constant Term	Coefficients of Explanatory Variables:				
		$\dot{P}_t^*$	$(U_t^*)^{-2}$	$(U_t^*)^{-1}$	$(Z/Q)_{t-2}^*$	$\dot{W}_{us_t}^*$
(5.1e)	-3.8749	0.43603	16.529	–	0.05536	0.26099
(5.2e)	-5.00115	0.40398	–	5.7908	0.06040	0.32257
(5.3e)	-4.4311	0.47155	22.429	–	0.06802	–
(5.5e)	0.6784	0.45643	25.987	–	–	0.36418
(5.7e)	1.4221	0.51809	38.354	–	–	–

The relationship between the equilibrium rate of change of wages and unemployment is highly nonlinear, but in all cases the effect of the nonlinear form chosen (the reciprocal or the square of the reciprocal of the unemployment rate) is to make the steady state wage change much more sensitive to the unemployment rate when it is low than when there already is a large amount of unemployment. Thus, when the rate of change of consumer prices is zero, when the level of profits (before taxes) per unit of output is set equal to its mean over the sample period, and when the U.S. wage change is assumed to be equal to 3.2 per cent, equation (5.1e) indicates that a variation in the unemployment rate from 3 to 4 per cent of the labour force will lower the steady state rate of growth of wages from 4.21 per cent to 3.40 per cent per year. However, under the same conditions with regard to profits, consumer prices, and U.S. wages, a once-and-for-all movement in the unemployment rate from 7 to 8 per cent will only reduce the rate of change of money wages from 2.71 per cent to 2.63 per cent per annum (see Table 6.2). In other words, a one percentage point variation in the unemployment rate will reduce the steady state rate of change of money wages by 0.81 of a percentage point in the first set of circumstances, but by about one tenth as much (0.08 of a percentage point) in the second set of circumstances. This illustrates the highly nonlinear nature of the estimated wage-change-unemployment relationship.

Table 6.2 shows the figures for several alternative wage-change-unemployment relationships, based on the steady state wage adjustment equations of Table 6.1. These are plotted in Figures 6.1, 6.2 and 6.3. In order to show the equilibrium rate of change of wages as a function of the unemployment rate alone, certain assumptions must be made about the values of the other explanatory variables. We have assumed that $\dot{P}_t^*$, the four-quarter average of yearly rates of change of the consumer price level, is equal to zero; that $(Z/Q)_{t-2}^*$, the four-quarter average of profits per unit of output, is equal to 97.75, its average over the sample period 1953-I through 1965-II; and that $\dot{W}^*_{us_t}$, the four-quarter average of yearly rates of change of U.S. wages, is equal to 3.2 per cent per annum.[1] The estimates have been calculated for unemployment rates ranging from 2½ to 8 per cent of the labour force, which fall within the range of the data from which the relationships have been derived.[2]

Table 6.2

The Relationship between $\dot{W}^e_t$ and U^*_t for Various Steady State Wage Adjustment Relationships with

$\dot{P}^*_t = 0$, $(Z/Q)^*_{t-2} = 97.75$, and $\dot{W}^*_{us_t} = 3.2$

Unemployment Rate (U^*_t) (Per Cent of Labour Force)	$\dot{W}^e_t$ (Per Cent per Year) Estimated from Equation:				
	(5.1e)	(5.2e)	(5.3e)	(5.5e)	(5.7e)
2.5	5.02	4.25	5.81	6.00	7.56
3.0	4.21	3.87	4.71	4.73	5.68
4.0	3.40	3.38	3.62	3.47	3.82
5.0	3.03	3.09	3.12	2.88	2.96
6.0	2.83	2.90	2.84	2.57	2.49
7.0	2.71	2.76	2.68	2.37	2.20
8.0	2.63	2.66	2.57	2.25	2.02

It will be observed that all five wage adjustment relationships yield a rather similar picture of the wage-change-unemployment relationship. In particular, equations (5.1e) and (5.2e) give rise to very similar expected rates of change of money wages for unemployment rates in the range of 4 to 8 per cent of the labour force, although the formulation with the square of the reciprocal of the unemployment rate, equation (5.1e), shows higher expected rates of change of wages at unemployment rates below 4 per cent. From Figures 6.2 and 6.3, it is apparent that the wage-change-unemployment relationship is flatter (variations in the rate of change of wages are less pronounced in going from high to low unemployment rates) if the wage adjustment relationship includes both unit profits and U.S. wage changes as explanatory variables than if either or both of these determinants are omitted. The curves based on equations (5.3e) and (5.5e), including unit profits and U.S. wage changes respectively, are flatter than equation (5.7e), which excludes both these variables; equation (5.1e), which includes both U.S. wage changes and unit profits, is the least steep of the four relationships. It is

[1] Some readers will recognize the 3.2 per cent per year figure as the "guidepost" of the U.S. Council of Economic Advisers. While this assumption is merely a rough guess about wage behaviour in the United States, it is more realistic than assuming a complete freeze on U.S. money wages, which would imply that the U.S. wage change variable would be set equal to zero.

[2] Actually, quarterly rates of unemployment from 1953 to 1965 fell within the interval from 1.9 per cent to 11.0 per cent when unadjusted for seasonality. All estimates reported in Chapter 5 are based on data which were not adjusted for seasonality. However, with the unadjusted data transformed on the basis of a weighted five-month moving average, unemployment rates (U^*) lay within the range from 2.9 per cent to 7.5 per cent.

Figure 6.1

TWO CANADIAN WAGE ADJUSTMENT CURVES, BASED ON DATA FOR THE 1953-65 PERIOD

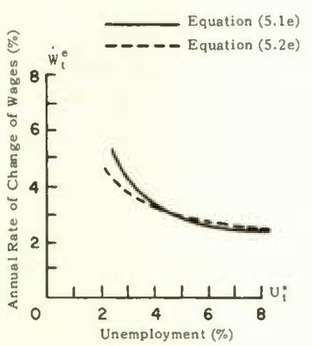


Figure 6.2

THREE CANADIAN WAGE ADJUSTMENT CURVES, BASED ON DATA FOR THE PERIOD 1953-65, GROUP A

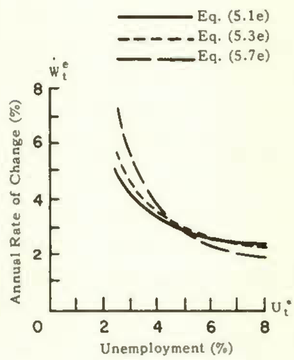


Figure 6.3

THREE CANADIAN WAGE ADJUSTMENT CURVES, BASED ON DATA FOR THE PERIOD 1953-65, GROUP B

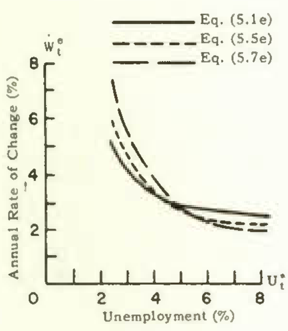
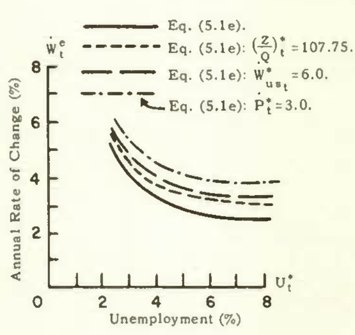


Figure 6.4

SHIFTS IN A CANADIAN WAGE ADJUSTMENT CURVE, DUE TO VARIATIONS IN THE DETERMINANTS OF WAGE CHANGES OTHER THAN THE RATE OF UNEMPLOYMENT



not difficult to explain this difference on statistical grounds. Both profits per unit of output and U.S. wage changes tend to vary, to some extent, along with the unemployment rate; hence, if these variables are not included explicitly in the statistical formulation estimated, their effects are captured, to some extent, by the unemployment rate which acts, in part, as a proxy for these omitted influences.

The influence of the other variables on the steady state rate of change of wages may be briefly discussed.[1] From Table 6.1, we see that, in each of the five steady state wage adjustment equations, increases in the consumer price level result in less than full adjustment of money wages, the coefficient on the average price change being 0.4 or 0.5. This is generally consistent with the studies of the wage adjustment relationship reviewed in Chapter 3. A rise in the (average) ratio of profits to output of 10 index points, which is within the range of variation recorded for this variable during the sample period, will increase the predicted rate of wage change by 0.55 to 0.68 of a percentage point, in addition to what this magnitude would have been otherwise. Consequently, it is apparent that, according to the computed steady state equations, variations in the ratio of profits to output have a nontrivial impact on the rate of change of money wages. Finally, the steady state coefficient of U.S. wage changes (the four-quarter average of this variable) ranges from 0.26 to 0.36, indicating that an additional increase of one percentage point in the rate of change of U.S. wages induces, by itself, an additional increase in the rate of change of Canadian wages of 0.26 to 0.36 of a percentage point. The effects of shifts in each of these three variables on the wage-change-unemployment relationship based on equation (5.1e) is presented graphically in Figure 6.4. In this chart, each curve is based on the assumptions underlying Table 6.2 and Figures 6.1, 6.2, and 6.3, except where specifically noted otherwise.

3. Steady State Price Change Equations

For the "normal" 1953-65 period, our best price change relationship, from Chapter 5, was:

$$(5.36) \qquad \dot{P}_t = -0.62164 + 0.19877\dot{W}_t + 0.09982\dot{F}_t + 0.81715\dot{P}_{t-1}\ .$$

Here, also, it can be shown that, if the rate of change of money wages and the rate of change of import prices remain constant for a long period of time, the

[1] The range of quarterly variation in the explanatory variables other than U^* for the period 1953-I through 1965-II is as indicated. The dates when the minima and maxima were recorded are indicated in parentheses.

	Minimum Value	Maximum Value
$\dot{P}^*$	-1.3 (1953-II)	3.2 (1957-III)
$(Z/Q)^*$	90.4 (1954-IV)	112.7 (1953-I)
$\dot{W}^*_{us}$	2.3 (1955-I)	6.3 (1953-III)

actual rate of change of consumer prices will (aside from the stochastic disturbances assumed away in this theoretical analysis) converge to a moving or dynamic "equilibrium" rate of change of consumer prices. To find the relationship between this steady state value of $\dot{P}_t$ and the assumed constant rates of change of money wages and import prices, we may write:

$$(6.3) \qquad \dot{P}_t = \dot{P}_{t-1} = \dot{P}_t^e ,$$

that is, both the current and the lagged rate of change of consumer prices may be set equal to a common value. Substituting this common value into equation (5.36) we obtain:

$$(6.4) \qquad \dot{P}_t^e - 0.81715\dot{P}_t^e = -0.62164 + 0.19877\dot{W}_t + 0.09982\dot{F}_t ,$$

which in turn simplifies into:

$$(5.36e) \qquad \dot{P}_t^e = -3.3997 + 1.0871\dot{W}_t + 0.54591\dot{F}_t .$$

Several brief comments may be offered on the steady state price change relationship, equation (5.36e). First, the steady state coefficient on the wage change variable is 1.09; in other words, after all lagged influences have worked on their effects, a rise in the rate of change of money wages of one percentage point appears to induce an increase in the rate of change of consumer prices of slightly more than one percentage point, in addition of course to the rise that would have otherwise taken place. There may be some simultaneous equations bias from the feedback of consumer prices on wages in this computed result. However, the two-stage least squares estimates of the parameters of this price change equation, which were presented in the Appendix of the preceding Chapter, suggest that this bias is quantitatively small.[1] The steady state coefficient of the rate of change of import prices indicates that an additional percentage point increase in this variable is associated with an additional increase in the rate of change of the consumer price level of 0.55 of a percentage point. Finally, the constant term indicates that if both money wages and import prices were to be held absolutely rigid (that is, the rate of change of both of these variables were to take on the value of zero), then, theoretically, consumer prices would fall by approximately 3.4 per cent per annum. In a twentieth century economy, it is difficult to imagine consumer prices falling by this amount under almost any set of circumstances; consequently, the constant term is best interpreted as a retarding effect applying to the observed (constant) rates of change of wages and of import prices. In other words, one should be careful not to extrapolate a statistical relationship, particularly one referring to a steady state condition, beyond the range of the actual observations. As argued in the preceding Chapter, one interpretation of this large negative constant term is that it measures the effect of productivity growth on the time path of prices. As pointed out in Chapter 2,

[1] Moreover, the ordinary and the steady state coefficient on wage changes is slightly greater for the two-stage least squares estimates, contrary to what one might naively expect.

normally prices can rise at slower rates than the rate of rise of wages and other input prices, because of the effect of rising productivity in mitigating the increases in factor costs per unit of output. Although it may not be possible to estimate directly through regression analysis the cost and price-reducing effects of productivity growth (because productivity—or at least the relevant type of productivity variable—may grow at a nearly constant rate), the productivity effect on prices may show up in the estimated constant term of the computed regression. In this connection, it was observed that the value of the constant term of the derived equilibrium price change equation is both statistically significant and of the right order of magnitude to be interpreted as a productivity effect.

In Chapter 4 we presented some alternative price change relationships. One of these, equation (5.39), is reproduced immediately below:

$$(5.39) \qquad \dot{P}_t = -0.21296 + 0.08165\dot{W}_t + 0.12939\dot{F}_t + 0.19456\dot{P}_{us_t} + 0.95105\dot{P}_{t-1} - 0.32704\dot{P}_{t-2} .$$

As explained in Chapter 5, this relationship is based on data for the entire period 1949-65, which appears to have some definite peculiarities, due to the Korean War disturbances near the beginning of this period. Nevertheless, it is still of some interest to examine the steady state price change equation associated with this price change relationship.[1] To obtain this steady state equation, we proceed as before, setting the two lagged price change variables equal to the current price change, as this condition must hold in the steady state condition under discussion. Solving the resulting equation, one obtains:

$$(5.39e) \qquad \dot{P}_t^e = -0.5664 + 0.21716\dot{W}_t + 0.34413\dot{F}_t + 0.51946\dot{P}_{us_t} .$$

Several brief observations on equation (5.39e) are worth noting. First, it will be observed that the introduction of the rate of change of U.S. consumer prices reduces the absolute size of the estimated impact on the Canadian consumer price change of a change in Canadian wages, of a change in import prices, and of the constant term, which we interpreted earlier as a productivity effect. Moreover, the estimated effect of an additional one percentage point increase in Canadian wages is now smaller than that of an additional one percentage point increase in the implicit deflator of imports of goods and services. Perhaps the most striking feature of the steady state price change equation (5.39e) is the pronounced

[1] One can raise the issue of whether the form of the difference equation (5.39) is such that the price change variable will in fact converge to a steady state value, provided all values of the "independent" variables on the right-hand side of equation (5.39) remain constant indefinitely. For equation (5.39), the answer is in the affirmative. Mathematically, the difference equation in the time-dated price change variable is a linear, second order difference equation with constant coefficients. For equation (5.39), the roots of the characteristic equation of this difference equation are a complex conjugate pair, with a radius vector within the unit circle. Thus the solution time path is one of "true cycles" (a sinusoidal curve, in contrast to the period-to-period oscillations characterizing the first order difference equations discussed above), and these cycles are damped in character, converging eventually to a steady state value of the price change variable. It is interesting to note that the period for one complete (damped) cycle of the price change variable is 10.7 quarters or approximately 2.7 years, which would appear to be of the right order of magnitude for the short cycle of post-war experience.

degree to which Canadian consumer price changes appear to depend upon U.S. consumer price changes. Equation (5.39e) asserts that, other factors remaining unchanged, an additional one percentage point increase in the U.S. consumer price level is associated with an additional increase in the Canadian consumer price level of slightly more than half a percentage point.

As suggested in Chapter 5, one possible rationalization of this strong partial effect might be the tendency for Canadian price-setters to keep a close watch on developments in the United States and to follow changes in U.S. pricing patterns rather closely. Of course, this outcome could also reflect statistical illusion; the two consumer price indexes could merely be reacting to common influences, even after the changes in Canadian import prices have been explicitly taken into account in the estimation procedure. On the other hand, one might argue that the causal relationships are reasonably close to those depicted in the regression equation, in view of the much greater magnitude of the U.S. economy. In sum, equation (5.39e) asserts that domestic factors (summarized by the Canadian wage change variable) are of secondary importance in explaining changes in the Canadian consumer price level, in comparison with developments originating outside the Canadian economy. The combined effect of foreign price changes as estimated in equation (5.39e) is especially evident when one recognizes that an additional one percentage point increase in both import prices (reflecting largely U.S. prices) and U.S. consumer prices induces an additional increase in Canadian consumer prices of 0.86 of a percentage point.[1]

Finally, the steady state equation obtained from a price change relationship based on the unit labour cost approach, equation (5.35), is:

$$(5.35e) \qquad \dot{P}^e_t = 0.84543 + 0.54738\,(U\dot{L}C^n)_t + 0.51634\dot{F}_t\,.$$

For this steady state relationship, a variation of one percentage point in the (constant) rate of increase in normal unit labour costs is associated with an additional increase in the steady state rate of increase in consumer prices equal to 0.55 of a percentage point. Since the rate of rise of unit labour costs is approximately the rate of change of money wages less the rate of growth of normal labour productivity, the implied effect of a variation in the (continuing) rate of change of wages is implicitly smaller than the estimate of this coefficient in equation (5.36e) above. Moreover, in conjunction with the constant term and with

---

[1] For equation (5.38), the corresponding steady state equation is:

$$(5.38e) \qquad \dot{P}^e_t = 0.350 + 0.839\,\dot{P}_{us_t}$$

It may be noted that this steady state price change relationship is similar to (but not identical with) the price change equation (5.37), which closely approximates equation (5.38e) in form but which was estimated in this form directly (that is, without taking lags explicitly into account). Even under the extreme view that Canadian consumer price developments reflect only U.S. movements and immediate past history, with equation (5.38e) it is by no means certain that the Canadian Consumer Price Index must rise more rapidly than the American, although that is the expected outcome at low rates of change of the U.S. Consumer Price Index. If the U.S. Consumer Price Index were to rise more rapidly than 2.2 per cent per year, Canadian consumer prices would be expected to rise less rapidly, according to equation (5.38e). It is also interesting that the coefficient of $\dot{P}_{us_t}$ in equation (5.38e), 0.84, is virtually the same as the sum of the parameters of $\dot{F}_t$ and $\dot{P}_{us_t}$ in equation (5.39e), 0.86.

an assumed rate of growth of normal productivity in the range between 3.7 and 4.0 per cent per year, the dampening effects of productivity growth also appear to be smaller for equation (5.35e). The effect of a variation in the rate of change of import prices is quite similar to the estimate of equation (5.36e); for equation (5.35e), an additional one percentage point in the rate of increase of import prices is associated with an additional rise in the steady state rate of increase in consumer prices of 0.52 of a percentage point, which is very close to the effect of a variation in the rate of change of unit labour costs.

None of the trade-off equations presented in the following section is based on either equation (5.39e) or equation (5.35e), because of possible abnormalities in the period on which the former relationship is based and because of the marginal statistical significance of the labour cost variable in equation (5.35), from which the latter steady state relationship was derived. However, it is interesting to observe how the use of alternative price change equations, particularly one laying heavy stress on U.S. developments, conditions one's view of the trade-off relationship. For this reason, several tentative trade-off relationships, derived from equations (5.39e) and (5.35e) are presented in the Appendix of this Chapter. In addition, this Appendix gives the trade-off relationship derived from the two-stage least squares estimates of a wage change and a price change equation presented in the Appendix of the preceding Chapter.

4. The Estimated Trade-Off Options

If one writes down the steady state wage change and price change equations, it becomes apparent that one is dealing with a small system of two equations in several unknowns. We have derived the following two steady state relationships:

$$(5.1e) \qquad \dot{W}_t^e = -3.8749 + 0.43603\,\dot{P}_t^* + 0.05536\,(^Z/Q)_{t-2}^* + 0.26099\,\dot{W}_{us_t}^* + 16.529\,(U_t^*)^{-2}\text{, and}$$

$$(5.36e) \qquad \dot{P}_t^e = -3.3997 + 1.0871\,\dot{W}_t + 0.54591\,\dot{F}_t\,.$$

Combining these two relationships, we can eliminate the wage change variable. This results in a single relationship between the rate of change of the consumer price level, the unemployment rate, and several outside (or "exogenous") variables. In deriving this trade-off relationship, we are assuming that price changes and wage changes are constant at their long-run steady state values; this enables us to equate $\dot{W}_t^e$ with $\dot{W}_t$ and $\dot{P}_t^e$ with $\dot{P}_t^*$.

Substituting equation (5.1e) into (5.36e), we obtain:

$$(6.5) \qquad \dot{P}_t^e = -3.3997 + 0.54591\,\dot{F}_t + 1.0871\,[-3.8749 + 0.43603\,\dot{P}_t^e + 0.05536\,(^Z/Q)_{t-2}^* + 0.26099\,\dot{W}_{us_t}^* + 16.529\,(U_t^*)^{-2}]\,,$$

which reduces to:

$$(6.6) \qquad \dot{P}_t^e - .47400\, \dot{P}_t^e = -3.3997 - 4.2123 + 0.54591\, \dot{F}_t + 0.06018\, (Z/Q)^*_{t-2} + 0.28371\, \dot{W}^*_{us_t} + 17.968\, (U_t^*)^{-2},$$

and thus:

$$(6.7) \qquad \dot{P}_t^e = -14.472 + 1.0378\, \dot{F}_t + 0.11441\, (Z/Q)^*_{t-2} + 0.53937\, \dot{W}^*_{us_t} + 34.161\, (U_t^*)^{-2}.$$

This is the familiar trade-off relationship between the rate of change of the consumer price level and several explanatory variables, including the rate of unemployment. It should again be emphasized at this point that this derived relationship is not based on mathematically exact relationships, but on statistical relationship—that is, on relationships subject to random disturbances. Hence this derived trade-off relationship is also subject to stochastic disturbances about the predicted values of this relationship; these predicted values might best be considered as positions of central tendency, analogous to an arithmetic mean for a statistical frequency distribution. In any case, the derived trade-off relationship represents an abstraction, because the real world variables rarely grow at constant rates for a long enough period of time so that the wage and price change variables may actually attain their long-run steady state values. Further qualifications are given in the concluding paragraphs of this section.

In a similar fashion, a trade-off relationship can be computed from the steady state wage adjustment relationships (5.2e), (5.3e), and (5.7e), in conjunction with the equilibrium price change equation (5.36e). The results of these computations are presented in Table 6.3. In this Table, an empty cell indicates that the variable in question does not enter explicitly into the particular trade-off relationship under consideration.

Table 6.3

Derived Trade-Off Relationships: $\dot{P}_t^e$ as a Linear Function of the Indicated Explanatory Variables, 1953-65

Equation Number	Steady State Wage Change Equation on Which the Trade-Off Equation is Based	Constant Term	Coefficients of Explanatory Variables:			
			$\dot{F}_t$	$(Z/Q)^*_{t-2}$	$\dot{W}^*_{us_t}$	$(U_t^*)^{-2}$
(6.7)	(5.1e)	-14.472	1.0378	0.11441	0.53937	34.161
(6.8)	(5.2e)	-15.755	0.97337	0.11707	0.62524	11.224#
(6.9)	(5.3e)	-16.858	1.1201	0.15171	—	50.026
(6.10)	(5.7e)	- 4.244	1.2498	—	—	95.451

Coefficient of $(U_t^*)^{-1}$

In order to present these trade-off relationships as two-dimensional curves, one must specify particular values for the explanatory variables (other than the unemployment rate) in these relationships. We may first consider a situation in which inflationary pressures from the outside are assumed to be absent: we set $\dot{F}_t$, the rate of change of import prices, equal to zero; where appropriate, $\dot{W}^*_{us_t}$ is set equal to the Council of Economic Advisers' "guidepost" value of 3.2 per cent per year; and $(Z/Q)^*_{t-2}$, the profits variable, is set equal to 97.75, its 1953-65 sample period mean. The results of computing several trade-off curves, under these assumptions, are presented in Table 6.4 and in Figures 6.5 and 6.6. Several comments on these relationships may be offered.

Table 6.4

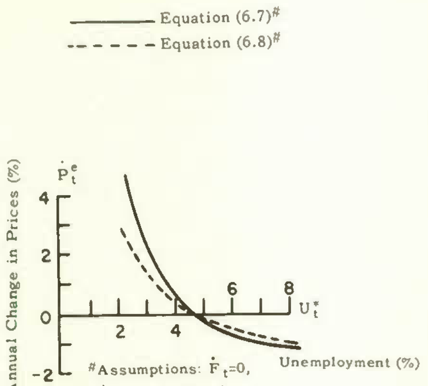
Estimated Price-Change-Unemployment Trade-Offs Based on Derived Trade-Off Relationships, 1953-65 ("Non-Inflationary" Environment)

Unemployment Rate (U^*_t) (Per Cent of Labour Force)	Rate of Change (Per Cent per Year) of Consumer Prices ($\dot{P}^e_t$), with $\dot{F}_t$ = 0 and (where appropriate) $\dot{W}^*_{us_t}$ = 3.2 and $(Z/Q)^*_{t-2}$ = 97.75: Equation (6.7)	Equation (6.8)	Equation (6.9)	Equation (6.10)
2.5	3.90	2.18	5.98	11.03
3.0	2.23	1.43	3.53	6.36
4.0	0.57	0.50	1.10	1.72
5.0	-0.20	-0.07	-0.03	-0.43
6.0	-0.61	-0.44	-0.64	-1.59
7.0	-0.86	-0.71	-1.01	-2.30
8.0	-1.03	-0.91	-1.25	-2.75
Implied Unemployment Rates "Required" for a Constant Consumer Price Level ($\dot{P}_t$ = 0), According to the Same Trade-Off Equations:	4.69	4.86	4.99	4.74

Under these conditions, with a relatively non-inflationary external environment, the trade-off between unemployment and inflation in the range of recently experienced unemployment rates seems somewhat sharper than previously thought. Thus, all of these four trade-off curves show a large amount of agreement concerning the expected amount of unemployment "required" for price level stability; all the estimates of this level of unemployment lie in the narrow range between 4.7 and 5.0 per cent of the labour force. There is somewhat less agreement, among these four curves, of the expected amount of inflation at the "full employment" rate of unemployment, which we take to be 3 per cent of the labour force: these estimates range from 1.4 per cent per year (with the unemployment rate entering in equation (6.8) as an unsquared reciprocal) to 6.4 per cent per annum. Thus, with an external environment favourable to price level stability, relatively small increments in unemployment appear to have a substantial effect in reducing inflationary pressures when the level of unemployment is less than 4 per cent. In terms of our preferred trade-off curve, derived from equation (6.7), the rate of

Figure 6.5

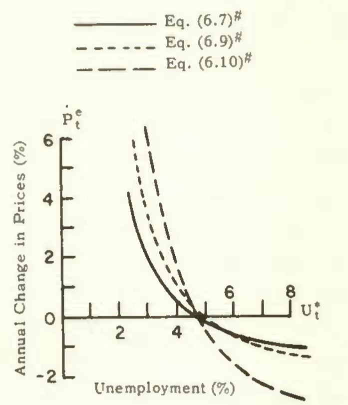
TWO CANADIAN TRADE-OFF CURVES, BASED ON THE PERIOD 1953-65



#Assumptions: $\dot{F}_t=0$, $\dot{W}^*_{us_t}=3.2$, $(Z/Q)^*_{t-2}=97.75$.

Figure 6.6

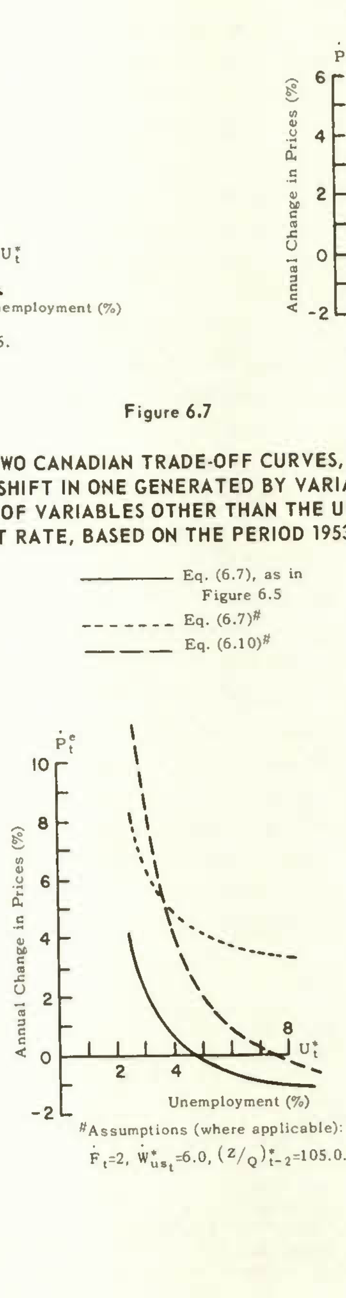
THREE CANADIAN TRADE-OFF CURVES, BASED ON THE PERIOD 1953-65



#Assumptions (where applicable): same as for Figure 6.5.

Figure 6.7

TWO CANADIAN TRADE-OFF CURVES, WITH A SHIFT IN ONE GENERATED BY VARIATIONS IN VALUES OF VARIABLES OTHER THAN THE UNEMPLOYMENT RATE, BASED ON THE PERIOD 1953-65



#Assumptions (where applicable): $\dot{F}_t=2$, $\dot{W}^*_{us_t}=6.0$, $(Z/Q)^*_{t-2}=105.0$.

unemployment "required" for price level stability under the conditions assumed is 4.7 per cent, which some individuals at least would not find excessive. On the other hand, the expected rate of inflation at the level of 3 per cent unemployment is 2.2 per cent. The average "trade-off" of an increased annual rate of inflation per percentage point decrease of the unemployment rate is 1.3, and this trade-off ratio rises to 1.7 in the range of the unemployment rate between 4.0 and 3.0. Thus, under the conditions assumed above and subject to the qualifications presented below, it appears that deflationary policies can have a substantial influence in reducing the expected rate of inflation.[1]

It is interesting to observe how one's view of the trade-off curve changes if differing trade-off relationships are used as the basis for deriving this trade-off curve. If the underlying wage adjustment relationship uses the reciprocal of the unemployment rate (instead of the square of the reciprocal of this variable), then, as Figure 6.5 indicates, the expected rates of increase of the consumer price level are fairly similar for the two curves when the unemployment rate lies in the range between 4 and 8 per cent, but the expected amount of inflation for low values of the unemployment rate is smaller with the trade-off curve based on the straight reciprocal of the U_t^* variable. There is also some tendency for the trade-off curve to be flatter with the formulation employing the simple reciprocal of the unemployment rate than with the alternative utilizing the squared reciprocal of this variable. As for the inclusion or the exclusion of additional variables other than the unemployment rate and the rate of change of import prices, Figure 6.6 indicates that the trade-off curve appears to be considerably steeper when the U.S. wage change variable does not enter explicitly into the trade-off function, in relationship (6.9), and appreciably steeper still when the profits variable is also dropped, in relationship (6.10). As pointed out in our discussion of the wage adjustment equation, this variation in the picture of the trade-off curve is believable, because historically high profit margins, low unemployment rates, and high rates of U.S. wage changes have tended to go together. Thus, when these variables are not included explicitly in the wage adjustment relationship, their effects are captured in part by the unemployment rate. When the wage adjustment relationship is substituted into the price change equation to derive a trade-off relationship, the more pronounced impact of the unemployment rate, in the absence of these supplementary explanatory variables, tends to persist. In this manner, one might rationalize the appearance of the trade-off curves in Figure 6.6. Moreover, the argument presented above would lead one to choose equation (6.7) as the most accurate representation of the hypothetical trade-off relationship, because the

---

[1] This statement should be qualified, to some extent, by the pictures of the trade-off curve presented and discussed in the Appendix. Although we believe that the first two sets of alternative trade-off relationships are less accurate than those presented in the text, nevertheless a *caveat* seems in order. The trade-off curves based on equation (5.39e) are considerably flatter than those of the text, suggesting that a mild dampening of aggregate demand will not be very helpful in promoting price level stability. The trade-off curves based on the unit labour cost version of the price change relationship, equation (5.35e), also seem to suggest a greater conflict between the goals of high employment and price stability, as well as somewhat less favourable trade-offs in the high-employment range (below 4 per cent unemployment). On the other hand, the trade-off relationship based on the two-stage least squares equations looks very much like the trade-off equation (5.7) above; if anything, the derived curve is steeper in the low-unemployment range, suggesting a favourable outlook for a mild deflationary policy.

wage adjustment relationship underlying this equation is probably the best description of wage behaviour, in our view, that has been estimated in this study.

It is also of some interest to note how the trade-off curve shifts in response to changes in the external environment. According to Table 6.3, shifts in the values of the variables other than the unemployment rate have an appreciable influence on the expected rate of inflation; in terms of the two-dimensional trade-off curve, changes in the values of these variables produce an appreciable shift in the derived (steady state) trade-off curve. Thus, at a given unemployment rate and after all lagged influences have worked out their effects, a rise in the rate of increase of import prices of one percentage point will ultimately produce an additional increase in the expected rate of change of consumer prices of 0.97 to 1.25 of a percentage point. Changes in unit profits variable will also have an appreciable influence, a rise of 10 index points in this ratio being associated with an expected increase in the rate of change of consumer prices of 1.1 to 1.5 additional percentage points. And the influence of the rate of change of U.S. wages appears to be far from trivial: an additional percentage point increase in this variable will induce, in the new steady state of the variables, an additional 0.54 to 0.63 of a percentage point increase in the rate of change of Canadian consumer prices. The influence of foreign price and wage developments, particularly from the United States, on Canadian consumer price movements appears to be very pronounced. If one assumes, for example, both an additional increase of one percentage point in import prices, based mainly on imports from the United States and a matching additional increase of one percentage point in the U.S. wages, according to equation (6.7) one can expect an increase in Canadian consumer prices of 1.58 percentage points more than the expected rate of change in absence of these external influences.

It is of some interest to consider what the expected trade-offs between unemployment and inflation appear to be when the external environment is relatively inflationary. For definiteness, we shall assume that the implicit deflator of the imports of goods and services rises at the rate of 2 per cent per annum; moreover, for equation (6.7), we shall assume that U.S. wages rise at the rate of 6 per cent per year and that the ratio of profits to output has a value of 105 (index points). These are all fairly high values, but well within the range of historical experience, over the sample period studied. One can then compute the expected rate of inflation at various rates of unemployment. The results of these computations appear in Table 6.5 and are plotted in Figure 6.7. In Figure 6.7, the trade-off curve, derived from equation (6.7) under the earlier set of assumptions, is plotted by the heavy line, for purposes of facilitating comparisons; the dotted curve represents the trade-off curve derived from equation (6.7) under the more inflationary set of assumptions, and the dashed-line trade-off curve is derived from equation (6.10), under the new set of assumptions. We focus first on the trade-off curve derived from our preferred trade-off equation (6.7). Under the conditions postulated above, the economy is almost certain to experience some degree of inflation no matter how expansionary or how restrictive monetary and fiscal policy happens to be. At the 3 per cent rate of unemployment deemed to be a full-employment value, the expected rate of increase of the consumer price level is roughly 6.6 per cent per year. It is true that if the unemployment rate were reduced to 5 per cent by restrictive public policy, the expected rate of inflation would fall to 4.2 per cent per annum. But, beyond this point, there is relatively little gain to further deflation. Thus a 10 per cent unemployment rate is associated with an expected annual rate of increase of consumer prices of 3.2 per cent, which is still a substantial amount. In particular, there appears to be no value of the unemployment rate (in the range of post-war experience and slightly beyond) that is consistent with an expected rate of change of consumer prices equal to zero.

Table 6.5

Estimated Price-Change-Unemployment Trade-Offs Based on Derived Trade-Off Relationships, 1953-65 ("Inflationary" Environment)

Unemployment Rate (U_t^*) (Per Cent of Labour Force)	Rate of Change (Per Cent per Year) of Consumer Prices ($\dot{P}_t^e$) with $\dot{F}_t$ = 2.0 and (where appropriate) $\dot{W}^*_{us_t}$ = 6.0 and $(Z/Q)^*_{t-2}$ = 105.0: Equation (6.7)	Equation (6.10)
2.5	8.32	13.53
3.0	6.65	8.86
4.0	4.99	4.22
5.0	4.22	2.07
6.0	3.80	0.91
7.0	3.55	0.20
8.0	3.39	−0.25
Implied Unemployment Rates "Required" for Constant Consumer Price Level ($\dot{P}_t$ = 0), According to the Same Trade-off Equations:	None under 10% of the Labour Force	7.41

It is otherwise with the trade-off curve based on equation (6.10). Although, according to the dashed-line curve, the expected rate of inflation (8.9 per cent per year) is higher at the full-employment value of the unemployment rate (3 per cent), this expected rate of inflation declines fairly rapidly as the unemployment rate increases. Thus, at 5 per cent unemployment, the expected rate of inflation is 2.1 per cent per annum, and, theoretically, an unemployment rate of 7.4 per cent would be sufficient, even under these unfavourable external conditions, to hold the expected rate of rise of consumer prices to zero. This trade-off curve is probably less realistic than its alternative based on equation (6.7), because the curve based on equation (6.10) implicitly "builds in" the effects of changing profits margins and changing rates of change of U.S. wages, as pointed out above. Since profits per unit of output are only partially responsive to aggregate demand conditions and since the rate of rise of U.S. wages only very slightly so (i.e. to Canadian demand conditions), it would appear that the trade-off curve based on equation (6.10) overestimates the response of the rate of change of

Canadian consumer prices to dampened domestic demand, even under the new set of circumstances assumed for the purposes of the discussion.

We may conclude this section by presenting some qualifications or limitations of this type of analysis. First, as pointed out earlier, these derived trade-off relationships are best regarded, not as mathematically exact equations, but as loci of central tendencies in a collection of conditional probability distributions, under the assumed set of conditions. Even leaving aside the issue of wage and price changes settling down to their moving equilibrium values, the expected rate of change of the consumer price level for a given rate of unemployment (and given values of the other determinants of this variable) will not inevitably be realized. One may be unfortunate and experience more than the expected amount of inflation or, conversely, the policy-makers may be lucky and experience a smaller increase in the price level than predicted. What the trade-off relationship indicates is a predicted rate of inflation (for a given unemployment rate and particular values of the other explanatory variables), which might be expected to prevail on average if the situation were to be repeated for a sufficient number of times, under an unchanged structure. But one should surely not expect an individual observation to lie exactly on the calculated trade-off relationship—that is asking for a precision not available at this stage of the art. Secondly, the computed trade-off relationships are not derived directly from fitted wage adjustment and price level change regressions, but indirectly from the associated steady state equations. Hence, the derived trade-off relationships implicitly assume that the rate of change of consumer prices (and also of money wages) has already settled down to the steady state values. In the real world, of course, unemployment rates, rates of change of import prices, profit margins and other relevant variables generally do not stay constant. Thus the steady state trade-off relationship represents at best only the position to which the system is striving, although it will rarely (if ever) attain this position. As argued in Chapter 4, this relationship is closely analogous to the hypothetical position of long-run equilibrium in a competitive industry, which is also rarely attained but which is still a useful simplification for analytical purposes.

A third set of qualifications on the analysis relates to its aggregative character. Like all analyses conducted on an aggregative level, ours abstracts from a number of factors peculiar to individual industries or regions of the country. This type of simplification induces a certain amount of distortion into one's view of the economy, which is not always adequately summarized by the inclusion of a simple, additive stochastic disturbance term.[1] Closely related to this question is the issue of whether increased stability of the economy in general (so that recessions in output and in the rate of unemployment were avoided) might shift the trade-off curve towards the axes (i.e., mitigate the conflict between the goals of high employment and stable prices). One of our commentators has argued that this

[1] For a fuller discussion of the limitations of an aggregative analysis of inflation, see Ronald G. Bodkin, *The Wage-Price-Productivity Nexus* (Philadelphia: University of Pennsylvania Press, 1966), Chapter 7.

is in fact so,[1] and that, for this reason, the derived trade-off curves of this Chapter are more nearly upper limits than measures of central tendency. It is not difficult to construct an appealing argument for this position. Thus, if the economy were considerably more stable than it is at present, presumably structural imbalances (which tend to raise prices and wages considerably more in the excess demand sectors than to lower them in the deficient demand sectors) could be avoided.[2] Moreover, with the knowledge that the prosperity was a permanent one, presumably sellers of goods and labour services possessing some degree of market power would not be so tempted to take advantage of favourable demand conditions as they would if they thought that the prosperity was an evanescent one. On the other hand, another school of thought would stress the importance of a fear of unemployment and of undercapacity utilization in "disciplining" the wage and price requests of less than perfectly competitive sellers, who are viewed as capable of making exorbitant demands if they believe that the authorities will maintain full employment at any cost.[3] Regardless of which of these two opposing tendencies may be stronger, we should not claim that the estimated trade-off relationships would be even approximately valid if the structure of the economy shifts drastically. At best, the empirical analyses pursued in this Chapter are relevant to future conditions only if the nature of the economy during this future period closely resembles the economy's structure during the sample period to which the underlying relationships were fitted.

In addition to the qualifications given above, the reader is also reminded of those relating to the fitted regressions, which were presented in Section 5 of the preceding Chapter. We should argue, however, that these shortcomings and limitations do not destroy the usefulness of the approach adopted here and in Chapter 5. Instead, they merely serve to emphasize that these results cannot be used blindly as infallible guides; rather, to be employed properly, they must be interpreted with judgment and with an awareness of an inherent margin of uncertainty. Undue importance should not be attached to the particular numerical results obtained; instead, the reader should take away a broad impression of the conflict between the two policy goals under examination.

5. Concluding Observations

Perhaps the most striking feature of our results is the powerful influence which foreign–especially U.S.–prices and wages have on the stability of Canadian consumer prices and wages. Evidence of the strength of this influence

---

[1] In "A Theory of the Wage-Price Process in Modern Industry" (*op. cit.),* Otto Eckstein also argues that "variability in the growth rate is an important source of inflation". (p. 282). Hence, by implication, increased stabilization of the economy would in itself reduce the conflict between high employment and price level stability, if we have interpreted Eckstein correctly.

[2] Two basic references on this effect are Charles L. Schultze, "Recent Inflation in the United States", Study Paper No. 1, prepared for the Joint Economic Committee of the U.S. Congress, *Study of Employment, Growth, and Price Levels* (Washington: U.S. Government Printing Office, 1959) and Richard G. Lipsey, "The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1862-1957: A Further Analysis" (*op. cit.*), pp. 12-23.

[3] Lucid statements of this point of view may be found in two articles by Walter A. Morton, "Trade Unionism, Full Employment, and Inflation," *American Economic Review,* March 1950, pp. 13-39, and "Keynesianism and Inflation," *Journal of Political Economy,* June 1951, pp. 258-265.

comes to light repeatedly in our analysis. Furthermore, our estimates indicate that before-tax-profits per unit of output in manufacturing and the level of unemployment are significantly related to the stability of Canadian consumer prices and wages. Both unit profits and unemployment can be considered as proxies for the level of aggregate demand in Canada. Consequently, our estimates imply a significant relationship between the level of aggregate demand and the degree of price stability in the country. In addition, the relationship between unit profits and price stability may reflect some influences of market power on the rate of change of the price level.

Our best estimates indicate that if external prices remain stable and unit profits are "normal",[1] Canada will require an unemployment rate of roughly 4¾ per cent in order to achieve price stability. With an unemployment rate of 3 per cent, stable foreign prices and normal unit profits, prices can be expected to rise at 2¼ per cent per year. In order to induce a decrease of 1 per cent annually in consumer prices under these assumptions, an unemployment rate of about 8 per cent would be needed.[2]

This picture is substantially changed when foreign inflation is introduced into the picture. If one assumes an increase of foreign prices of 2 per cent annually and a corresponding higher rate of increase in U.S. wages, there appears to be no level of unemployment within the range of post-war experience which will secure price stability in Canada.

The importance of this result from the standpoint of Canadian economic policy bears considerable emphasis. In planning Canada's economic policies, it is unrealistic to define an isolated price objective without recognizing the impact of external prices and factor costs. Because of these strong external influences on Canadian prices, it is questionable whether one can say that Canadian policy should aim at "reasonable" price stability or should allow prices to drift upward at a low rate of increase of perhaps 1 to 1½ per cent annually. Canadian government policy has almost no control at all over one of the key determinants of Canadian price stability–i.e., foreign price influences. This is especially true so long as the country remains on a fixed foreign exchange rate. The Government does have some measure of control over the aggregate level of domestic demand. In principle, it might attempt to depress domestic demand sufficiently to offset the effect of rising external prices and costs. In fact, such a policy might easily mean that the country would frequently have to tolerate rates of unemployment well in excess of 10 per cent. Such a policy strategy can be seriously questioned. The social costs of offsetting imported inflation at levels of unemployment of this magnitude would be extremely high. Moreover, since the rate at which foreign

---

[1] "Normal" profits are defined here as the average level of unit profits from 1953 to 1965.

[2] The estimates of these magnitudes based on the trade-off curve derived from the two-stage least squares regression, which is presented in the Appendix, are close, but not identical, to those presented in this paragraph. The estimate of the unemployment rate "required" for price level stability is slightly lower, at 4.6 per cent of the labour force, while the expected rate of inflation at a 3 per cent rate of unemployment is somewhat higher, at slightly more than 2¾ per cent per year. The estimate of the rate of unemployment needed to induce an actual decline of 1 per cent annually in the consumer price level is approximately 6¼ per cent.

prices increase varies considerably from year to year, a policy of fully compensating for the effects of foreign price changes through variations in domestic demand would entail imposing sharp fluctuations on the level of domestic demand.[1] The continuing uncertainties which such fluctuations would entail might add a further cost to a policy of this kind designed to offset fully imported inflation. Alternatively, the policy-makers might virtually eliminate our foreign trade and so effectively insulate the country from foreign price influences. However, almost all Canadians would agree that the costs of such a policy would be prohibitive.

In view of the influence of foreign prices and costs and of the limitations of domestic policy, the price objective for Canadian economic policy can perhaps be sensibly defined only in relation to U.S. and other foreign prices. Thus, one might define Canada's price objective as not allowing prices in Canada to rise faster than in the United States, or as holding the rise in Canadian prices to a certain percentage below or above the rise in U.S. prices. By casting the definition of the price level objective for economic policy in these terms, one would explicitly recognize the paramount importance of the prices of goods and services imported from the United States and other foreign countries in determining Canadian prices. Consequently, a policy objective defined in these terms would, in our view, imply, as well, a healthy recognition of the limitations of Canadian policy in offsetting these external influences.

[1] These points are more fully developed in Chapter 9 below.

APPENDIX

Some Alternative Trade-Off Relationships

A. *Trade-Offs Based on 1949-65 Data*

In Section 3, we briefly discussed an alternative equation explaining rates of change of the Canadian consumer price level. From this relationship, the following equilibrium price change equation was calculated:

$$(5.39e) \qquad \dot{P}^e_t = -0.56640 + 0.21716\dot{W}_t + 0.34413\dot{F}_t + 0.51946\dot{P}_{us_t}$$

As pointed out, this equilibrium price change equation lays far heavier stress, than does equation (5.36e), on foreign influences conditioning the rate of change of Canadian consumer prices. Hence it is of some interest to examine the view of the trade-off relationship to which such an equation gives rise.

If one substitutes equation (5.1e) into equation (5.39e), the result obtained, after some algebraic manipulation, is:

$$(6.11) \qquad \dot{P}^e_t = -1.5551 + 0.01328\,(Z/Q)^*_{t-2} + 0.06261\,\dot{W}^*_{us_t} + 0.38012\dot{F}_t + 0.57379\dot{P}_{us_t} + 3.9650(U^*_t)^{-2}\,.$$

If, on the other hand, the wage adjustment relationship is (5.7e), the derived result is:

$$(6.12) \qquad \dot{P}^e_t = -0.29022 + 0.38776\dot{F}_t + 0.58531\dot{P}_{us_t} + 9.3847(U^*_t)^{-2}\,.$$

Both equations (6.11) and (6.12) are trade-off relationships, relating an equilibrium rate of change of Canadian consumer prices to several explanatory variables. The coefficients of these trade-off relationships suggest that foreign influences (the rate of change of import prices and, especially, the rate of change of the U.S. consumer price level) are more important than domestic influences (principally the unemployment rate) on the rate of change of the domestic consumer price level.

This impression is confirmed by an examination of Table 6.6 and Figures 6.8 and 6.9. In columns (2) and (3) of Table 6.6 and in Figure 6.8, the trade-off relationship is reduced to a two-dimensional curve by making some relatively non-inflationary assumptions regarding the non-unemployment variables of this relationship. In particular, it is assumed that the rate of change of import prices and the rate of change of U.S. consumer prices is zero; for equation (6.11), it is also assumed that the ratio of profits to output is 97.75 (its 1953-65 average) and that the rate of change of U.S. wages is 3.2 per cent per annum. (In Figure 6.8, the dashed line represents the trade-off curve derived from equation (6.7), which has been inserted for purposes of facilitating comparisons.) In the final two columns of Table 6.6 and in Figure 6.9, the trade-off curve is computed or plotted under a relatively inflationary set of conditions: the rate of change of import prices is 2.0 per cent per year, the rate of change of U.S. consumer prices is 3.0 per cent per annum; for relationship (6.11), we also assume a rate of increase of U.S. wages of 6.0 per cent per year and a value of the profits-to-output variable equal to 105.0 index points. (In Figure 6.9, a dashed line for comparative purposes has also been included; this dashed line represents the trade-off curve derived from equation (6.11) under the original (non-inflationary) set of circumstances.)

Table 6.6

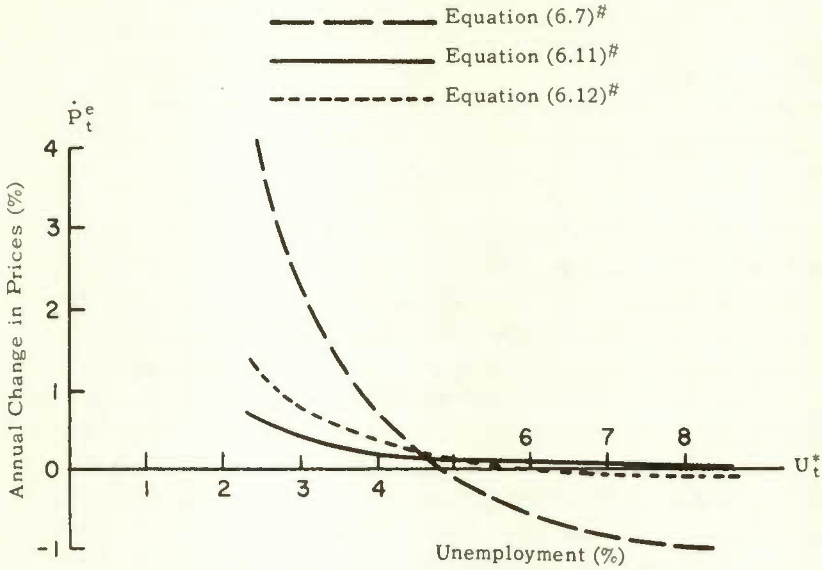
Trade-Off Curves Based on Price Change Equation (5.39e), under Two Sets of Circumstances

Unemployment Rate (U_t^*) (Per Cent of Labour Force)	Rate of Change (Per Cent per Year) of Consumer Prices ($\dot{P}_t^e$), with $\dot{F}_t = 0$, $\dot{P}_{us_t} = 0$, and (for 6.11) $(Z/Q)_{t-2}^* = 97.75$ and $\dot{W}_{us_t}^* = 3.2$, for:		Rate of Change (Per Cent per Year) of Consumer Prices ($\dot{P}_t^e$), with $\dot{F}_t = 2.0$, $\dot{P}_{us_t} = 3.0$ and (for 6.11) $(Z/Q)_{t-2}^* = 105.0$ and $\dot{W}_{us_t}^* = 6.0$, for:	
	Equation (6.11)	Equation (6.12)	Equation (6.11)	Equation (6.12)
(1)	(2)	(3)	(4)	(5)
2.5	0.58	1.21	3.33	3.74
3.0	0.38	0.75	3.14	3.28
4.0	0.19	0.31	2.94	2.83
5.0	0.10	0.09	2.86	2.62
6.0	0.05	-0.03	2.81	2.50
7.0	0.02	-0.10	2.78	2.43
8.0	0.01	-0.14	2.76	2.39
Unemployment Rate "Required" for Complete Stability of the Consumer Price Level, for the Relationship in Question under the Assumed Conditions:	8.37	5.69	None under 10%	None under 10%

The conclusions from this exercise are relatively straightforward. The trade-off curves based on equations (6.11) and (6.12) are both relatively flat, much more so than the trade-off curve derived from equation (6.7). In particular, beyond an unemployment rate of 4 or 5 per cent, the expected price level change seems very insensitive to variations in the level of unemployment. Hence, the curves in Figure 6.8 based on equations (6.11) and (6.12) seem to be very much in the spirit of the models analyzed in the standard courses in introductory economics or intermediate theory: there is very little change in prices until full employment is approached, and then prices begin to heat up. The trade-off curve based on equation (6.12) is somewhat steeper than that derived from (6.11), particularly in the full-employment region. As the discussion in Section 4 of the text would indicate, this is a highly reasonable result.

Figure 6.8

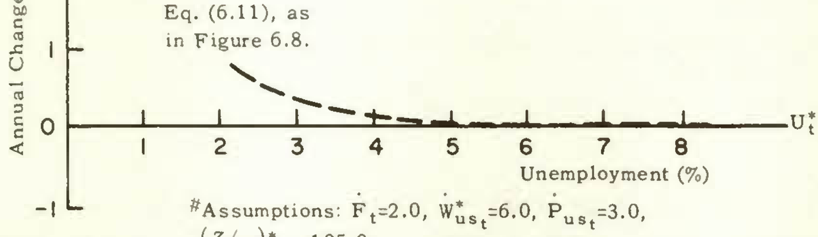
THREE POST-WAR CANADIAN TRADE-OFF CURVES, UNDER A RELATIVELY NON-INFLATIONARY EXTERNAL ENVIRONMENT



#Assumptions (where applicable): $\dot{F}_t$=0, $\dot{W}^*_{us_t}$=3.2, $(Z/_Q)^*_{t-2}$=97.75, $\dot{P}_{us_t}$=0.

Figure 6.9

AN ILLUSTRATION OF THE EFFECTS ON THE TRADE-OFF CURVES OF VARIATIONS IN THE DETERMINANTS OF PRICE CHANGES OTHER THAN THE RATE OF UNEMPLOYMENT



#Assumptions: $\dot{F}_t$=2.0, $\dot{W}^*_{us_t}$=6.0, $\dot{P}_{us_t}$=3.0, $(Z/_Q)^*_{t-2}$=105.0.

Under the more inflationary external circumstances assumed in Figure 6.9, some inflation seems inevitable, regardless of how restrictive domestic monetary and fiscal policy happens to be. Hence, under these conditions, there would be very little return to raising unemployment beyond the full-employment rate to reduce inflationary pressures, as the trade-off curve is quite flat. It is worth observing that, under the models assumed in this section of the Appendix, the rate of change of the Canadian Consumer Price Index is never far from the assumed rate of change of the U.S. consumer price level. This is hardly surprising, since the rate of change of the U.S. consumer price level is quantitatively the most important influence in the steady state price change equation upon which the trade-off relationships of this Appendix are based.

The analysis of this Appendix is subject to all the qualifications set forth in Section 4 and also to several of its own. One can argue that equation (5.39) is not completely satisfactory as a price change relationship, since it is based on data which include the rather unique Korean War period. Since equation (5.39) does not work well when the Korean War data are not included, the generality of this relationship and the associated steady state equation are subject to question. For this reason, we are inclined not to lay heavy emphasis on this analysis. Nevertheless, the general point, if qualified, does seem valid: *if* U.S. consumer price changes are ultimately an important influence on changes in the Canadian consumer price level, domestic policy can only have a secondary influence on the Canadian consumer price level, and that probably only in or near the full-employment range of the unemployment rate. In turn, this suggests that one might wish to define one's price level goal, not in absolute terms, but in terms of the behaviour of the U.S. consumer price level.

B. *Trade-Offs from Price Equation with Unit Labour Costs*

Also in Section 3 of this Chapter, a steady state equation explaining variations in the rate of price change based on the unit labour cost approach was obtained; this equation is:

$$(5.35e) \qquad \dot{P}_t^e = 0.84543 + 0.54738\,(\dot{ULC}^n)_t + 0.51634\,\dot{F}_t\,.$$

Since, by definition, we have:

$$(5.30) \qquad ULC_t^n = \frac{W_t}{A_t^*/100}\,,$$

the following approximation is valid:

$$(6.13) \qquad (\dot{ULC}^n)_t = \dot{W}_t - \dot{A}_t^*\,.$$

On the basis of the analysis of Section 3 of the preceding Chapter, we may choose 3.7 per cent per year as a "normal" rate of growth cf labour productivity for recent years. Substituting this value into equation (6.13) and equation (6.13) in turn into equation (5.35e),[1] we obtain:

$$(6.14) \qquad \dot{P}_t^e = -1.1799 + 0.54738\,\dot{W}_t + 0.51634\,\dot{F}_t\,.$$

At this point, the derivation of a trade-off relationship is straightforward and follows the method employed in the text.

If one substitutes wage adjustment equation (5.1e) into equation (6.14), the resulting trade-off equation may be computed:

$$(6.15) \qquad \dot{P}_t^e = -4.3357 + 0.03980\,(Z/Q)^*_{t-2} + 0.18765\,\dot{W}^*_{us_t} + 0.67821\,\dot{F}_t$$

$$+ 11.884\,(U_t^*)^{-2}\,.$$

On the other hand, if the wage adjustment equation utilized is (5.7e), the derived trade-off relationship is:

$$(6.16) \qquad \dot{P}_t^e = -0.56036 + 0.72073\,\dot{F}_t + 29.305\,(U_t^*)^{-2}\,.$$

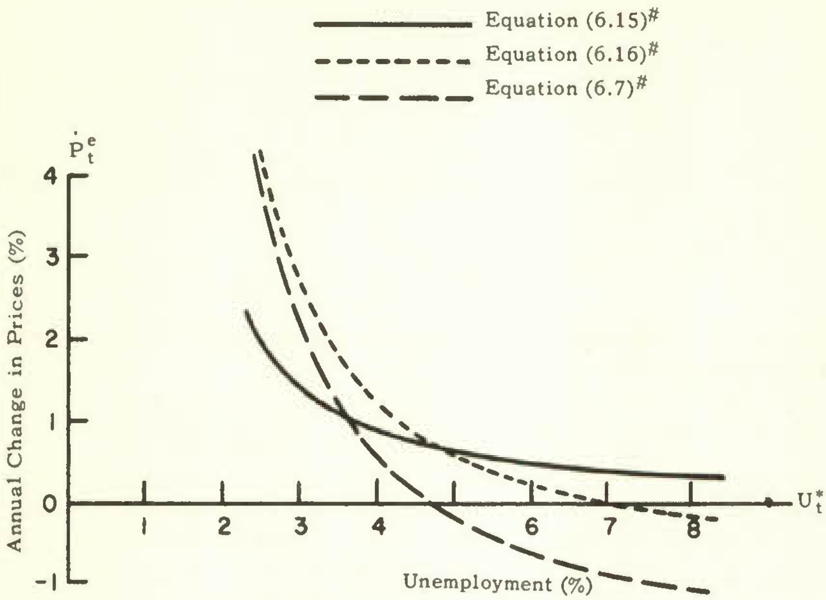
These trade-off relationships are presented in Table 6.7 and graphically in Figures 6.10 and 6.11. As before, columns (2) and (3) of the tabular presentation give the rates of inflation predicted by equations (6.15) and (6.16) respectively under a relatively non-inflationary set of circumstances; and columns (3) and (4), the predicted rates of change in the Consumer Price Index under a more inflationary external environment.

The conclusions which emerge from this analysis may be briefly discussed. Equation (6.15) gives rise to a flatter trade-off curve than does equation (6.7) of the text, and the same comparison can be made between the trade-off curve based on equation (6.16) and that derived from equation (6.10). In the relatively non-inflationary set of circumstances, the trade-off curve derived from equation (6.15) predicts only a 1½ per cent annual increase in consumer prices at a 3 per cent rate of unemployment which we have tentatively taken to be a full-employment rate. Although this is a lower expected rate of inflation than with equation (6.7), the predicted rate of increase in consumer prices at the 5 per cent rate of unemployment is 0.6 per cent per year, which is considerably higher than with the trade-off curve of the text. Moreover, there is no level of unemployment less than 10 per cent of the labour force which is capable of absolutely stabilizing the consumer price level, i.e., yielding a zero value for the expected rate of rise of consumer prices. The comparison between the trade-off curves based on equations (6.16) and (6.10) is similar. Thus, although the former trade-off curve (graphed in Figure 6.10) indicates a predicted rise in consumer prices of 3¾ per cent per year at the 3 per cent unemployment rate, the estimate of the rate of unemployment "required" to stabilize completely the Consumer Price Index is roughly 7¼ per

[1] If, instead of substituting the value 3.7 for $\dot{A}_t^*$, this variable is carried explicitly through the derivation, the resulting trade-off relationship will indicate that the rate of change of consumer prices varies negatively with the "normal" rate of productivity growth, in accord with the theoretical developments in Chapter 2 above.

Figure 6.10

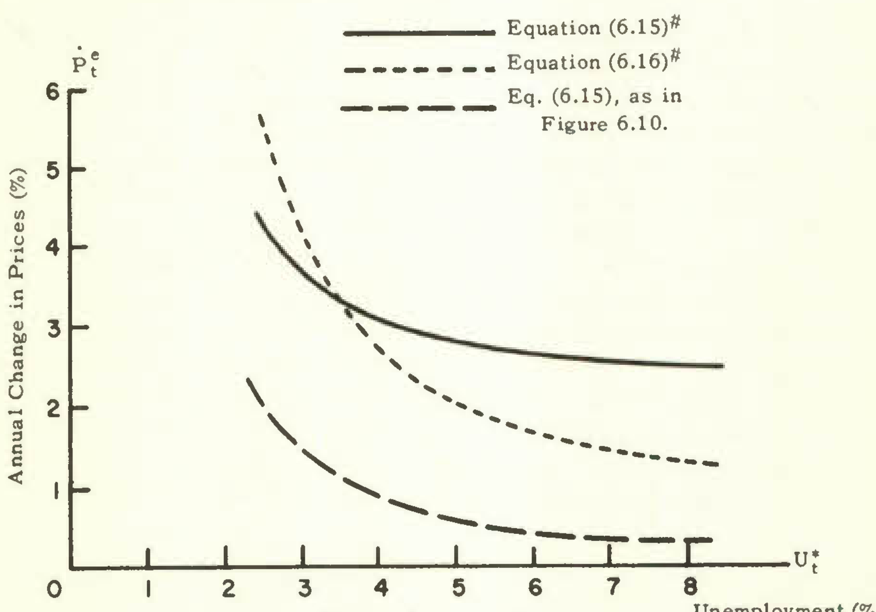
THREE CANADIAN TRADE-OFF CURVES, BASED ON THE PERIOD 1953-65, ASSUMING A "NON-INFLATIONARY" EXTERNAL ENVIRONMENT



#Assumptions: $\dot{F}_t = 0$, $\dot{W}^*_{us_t} = 3.2$, $(Z/Q)^*_{t-2} = 97.75$.

Figure 6.11

TWO CANADIAN TRADE-OFF CURVES, UNDER A RELATIVELY "INFLATIONARY" EXTERNAL ENVIRONMENT



#Assumptions: $\dot{F}_t = 2.0$, $\dot{W}^*_{us_t} = 6.0$, $(Z/Q)^*_{t-2} = 105.0$.

cent. With this view of the trade-off options, a reduction of aggregate demand in order to reduce the rate of inflation is hardly an attractive policy, particularly at unemployment rates in excess of 5 per cent of the labour force.

Table 6.7

Trade-Off Curves for the Period 1953–65, Based on Price Change Equation (5.35e), under Two Sets of Conditions

Unemployment Rate (U_t^*) (Per Cent of Labour Force)	Annual Percentage Rate of Change of Consumer Prices ($\dot{P}_t^e$) with $\dot{F}_t = 0$ and (for 6.5) $(Z/Q)_{t-2}^* =$ 97.75 and $\dot{W}_{us_t}^* = 3.2$, for:		Annual Percentage Rate of Change of Consumer Prices ($\dot{P}_t^e$) with $\dot{F}_t = 2.0$ and (for 6.15) $(Z/Q)_{t-2}^* =$ 105.0 and $\dot{W}_{us_t}^* = 6.0$, for:	
	Equation (6.15)	Equation (6.16)	Equation (6.15)	Equation (6.16)
(1)	(2)	(3)	(4)	(5)
2.5	2.06	4.13	4.23	5.57
3.0	1.48	2.70	3.65	4.14
4.0	0.90	1.27	3.07	2.71
5.0	0.63	0.61	2.80	2.05
6.0	0.49	0.25	2.66	1.70
7.0	0.40	0.04	2.57	1.48
8.0	0.34	−0.10	2.51	1.34
Unemployment Rate "Required" for Complete Stability of the Consumer Price Level, for the Relationship in Question, under the Assumed Conditions:	None under 10% of the Labour Force	7.23	None under 10% of the Labour Force	None under 10% of the Labour Force

Under the more inflationary external environment, the derived trade-off curves are higher in the field, although the upward shift is not as great as with the text equations (6.7) and (6.10). For both trade-off curves, there is no level of unemployment, within the observed range, which will eliminate entirely the predicted upward trend in consumer prices. On the other hand, the expected rate of increase of the Consumer Price Index at the 3 per cent unemployment rate is only 3.6 per cent per year with the trade-off curve based on equation (6.15) and only 4.1 per cent per annum with that generated by equation (6.16). At the 5 per cent rate of unemployment, the predicted annual increases in consumers prices are 2.8 and 2.0 per cent, respectively. The impression of smaller sensitivity to external influences is confirmed by an examination of the coefficients of the $\dot{F}_t$ variable in equations (6.15) and (6.16) and of the coefficient of the $\dot{W}_{us_t}$ variable in the former equation.

Again, the caveats at the end of Chapters 5 and 6 should be kept in mind. In this connection, the reader is reminded of the marginal statistical significance of the normal unit labour cost variable, in regression relationship (5.35).

C. *Trade-Offs from Two-Stage Least Squares Estimates*

In the Appendix of the preceding Chapter, two sets of two-stage least squares estimates of the parameters of equations (5.1) and (5.36) were presented. The steady state equations derived from the second set of parameter estimates are:

$$(5.1''e) \qquad \dot{W}_t^e = -3.4457 + 0.44997\,\dot{P}_t^* + 0.23384\,\dot{W}_{us_t}^* + 0.05065\,(Z/Q)_{t-2}^* + 19.112\,(U_t^*)^{-2}\text{, and}$$

$$(5.36''e) \qquad \dot{P}_t^e = -3.6138 + 1.1417\,\dot{W}_t + 0.55147\,\dot{F}_t\,.$$

Substituting equation (5.1"e) into equation (5.36"e) and rearranging, one obtains the following trade-off equation:

$$(6.17) \qquad \dot{P}_t^e = -15.521 + 44.870\,(U_t^*)^{-2} + 0.54897\,\dot{W}_{us_t}^* + 0.11892\,(Z/Q)_{t-2}^* + 1.1340\,\dot{F}_t\,.$$

As before, equation (6.17) can be plotted as a two-dimensional curve, once a set of values for the variables other than the unemployment rate is specified. This has been done in Figure 6.12 for two sets of values of the "external" variables. The first set is the assumed non-inflationary external environment carried throughout the text and the first two sections of the Appendix, while the second set is

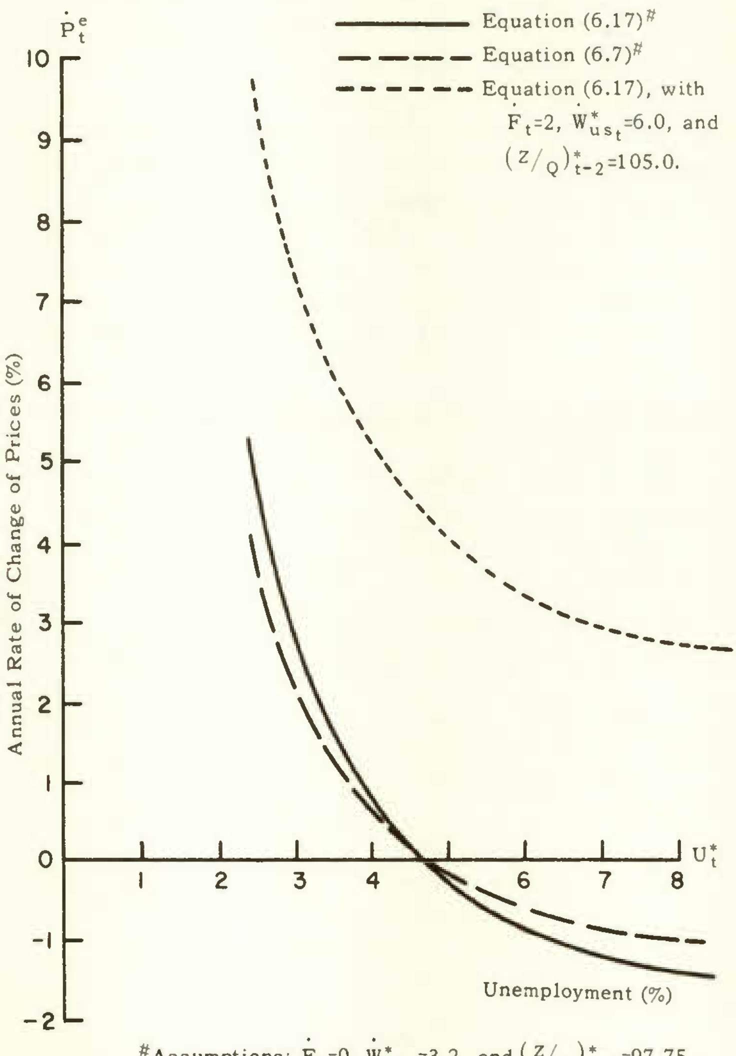
Table 6.8

Trade-Off Curves, Based on Two-Stage Least Squares Parameter Estimates for the Period 1953–65, under Two Sets of Conditions

Unemployment Rate (U_t^*) (Per Cent of Labour Force)	Annual Percentage Rate of Change of Consumer Prices ($\dot{P}_t$) with $\dot{F}_t = 0$, $(Z/Q)_{t-2}^* = 97.75$ and $\dot{W}_{us_t}^* = 3.2$	Annual Percentage Rate of Change of Consumer Prices ($\dot{P}_t$) with $\dot{F}_t = 2.0$, $(Z/Q)_{t-2}^* = 105.0$ and $\dot{W}_{us_t}^* = 6.0$
(1)	(2)	(3)
2.5	5.04	9.71
3.0	2.85	7.51
4.0	0.66	5.33
5.0	–0.34	4.32
6.0	–0.89	3.77
7.0	–1.22	3.44
8.0	–1.44	3.23
Unemployment Rate "Required" for Complete Stability of the Consumer Price Level, under the Assumed Conditions:	4.58	None under 10% of the Labour Force

Figure 6.12

A CANADIAN POST-WAR TRADE-OFF CURVE BASED ON TWO-STAGE LEAST SQUARES PARAMETER ESTIMATES, UNDER TWO SETS OF EXTERNAL CONDITIONS



#Assumptions: $\dot{F}_t$=0, $\dot{W}^*_{us_t}$=3.2, and $(Z/_Q)^*_{t-2}$=97.75.

the considerably more inflationary external conditions which we have also discussed before. (The information summarized in the graph is also presented in Table 6.8 above.) In Figure 6.12, we also present a trade-off curve derived from equation (6.7) of the text under the first (the relatively non-inflationary) set of values for the variables other than the unemployment rate. The comparison suggests that the trade-off curve derived from the two-stage least squares estimation procedure is slightly steeper. Thus the expected rate of inflation at the 3 per cent rate of unemployment is 2.8 per cent per year (as compared to an annual rate of 2¼ per cent for the trade-off curve based on ordinary least squares estimates). On the other hand, the two-stage least squares estimate of the rate of unemployment "required" for a zero rate of expected change in the consumer price level is slightly lower, at 4.6 per cent of the labour force. Moreover, according to the trade-off curve based on equation (6.17) under relatively non-inflationary circumstances, an appreciable amount of actual deflation is the expected outcome if the unemployment rate exceeds 6 per cent. If the external environment is inflationary, then the trade-off curve based on equation (6.17) shifts upward appreciably. At a 3 per cent rate of unemployment, the predicted rise in consumer prices under these conditions is 7½ per cent per year, while at a 6 per cent unemployment rate, the expected rate of inflation is still 3¾ per cent per annum. The earlier conclusion that some inflation seems unavoidable when the external environment is tending in that direction is confirmed by the trade-off relationship derived from the two-stage least squares parameter estimates. In fact, as a comparison of the coefficients of equations (6.7) and (6.17) will show, the latter relationship, which has been discussed in this section of the Appendix, is slightly more sensitive to shifts in the values of these non-unemployment variables.

It is perhaps tedious to recall the previously stated qualifications once again. Nevertheless, the reader is cautioned that the use of a somewhat more sophisticated estimating technique does not consign to oblivion all of the limitations discussed earlier regarding this analysis.

PART III

CANADIAN HISTORICAL EVIDENCE, INTERNATIONAL COMPARISONS, AND CONCLUSIONS

CHAPTER 7

HISTORICAL ESTIMATES OF THE TRADE-OFF OPTIONS FOR CANADA

1. Scope and Purpose

The primary focus of this study has been on estimating Canadian wage and price change relationships for the period from 1953 to 1965 and on deriving estimates, for this period, of the trade-offs between price stability and the level of unemployment. Our research on these relationships has been presented in Part II of this study. In Part III, the analysis will be extended in two dimensions in order to provide a further test of our post-war analysis and to place our empirical results for more recent years in clearer perspective. In this Chapter, some of the key relationships derived in Part II are re-estimated on the basis of annual historical data extending from 1921 to the present, omitting the war years, 1940 to 1945. In Chapter 8, these same key relationships are fitted to quarterly data for the period from 1953 (or 1954) to 1965 for five "developed" foreign countries: the United States, Britain, France, Germany (the Federal Republic) and Sweden.

There are two main reasons for fitting the relationships derived for the period since 1953 to long-run historical data. The first is to see whether the variables which contribute significantly to an explanation of price and wage changes since 1953 are significantly related to price and wage changes over a longer period of historical experience. If in fact they are, the second reason is to compare the estimates for the historical relationships derived from annual data with the estimates for the quarterly post-war relationships, so that one may obtain some indication of the stability of the relationships. In Sections 2 and 3 below, we present our analysis of the historical wage change and price change relationships, respectively. In Section 4, numerical estimates of the trade-off relationship are presented and compared with the corresponding estimates derived from the quarterly post-war relationships.

Before discussing the historical estimates of the relationships in question, two general points relating to these estimates might be particularly noted. The first relates to the quality of the data available for historical analysis. The quality of the figures available for the pre-war years is inferior, probably by a substantial margin, to the quality of the figures available for post-war years. For some series such as those relating to unemployment and earnings, the reliability of pre-war data is especially questionable. As with the post-war data, in some cases the statistics relating to the manufacturing sector seem to be of somewhat higher quality than the data for the economy as a whole, including some of the primary production sectors. Further comments on the quality of particular statistical series will be made in the course of the discussion that follows.

The second noteworthy point relates to whether or not there are any *a priori* reasons that one should expect to find stable wage and price change relationships for the past 40 years. In Chapter 1, it was argued that these relationships depend on the structure of the economy, reflecting attitudes, institutional arrangements and behaviour patterns. It is generally recognized that all three of these factors have undergone, in Canada as well as abroad, a wide variety of fundamental changes since the 1920's. These changes were enhanced by a number of unique historical events: first, the wrench of the Great Depression of the 1930's; secondly, the shock occasioned by the Second World War and also the subsequent period of reconstruction and rehabilitation; and, thirdly, the post-war economic transformation accompanied by more or less continuous growth and unprecedented prosperity. Vast changes in institutional arrangements, attitudes, behaviour patterns and technical capabilities have been associated with these sharp swings in economic circumstances. In the light of the historical experience of the past 40 years, one would hardly be surprised to find that the structure of the economy had changed substantially and consequently that the relationships between prices, wages and unemployment had altered. Moreover, there is no *a priori* reason that one should particularly expect the shifts that may have occurred to have manifested themselves either completely in any one year or in a continuous fashion; these shifts might conceivably have been discontinuous and irregular. If, in fact, one found that, despite the substantial changes in the structure of the economy, the relationships appeared to have remained quite stable, one might simply ascribe it to historical accident. Alternatively, one might conclude that the relationships in question were, in fact, very strong and so deeply embedded in the behaviour patterns of the economy that, despite all the other changes which had occurred during this epoch, these relationships had persisted, largely unchanged.

This latter conclusion could have important implications for government policy. Any policies which a government might wish to consider for the primary purpose of shifting these wage and price change relationships so as to reduce the conflicts between the policy objectives of high employment and price level stability might be open to some doubt. If these relationships had persisted in broad outline through the severe shocks to the economy effected by the Great Depression, the Second World War and the post-war economic transformation, one might legitimately question whether any of the policy instruments available to governments could shift the relationships in a manner that would significantly reduce the conflicts among policy objectives. If, on the other hand, one found a large degree of instability in the wage and price change relationships, it would appear to be more likely that an "incomes policy" might meet with success in shifting the trade-off relationship. Moreover, since the changes "in nature" are likely to be of a different character than those induced by government policy, the outcome in any case is at most suggestive, rather than conclusive.

2. Historical Wage Adjustment Relationships

As in Chapter 5, the estimated wage adjustment relationships attempt to explain the percentage rate of change in wages. For the post-war quarterly estimates, average hourly earnings in manufacturing were used as the "wages" variable. This series begins in 1934 and consequently does not go back far enough for purposes of this analysis. Two series which are available from the early twenties were considered. Both series are indexes of average wage rates derived from a survey conducted by the Department of Labour. The first series is a general index of average wage rates encompassing logging, coal mining, metal mining, manufacturing, construction, railways, telephones and personal services. The second series is an index of average wage rates in manufacturing only. We chose to base our estimates on the second series, which relates to manufacturing only, for two reasons. First, we thought it likely that the data for this sector would be more reliable than the data for most of the other sectors of the economy included in the general index. Secondly, this series is likely to be more closely comparable with the average hourly series used for the post-war quarterly estimates. Some experiments, however, were run on the basis of the general index of wages as well as on the basis of two derived series of average hourly earnings in manufacturing.[1] The results of these tests tended to confirm our choice of the index of average hourly wage rates in manufacturing. We were able to obtain more consistent and meaningful explanations of the percentage rate of change in this series than with any of the other series.

In deriving our historical relationships, we fitted linear regressions to annual data, employing the ordinary least squares technique. The form of the equations fitted was similar to the form used for the post-war quarterly estimates. The annual percentage change in wages was assumed to be a linear function of the annual percentage change in the Consumer Price Index, the reciprocal of the unemployment rate expressed as a percentage, the annual percentage change of wages in the United States, and the level of the index of profits per unit of output in manufacturing. The rationale for including these variables in the explanation of wage changes has been outlined in earlier portions of this study. In some experiments, additional variables were also included in the explanation of wage changes in order to test for the possibility of shifts in the relationships over time.

The form in which each variable was included in the annual estimates differs somewhat from the form adopted for the quarterly estimates. The form of the variables for the quarterly estimates has been described earlier. For the annual estimates, percentage changes in wages and prices were calculated on a year-to-year basis, and the levels of unemployment and unit profits reflect the average level of these variables for each year. No attempt was made to build a distributed lag into the form of the variables, as in the case of the quarterly estimates, but the dependent variable lagged one year was included as an explanatory variable in some experiments in order to take some lagged effects into account.[2]

---

[1] We compiled two series of average hourly earnings in manufacturing which were based on data on annual labour income in manufacturing (including supplementary labour income and excluding supplementary income, respectively) as the numerator and which utilized the annual average number of workers in manufacturing multiplied by the average annual number of hours worked in manufacturing as the common denominator.

[2] This explanatory variable can be derived from a Koyck-type lag structure as discussed in Chapter 5.

The exact form in which variables were included in our estimate is as indicated below; as before, the sources of the underlying data are presented in parentheses, following the definitions of the variables:

$\dot{W}_t = \frac{W_t - W_{t-1}}{W_{t-1}} \cdot 100$ = percentage change in the index of average wage rates in manufacturing (1949 value=100) between year t and the previous year (*Historical Statistics of Canada,* series D-5, p. 84, and Department of Labour, *Wage Rates, Salaries, and Hours of Labour,* Ottawa, 1964, Table A, p. 26.

$\dot{W}_{us_t} = \frac{W_{us_t} - W_{us_{t-1}}}{W_{us_{t-1}}} \cdot 100$ = percentage change in average hourly earnings in manufacturing for production workers in the United States (*Historical Statistics of the United States, Colonial Times to 1957,* series D-626, p. 92, and *Monthly Labor Review* of the U.S. Bureau of Labor Statistics).

$\dot{W}^g_t = \frac{W^g_t - W^g_{t-1}}{W^g_{t-1}} \cdot 100$ = percentage change in the general index of wage rates between years t and t–1 (*Historical Statistics of Canada* and Dominion Bureau of Statistics).

L_t = average total labour earnings, including supplementary income, in manufacturing by production and nonproduction workers (*Historical Statistics of Canada).*

$(N.H)_t$ = the number of workers employed in manufacturing in year t multiplied by the average number of hours worked in manufacturing in year t (*Historical Statistics of Canada).*

$W^e_t = \frac{L_t}{(N.H)_t}$.

$\dot{W}^e_t = \frac{W^e_t - W^e_{t-1}}{W^e_{t-1}} \cdot 100$ = percentage change in average hourly earnings in manufacturing between years t and t–1.

$W^{e'}_t = \frac{L'_t}{(N.H)_t}$, where L'_t is average total labour earnings in manufacturing, excluding supplementary income (*Historical Statistics of Canada).*

$\dot{P}_t = \frac{P_t - P_{t-1}}{P_{t-1}} \cdot 100$ = percentage annual change in the Canadian Consumer Price Index, 1949 value=100 (*Historical Statistics of Canada,* series J–147, p. 304, and Dominion Bureau of Statistics).

Z_t = corporate profits in manufacturing before tax, converted to an index, 1949=100 (Dominion Bureau of Statistics).

Q = annual index of manufacturing output (1949=100) (*Historical Statistics of Canada,* series Q–138, p. 475, converted to a 1949 base, series Q–139, p. 475, and Dominion Bureau of Statistics [revised figures]).

$(Z/Q)_t$ = index of annual corporate profits per unit of output in manufacturing in year t (1949 value=100).

U_t^{-1} = reciprocal of U_t, where U_t is the percentage rate of unemployment in the civilian labour force in year t (*Historical Statistics of Canada,* series C–54, divided by series C–50, page 61, and Dominion Bureau of Statistics).

$$U_t^{-2} = \frac{1}{U_t^2}.$$

$(U^*)_t^{-1}$ = reciprocal of U_t^* where $U_t^* = \frac{1}{2}(U_t + U_{t-1})$.

$(U_b)_t^{-1}$ = reciprocal of (U_{b_t}) where U is T.M. Brown's series for unemployment as a percentage of the civilian labour force (Series 6, Table A–1, page 194, of T.M. Brown, *Canadian Economic Growth,* Royal Commission on Health Services, 1965).

$$(U_b)_t^{-2} = \frac{1}{(U_b)_t^2}.$$

$(U_b^*)_t^{-1}$ = reciprocal of $(U_b^*)_t = \frac{1}{2}(U_{b_t} + U_{b_{t-1}})$.

DUM I = 0, 1922 to 1939 inclusive; = 1, 1946 through 1963 (allows for a break in the relationships between the pre-war and post-war periods).

DUM II = 0, 1922 through 1929 and 1946 through 1963; = 1, 1930 to 1939 inclusive (allows for a possible abnormality in the relationships during the 1930's).

DUM III = 0, 1922 through 1939 and 1953 through 1963; = 1, 1946 through 1952 (allows for a possible abnormality in the relationships during the immediate post-war period).

t = time, numbering consecutively from 1921 (=1) to 1963 (=43).

As in the earlier chapters, the computed t-ratios are given in square brackets below the associated regression coefficients, while the estimated standard errors appear in parentheses. R^2 is the coefficient of multiple determination, unadjusted for degrees of freedom, and D.W. is the Durbin-Watson test statistic.

In estimating a historical wage change relationship, we concentrated on the whole period from 1922 to 1963, as well as on subperiods within this time-span. Our "best" equations explaining $\dot{W}_t$ are shown in Table 7.1. As before, these estimates are judged superior to others with the criteria being the value of the coefficient of multiple determination, the size of the t-ratios, the value of the

Table 7.1

Historical Wage Adjustment Regression Relationships, Selected Sample Periods

Equation Number	Sample Time Period	Constant Term	Coefficients of Explanatory Variables:						R^2	D.W.
			$\dot{P}_t$	U_t^{-1}	$(Z/Q)_t$	$\dot{W}_{us_t}$	$\dot{W}_{t-1}$	DUM III		
(7.1)	1930-39 and 1946-63	0.03147	0.51079 [4.50]	13.436 [3.85]	—	0.14921 [2.23]	—	—	0.908	1.53
(7.2)	1926-39 and 1946-63	-0.03417	0.46538 [4.12]	—	0.02560 [2.26]	0.16726 [2.51]	—	2.69164 [3.16]	0.900	1.62
(7.3)	1930-39	-3.89145	0.67515 [4.67]	69.103 [2.04]	—	—	—	—	0.856	2.24
(7.4)	1946-63	0.20478	0.44816 [3.33]	10.129 [1.63]	—	0.33340 [1.56]	—	—	0.898	1.33
(7.5)	1922-39 and 1946-63	1.87039	0.77305 [9.15]	—	—	—	—	2.77821 [2.88]	0.856	1.77
(7.6)	1953-63 (annual)	-0.33380	0.91659 [5.07]	14.398 [3.89]	—	-0.05014 [0.29]	—	—	0.874	1.42
			$\dot{P}_t^*$	$(U_t^*)^{-1}$		$\dot{W}_{us}^*$				
(5.6e)	1953-65 (quarterly)	-.52889	.41224	10.102	—	.46069	—	—	—	—

Durbin-Watson statistic, the appropriateness of the signs of the parameters and the reasonableness of the magnitudes of the parameters. It will be noted that the seven equations shown in Table 7.1 were fitted to data for seven different time periods. The post-war quarterly estimate, equation (5.6e), which is shown in Table 7.1, was derived in Chapter 6. This version of the estimated post-war quarterly relationship is the most suitable for purposes of comparison with our "best" historical wage change relationship, equation (7.1). Equation (5.6e) contains the same variables as equation (7.1) and unemployment enters both equations as the reciprocal of the unemployment rate, rather than as the reciprocal of the square of the unemployment rate.

Initially, an attempt was made to fit a relationship for the full period from 1922 to 1963, these two years marking the limits set by the availability of data for the variables with which we were concerned. Unit profit data, in fact, are not available beyond 1926. Consequently, for the period 1922 to 1963, we attempted to explain $\dot{W}_t$ as a function of $\dot{P}_t$, $\dot{W}_{us_t}$, U_t^{-1}, $\dot{A}_t$ and $\dot{W}_{t-1}$, together with a series of dummy variables and a time trend variable.[1] The dummy variables allowed for shifts in the constant term commencing with 1930, 1946 and 1953.[2] In most of these experiments, the war years 1940 to 1945 were excluded: however, some tests including these years were also run. Our best estimate for this entire period is equation (7.5), which explains the percentage rate of change in wages in terms of the percentage rate of change in consumer prices and a shift in the intercept of the relationship for the period 1946 to 1952. The regression coefficients for all the other variables tested over this period were not significantly different from zero.

Although this result is of some interest, it was generally disappointing in that it failed to establish a significant relationship between $\dot{W}_t$ and any of the variables emphasized in the post-war quarterly estimates, except $\dot{P}_t$. However, the obvious limitations of the data employed to derive these estimates, especially for the earlier years, might allow one to argue that the failure to find more significant relationships reflects errors of observation, rather than a lack of significant relationships. Accordingly, additional experiments were undertaken for alternative sample periods.

The statistics for profits per unit of output in manufacturing are available only after 1925. Because of this and our interest in this variable as a determinant of $\dot{W}_t$, a second series of experiments was undertaken on the basis of the period from 1926 to 1963, omitting the years 1940 to 1946. Equation (7.2) is the best estimate which emerged from these tests. According to this equation, 90 per cent of the variation in the percentage rate of change in wages for this period is

---

[1] The $\dot{A}_t$ variable represents percentage changes in the level of manufacturing productivity: the precise definition of this variable and the data sources are given in Section 3 below.

[2] In addition to the three dummy variables defined on page 197, two further dummy variables were included in our experiments:

DUM IV = 0, 1922–39, and 1946–52, = 1, 1953–63.

DUM V = 0, 1922–39, and 1946–53: = 1, 1954–63.

These variables were not significant in our estimates of historical wage adjustment relationships.

explained by the percentage rate of change in consumer prices ($\dot{P}_t$), the level of unit profits in manufacturing $(^Z/Q)_t$, the percentage rate of change in U.S. wages ($\dot{W}_{us_t}$), and a dummy variable which allows for a shift in the constant term during the subperiod from 1946 to 1952.[1] The coefficients of the reciprocal of the unemployment rate and the reciprocal of the square of the unemployment rate, which were added to this relationship as alternative additional explanatory variables, were not statistically significant. Neither was the coefficient of a time trend nor that of the reciprocal of the time trend. None of the other dummies (DUM I or DUM II, as defined above), which were included in the relationship to allow for possible shifts in the constant term, was significant.

Although the relationship is satisfactory in many respects, the failure of unemployment to enter the relationship as a significant determinant of $\dot{W}_t$ means that it does not lend itself to our ultimate objective, which is to derive empirical trade-offs between price changes and unemployment. This consideration in itself does not, of course, provide an adequate reason for dismissing this relationship, but it did prompt a further consideration of the evidence.

As already noted, the reliability of the data for the pre-war period is particularly open to question. One of the weakest statistical series is that for the rate of unemployment. In our estimates, the official series, compiled by the Dominion Bureau of Statistics, has been used. An alternative series, however, has been made available by Professor T. M. Brown.[2] This series differs quite noticeably from the official series; the differences between this and the official series may be indicative of the degree of uncertainty to be associated with a measure of the rate of unemployment for the period prior to the Second World War.[3] Accordingly,

[1] According to the Theil-Nagar tables, the residuals of this regression are significantly autocorrelated at the 5 per cent level, but not at the 1 per cent level.

[2] T.M. Brown, *Canadian Economic Growth*, Royal Commission on Health Services (Ottawa: Queen's Printer, 1965), Series 6, Table A-1, p. 194.

[3] One can readily observe the divergence between Professor Brown's and the official series from the following table:

UNEMPLOYMENT AS A PERCENTAGE OF THE CIVILIAN LABOUR FORCE

Year	DBS	Brown	DBS – Brown
1926	3.0	3.0	0
1927	1.8	2.9	–1.1
1928	1.7	2.3	–0.6
1929	2.9	2.4	0.5
1930	9.1	7.1	2.0
1931	11.6	12.9	–1.3
1932	17.6	18.6	–1.0
1933	19.3	20.0	–0.7
1934	14.5	17.2	–2.7
1935	14.2	16.8	–2.6
1936	12.8	16.4	–3.6
1937	9.1	14.0	–4.9
1938	11.4	15.3	–3.9
1939	11.4	14.8	–3.4
1946	3.4	3.4	0
1947	2.2	2.4	–0.2
1948	2.3	2.5	–0.2
1949	2.8	3.5	–0.7
1950	3.6	3.8	–0.2

the experiments for the 1926-63 period were re-run, making use of Professor Brown's unemployment data. The substitution of the Brown unemployment rate did not make any difference to our results. In subsequent experiments for different time periods, our results were generally less satisfactory when Professor Brown's unemployment series was utilized than when the official Dominion Bureau of Statistics series was employed.

Additional experiments were undertaken in which we fitted relationships separately to the period 1922-29, 1930-39 and 1940-63. For the 1920's, in no case were we able to estimate a significant influence of the rate of unemployment on wage changes when the change in Canadian consumer prices was also included as an explanatory variable.[1] We were, however, able to establish such a relationship for the 1930's and for the post-war years. Our best estimates for these subperiods are equations (7.3) and (7.4), in the first of which unemployment appears as a significant explanatory variable and in both of which its influence is suggestive. This suggested that the 1920's are peculiar in some way—either because the data are misleading or because of the major shifts which occurred in the economy with the advent of the Great Depression—and that inclusion of the 1920's in our data was responsible for our failure to find a significant relationship for the entire historical period between wage changes and the rate of unemployment.

The final set of experiments therefore focused on the time period from 1930 to 1963, omitting the war years. The best estimate which evolved from these tests is in equation (7.1), which appears in Table 7.1. Equation (7.1) explains 91 per cent of the variation in $\dot{W}_t$ in terms of variation in the percentage rate of change in consumer prices, the reciprocal of the unemployment rate, and the percentage rate of change in U.S. wages.[2] The level of unit profits is not significantly related to $\dot{W}_t$ when the unemployment rate is included as it is in equation (7.1), but this variable becomes significant when the unemployment rate is omitted. These results may reflect the well-known problem of multicollinearity: if two explanatory variables are closely intercorrelated, the technique of multiple regression may not be able to disentangle their separate effects. It is also noteworthy that the dummy variable which permits a shift in the constant term from 1946 to 1952 is not significant in equation (7.1).

Two additional experiments allowing for shifts in the relationship were made on the basis of equation (7.1). In the first, a compound variable, $D.t.U^{-1}$, was added to the relationship. This variable is equal to the product of: (1) a dummy variable equal to unity from 1930-39 and equal to zero from 1946-63; (2) time, numbered consecutively from 1930 to 1963; and (3) U_t^{-1}, as already defined. The form of this variable was designed to allow for a continuous shift over time in the coefficient of unemployment rate during the 1930's. In the second experiment,

[1] Although the sample time periods do not coincide exactly, this result is broadly consistent with Professor Kaliski's results for the time period 1922—33. In all of his estimates which include both $\dot{P}_t$ and U_t^{-1} as explanatory variables, the coefficient of the unemployment variable is insignificant at the 5 per cent level, with the conventional two-tailed test. Kaliski, *op. cit.*, Table 13, p. 27.

[2] According to the Theil-Nagar test, the residuals of equation (7.1) are not significantly autocorrelated at the 1 per cent level (though they are at the 5 per cent level).

another compound variable, $D.U_t^{-1}$, was added to equation (7.1). This variable is equal to the product of: (1) a dummy variable equal to unity from 1930 to 1939 and equal to zero from 1946 to 1963; and (2) U_t^{-1}, as already defined. The form of this variable was intended to capture the possibility of a once-and-for-all shift in the coefficient of the unemployment rate between the 1930's and the post-war years. In neither experiment was the coefficient of these compound variables, $D.t.U^{-1}$ or $D.U^{-1}$, significantly different from zero when these variables were added separately to equation (7.1).

In addition, it may be reported that when the reciprocal of the square of the unemployment rate was substituted for the reciprocal of unemployment rate, U^{-2} was not statistically significant.

When one compares the parameters of equation (7.1), relating to the period from 1930-39 and 1946-63, with the parameters of equation (5.6e) based on the post-war quarterly estimates, it is evident that they differ somewhat. The smallest difference is the coefficients relating to the percentage rate of change in the Consumer Price Index. According to the annual historical estimates, a one percentage point change in $\dot{P}_t$ increases wages by 0.51 of a percentage point, in addition to whatever change in wages would have occurred anyway; according to the post-war quarterly relationship, the induced change in wages under the same conditions would be 0.41 of a percentage point. The difference for the unemployment coefficient is somewhat greater. The coefficient for U_t^{-1} in equation (7.1) is higher than the corresponding coefficient in equation (5.6e) (13.44 vs. 10.10). This implies that the historical relationship predicts a greater impact on the rate of change in wages for a given variation in the unemployment rate than the post-war quarterly estimates.

The largest differences in the coefficients for equations (7.1) and (5.6e) are found in the $\dot{W}_{us_t}$ variable and the constant term. According to equation (7.1), a one percentage point variation in the rate of change of U.S. wages can be expected to induce an additional change of 0.15 of a percentage point in Canadian wages; the corresponding figure from equation (5.6e) is 0.46 of a percentage point. In other words, the annual estimates suggest a substantially smaller impact of the U.S. wages on Canadian wages than the quarterly relationship. The historical relationship includes the depressed 1930's when the pressure of very heavy unemployment may have virtually eliminated foreign influences on Canadian wages. Moreover, important institutional changes have occurred since then, such as the development of much stronger trade unions numbering among their members a substantially higher proportion of the labour force.[1] In addition, the U.S. and Canadian economies have probably been more closely integrated in a wide variety of respects since 1953 than in earlier years. Consequently, one might expect to find that U.S. wage changes have had a greater impact on Canadian wage changes since 1953 than during the period 1930-39 and 1946-63 as a whole.[2]

[1] In 1939 trade union membership was 7.8 per cent of the labour force, and this proportion grew to 20.0 per cent in 1948 and 24.2 per cent in 1960. (These figures were computed from labour force data based on the Dominion Bureau of Statistics Labour Force Surveys and from estimates of trade union membership by the Department of Labour.)

[2] It must be admitted, however, that the regression coefficients of equation (7.6) give little support to this line of argument. The price change coefficient of this regression (0.92) seems unduly high, and possibly the short run of data is responsible for the peculiar results.

Table 7.2 shows the predicted rates of change of wages for several wage-change-unemployment relationships, which are based on equation (7.1) (estimated from annual data for 1930-39 and 1946-63), equation (7.6) (estimated from annual data for 1953-63), and equation (5.6e) (estimated from quarterly data from 1953 to 1965). As is evident from Table 7.1, the coefficient of U.S. wage changes in equation (7.6) is not statistically significant and consequently this estimate is open to considerable question. Nevertheless, it is of some interest to consider how this relationship compares with the post-war quarterly equation and with the longer-term relationship. The estimates shown in Table 7.2 are plotted in Figures 7.1 and 7.2. Two sets of assumptions have been made about the variables other than the unemployment rate which affect wage changes. The first set assumes that $\dot{P}_t$ remains unchanged and that $\dot{W}_{us_t}$ rises by 3 per cent per year. The second set of assumptions assumes a more inflationary environment, in which $\dot{P}_t$ rises at 3 per cent per year and $\dot{W}_{us}$ by 6 per cent per year. As Figures 7.1 and 7.2 indicate, the estimated effect of variations in the rate of unemployment on wages is greater for both estimated annual relationships, equations (7.1) and (7.6), than for the quarterly relationship, equation (5.6e). (This is shown on the charts by the more gentle slope of the quarterly relationship.) On the other hand, the estimated effect on wages of increases in consumer prices and U.S. wages is greater for the quarterly relationship than for the annual, historical regressions. This is indicated by the manner in which the curve based on equation (5. 6e) gains height on the curves based on equations (7.1) and (7.6) in Figure 7.2 in comparison to Figure 7.1.

Table 7.2

The Relationship between the Rate of Wage Changes and the Level of Unemployment for Various Wage Adjustment Relationships, Fitted to Canadian Historical Data, at Given Rates of Change of Consumer Prices and U.S. Wages

Unemployment Rate (U_t^*) (Per Cent of Labour Force)	$\dot{P}_t = 0$; $\dot{W}_{us_t} = 3$			$\dot{P}_t = 3$; $\dot{W}_{us_t} = 6$		
	Rate of Change of Wages (Per Cent per Year) Estimated from Equations:					
	(5.6e)#	(7.1)	(7.6)	(5.6e)#	(7.1)	(7.6)
2.5..........	4.89	5.85	5.28	7.51	7.83	7.87
3.0..........	4.22	4.96	4.32	6.84	6.94	6.91
4.0..........	3.38	3.84	3.12	6.00	5.82	5.71
5.0..........	2.87	3.17	2.40	5.49	5.15	4.99
6.0..........	2.54	2.72	1.92	5.16	4.70	4.51
7.0..........	2.30	2.40	1.57	4.92	4.38	4.17
8.0..........	2.12	2.16	1.32	4.73	4.14	3.91
9.0..........	1.98	1.97	1.12	4.59	3.95	3.71
10.0..........	1.86	1.82	0.96	4.48	3.80	3.55

Based on $\dot{P}_t^*$, $\dot{W}_{us_t}^*$ and V_t^*.

Figure 7.1

THREE CANADIAN WAGE-CHANGE-UNEMPLOYMENT CURVES, UNDER RELATIVELY NON-INFLATIONARY CONDITIONS

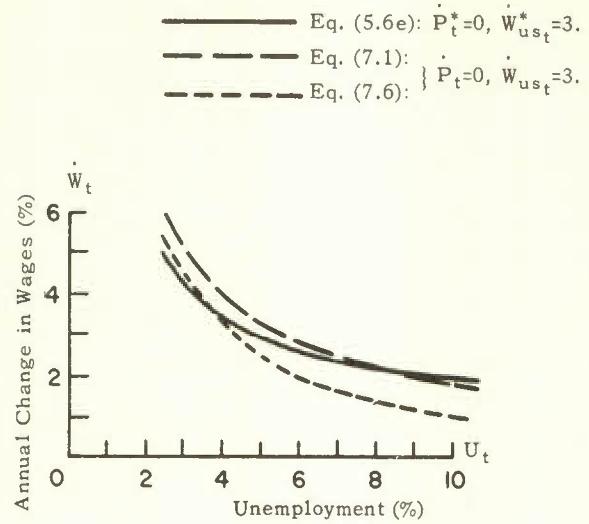
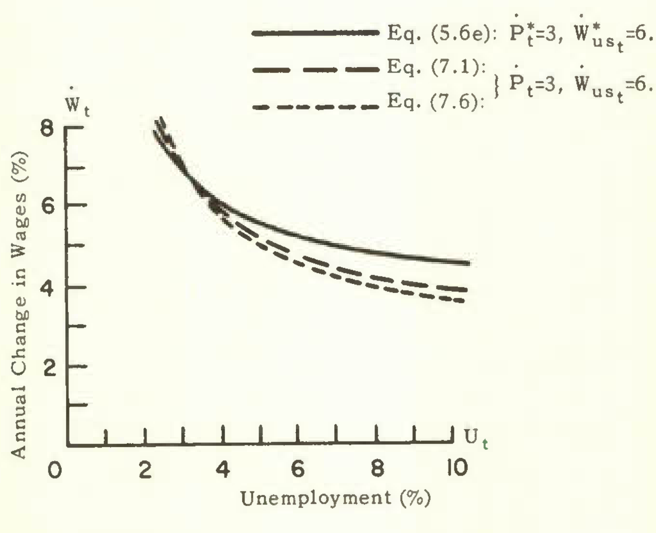


Figure 7.2

THREE CANADIAN WAGE-CHANGE-UNEMPLOYMENT CURVES, UNDER A RELATIVELY INFLATIONARY EXTERNAL ENVIRONMENT



In order to test for the stability of the estimated historical relationship, the Chow test outlined earlier was applied to equation (7.1). The two subperiods which were estimated for purposes of applying the test were 1930 to 1939 and 1946 to 1963.[1] The computed value of the F ratio on which the Chow test is based was 1.75. This is less than the critical value of the F ratio of 2.87 required to accept the hypothesis of a shift in the relationship at the 5 per cent level of statistical significance. From this, one may conclude that there is little reason to believe that the wage change relationship estimated as equation (7.1) shifted between the subperiods 1930-39 and 1946-63. In other words, one can view this equation as a reasonably stable relationship.[2]

In addition to the question of the stability of the estimated relationship, it is also interesting to consider whether the estimated relationship is reversible. For our purposes, two aspects of reversibility are considered. The first is concerned with the question of whether wage changes are more or less sensitive to price increases than to price decreases. The second aspect focuses on the question of whether the same relationship which explains both increases and decreases in wages can explain increases and decreases in wages separately; and if it does, how the estimated coefficients explaining increases and decreases separately compare with the coefficients of the relationship estimated on the basis of wage changes in both directions.[3] As far as this latter question is concerned, the number of observations during the whole sample period when wages decreased is so small–three in total–that it is not feasible to re-estimate the relationship for wage decreases only. Moreover, the number of observations underlying the re-estimation of the relationship for wage increases corresponds very closely to the number of observations for which the relationship was originally estimated, incorporating both decreases and increases in wages.

Table 7.3 shows the two variants of equation (7.1), which were estimated to test these two aspects of the reversibility of the relationship. In equation (7.7), $\dot{P}_t$ is replaced as an explanatory variable by $\dot{P}_t^+$ and $\dot{P}_t^-$. $\dot{P}_t^+$ is equal to $\dot{P}_t$ when $\dot{P}_t$ is positive and otherwise is equal to zero. $\dot{P}_t^-$ is equal to $\dot{P}_t$ when $\dot{P}_t$ is negative and otherwise is equal to zero. In effect, this means that $\dot{P}_t$ is split into, two component parts, rising prices ($\dot{P}_t^+$) and falling prices ($\dot{P}_t^-$), in order to estimate the sensitivity of wages to changes in prices when prices are rising and when prices are falling. In equation (7.7) the point estimate of the coefficient $\dot{P}^+$ is slightly greater than the coefficient $\dot{P}^-$, suggesting in a naive interpretation that wages are slightly more sensitive to price increases than to price decreases. However, the difference between these two coefficients is much less than its associated standard error, and the null hypothesis that these two coefficients

---

[1] The two subperiod relationships were equation (7.4) and the following equation for the period 1930-39:

$$\dot{W}_t = -5.31046 + \underset{[2.25]}{0.43807\dot{P}_t} + \underset{[2.54]}{79.013U_t^{-1}} + \underset{[1.64]}{0.14555\dot{W}_{us_t}}, \quad R^2 = .90018, \ D.W. = 1.65.$$

[2] The coefficient of the unemployment rate and the intercept of the relationship appear to have shifted quite perceptibly between the subperiods, however.

[3] Similar issues have been studied in connection with U.S. historical data in Ronald G. Bodkin, *The Wage-Price-Productivity Nexus*, pp. 151-155, with generally similar conclusions.

have the same universe value cannot be rejected. Nevertheless, the issue remains in doubt, because during the sample period, prices decreased in only five years, with four of these occurring consecutively at the beginning of the 1930's.

Table 7.3

Estimated Equations to Test for the Reversibility of the Canadian Historical Wage Change Relationships

Equation Number	Dependent Variable	Constant Term	Coefficients of Explanatory Variables:					R^2	D.W.
			U_t^{-1}	$\dot{W}_{us_t}$	$\dot{P}_t$	$\dot{P}_t^+$	$\dot{P}_t^-$		
(7.1)	$\dot{W}_t$	0.03147	13.436 [3.85]	0.14921 [2.23]	0.51079 [4.50]	–	–	.908	1.53
(7.7)	$\dot{W}_t$	0.00832	13.260 [3.57]	0.15253 [2.14]	–	0.52301 [3.81]	0.49271 [3.10]	.908	1.51
(7.8)	$\dot{W}_t^+$	0.36589	11.768 [3.49]	0.14207 [2.17]	0.55347 [4.49]	–	–	.881	1.56

Equation (7.8) is designed to test the second aspect of reversibility mentioned earlier. This equation is based on only observations when wages were rising, i.e., when $\dot{W}_t$ was positive. To distinguish this relationship from equation (7.1), the dependent variable is denoted as $\dot{W}_t^+$. As is evident from Table 7.3, the slope coefficients of equation (7.8) correspond very closely to those for equation (7.1), although the constant term is, as might have been anticipated, somewhat larger for the regression explaining only positive wage changes. Accordingly, there is little evidence of irreversibility in this sense. Admittedly, however, this conclusion is also subject to the serious qualification already mentioned, namely, that the regression explaining $\dot{W}_t$ is based on only a very limited number of observations for which wages actually decreased.

Finally, it is of some interest to consider briefly how our historical estimates of the wage change relationship compare with Professor Kaliski's earlier estimates. Generally, the relationships which were fitted are somewhat different and the estimates are based on different wage data and time periods so that a direct comparison cannot be made. Our results, however, do not provide strong support for his conclusion that "although the adjustment function does not fit the inter-war period as a whole, this is solely because it fails badly in the later 1930's. For the rest of the period, the function is an important part of the explanation".[1] Our results indicate a somewhat different conclusion, namely, that the relationship between wage changes and unemployment in the late 1920's is either very nebulous or indiscernible because of measurement problems and that a strong and moderately stable relationship is evident for the 1930's and the post-war years. As noted earlier, we were unable to estimate a significant relationship between wages and unemployment when other determinants of wage changes were taken

[1] Kaliski, *op. cit.*, p. 28.

into account for a historical sample period which included the 1920's. Unemployment entered the relationship as a significant determinant of wage changes only after we omitted the 1920's from our sample period.

3. The Relationship between Price and Wage Changes

The starting point for our examination of the historical relationship between prices and wages is equation (5.30), which is described in Chapter 5. This relationship explains the percentage rate of change in consumer prices as a linear function of a constant, the percentage rate of change in wages, the percentage rate of change in import prices, and the dependent variable lagged one period. In developing our historical estimates, no attempt was made to pursue the unit labour cost approach, which is also developed in Chapter 5. This approach did not work as effectively for the quarterly post-war relationships as the alternative approach of including wages and productivity separately. Moreover, unit labour costs, which is equal to wage earnings divided by output per man-hour, is a complex variable. We have already noted the limitations of the earnings data on which our historical estimates are based, while, for the pre-war years, the statistics on output per man-hour are probably even less reliable. To divide the first series by the second might well compound the substantial errors of observations in both series.

The historical estimates of the price-wage relationship, based on annual data for selected periods from 1923 to 1963, are shown in Table 7.4. Both $\dot{P}_t$ and $\dot{W}_t$ have already been defined. Other variables which entered into our tests, with the sources of the underlying data in parentheses, are as follows:

$\dot{F}_t = \frac{F_t - F_{t-1}}{F_{t-1}} \cdot 100$, where F_t is the annual index of Canadian commodity import prices (1948=100), as reported by the Dominion Bureau of Statistics and *Historical Statistics of Canada* (Table J. 118, p. 302).

$\dot{A}_t = \frac{A_t - A_{t-1}}{A_{t-1}} \cdot 100$, where A is output per man-hour in manufacturing, computed from data for manufacturing output and hours worked in manufacturing *(Historical Statistics of Canada).*

$Q_{dev}/Q_{tr} = \frac{Q_a - Q_e}{Q_e}$, where Q_a is the actual or reported output in manufacturing and Q_e is output estimated by fitting two log-linear trends to the output statistics, one to the years 1926–39 and a second for the years 1946–63.

$\log \frac{Q_a}{Q_p}$, where Q_a is reported output in manufacturing and Q_p represents a measure of potential output derived by using a linked-peak method. Two log-linear trends were fitted to the periods 1926–39 and 1946–63, using years of high employment as reference periods for fitting the trends.

$$\dot{P}_{us_t} = \frac{P_{us_t} - P_{us_{t-1}}}{P_{us_{t-1}}} . 100,$$

where P_{us_t} is the U.S. Consumer Price Index (1947–49=100) *(Historical Statistics of the United States,* Table E–113, p. 126).

The dummy variables (DUM I, DUM II, and DUM III) and the time trend variable t, which were utilized in estimating the wage change equation, were defined in the same way and also employed in connection with the prices change equation.

The only variables which, over the long historical periods considered, emerged as significant determinants of the annual percentage rates of change in the Consumer Price Index were the annual percentage rates of change in wages and in import prices and the annual percentage rate of change in consumer prices, lagged one year. Estimates for two historical periods are shown in Table 7.4: equation (7.9) is based on the period 1923-39 and 1946-63; equation (7.10) is based on the period 1930-39 and 1946-63.

Table 7.4

Historical Price Change Regression Relationships, Selected Sample Periods

Equation Number	Sample Time Period	Constant Term	Coefficients of Explanatory Variables:			R^2	D.W.
			$\dot{W}_t$	$\dot{F}_t$	$\dot{P}_{t-1}$		
(7.9)	1923-39 and 1946-63	-1.0099	0.53886 [3.75]	0.19757 [2.73]	0.21902 [2.23]	0.848	2.12
(7.10)	1930-39 and 1946-63	-1.4387	0.58522 [4.06]	0.20626 [2.88]	0.20316 [1.94]	0.883	2.46
(7.11)	1930-39	-1.5314	0.69993 [1.09]	0.14998 [0.68]	0.12616 [0.26]	0.794	2.43
(7.12)	1946-63	-1.8352	0.58185 [4.10]	0.24790 [3.05]	0.24726 [2.40]	0.884	2.29
(7.13)	1953-63 (annual)	-1.5410	0.46489 [2.69]	0.26375 [2.15]	0.49733 [2.19]	0.661	2.34
(5.36)	1953-65 (quarterly)	-0.62164	0.19877 [3.53]	0.09982 [2.97]	0.81715 [15.56]	0.865	2.04

A limited number of experiments were conducted to see what the effects on the estimated relationships would be when other variables were added to these relationships along with $\dot{W}_t$, $\dot{F}_t$ and $\dot{P}_{t-1}$. As was true with the post-war quarterly estimates, no evidence was found of a significant relationship between price changes and the percentage rate of change in labour productivity, $\dot{A}_t$, when this variable was added to these equations. The dummy variables permitting shifts in the constant term at the dates indicated earlier also proved to be statistically insignificant, as were the two time trend variables tested, t and $\frac{1}{t}$. In addition, the percentage rate of change in U.S. consumer prices, $\dot{P}_{us_t}$, was added to equation (7.9); this test also gave no evidence of a statistically significant relationship. Finally, two variables intended to capture the effects of excess demand, Q_{dev}/Q_{tr} and $\log \frac{Q_a}{Q_p}$, were included in equation (7.9). These variables are intended to reflect actual output in relation to the capacity to produce. Neither of these two proxies for the influence of demand was statistically significant.

In order to compare the coefficients of our annual historical relationships with the coefficients of the post-war quarterly estimate, the steady state values of the coefficients have been calculated. As outlined in Chapter 6, this is done by setting $\dot{P}_t = \dot{P}_{t-1} = \dot{P}_t^e$, where $\dot{P}_t^e$ is the steady state value of the rate of change in the Consumer Price Index at time t. When the required algebraic manipulations are completed, we obtain the equations shown in Table 7.5, which also repeats, for purposes of comparisons, equation (5.36e), which is based on the post-war quarterly data. As before, the steady state relationship is indicated by the same number as the original equation, with the letter "e" added as a suffix to this equation number, e.g., equation (7.9e) is the steady state relationship derived from equation (7.9) in Table 7.4.

Table 7.5

Coefficients of Steady State Price Change Relationships, Selected Sample Periods

Equation Number	Sample Time Period	Constant Term	Coefficients of Explanatory Variables: $\dot{W}_t$	$\dot{F}_t$
(7.9e)	1923-39 and 1946-63	-1.293	0.6900	0.2530
(7.10e)	1930-39 and 1946-63	-1.805	0.7344	0.2588
(7.13e)	1953-63 (annual)	-3.066	0.9248	0.5247
(5.36e)	1953-65 (quarterly)	-3.400	1.0871	0.5459

A comparison of the parameters of the equations shown in Table 7.5 suggests several interesting points. First of all, the parameters of the equation based on annual data for the 1953-63 period correspond rather closely with the parameters of the equation based on quarterly data for the period 1953-65. In every instance, the coefficients for the quarterly relationships are slightly larger than for the annual estimates, although the discrepancies probably reflect nothing more than sampling variability. Secondly, the parameters for the two relationships which are based in part on pre-war data are also quite similar to each other; in this case, the equation based on the sample period 1930-39 and 1946-63 has slightly larger coefficients than the estimates based on the sample period 1923-39 and 1946-63. (Here again, one would hesitate to say that more than sampling variability is responsible.) Thirdly, the coefficients for the two long-term relationships differ rather considerably from the coefficients for the equations for the periods beginning in 1953. The smallest relative discrepancy is for the coefficients of $\dot{W}_t$. Comparing equation (7.10e) with equation (5.36e), one finds that a variation of one percentage point in the rate of change in wages gives rise to an increase in consumer prices of 1.09 percentage points according to equation (5.36e) and 0.73 of a percentage point according to equation (7.10e), in addition, of course, to any changes occasioned by other influences. The impact of a variation in the rate of change in import prices on consumer price changes is approximately half as great if one judges this impact on the basis of the long-term relationship rather than on the basis of the quarterly estimate. A variation of one percentage point in the $\dot{F}_t$ variable induces an additional increase of 0.55 of a percentage point in $\dot{P}_t$ according to equation (5.36e) and of 0.26 of a percentage point according to equation (7.10e). Finally, the constant term in equation (5.36e) indicates that, with a zero change in $\dot{W}_t$ and $\dot{F}_t$, consumer prices would be expected to decrease by 3.4 percentage points annually; equation (7.10e) gives rise to the prediction that, under the same circumstances, they would decrease by 1.8 percentage points annually.

The lower sensitivity of price changes to wage and import price changes suggested by the long-term relationships, in comparison to the estimates for the periods beginning in 1953, seems likely to reflect, in part at least, the inclusion of the data for the 1930's.[1] During the severely depressed conditions which prevailed at that time, one might expect prices to reflect less fully the variations which occurred in wages and the prices of imported inputs. The differing estimates of the constant term between the long-term and the post-1953 relationships can readily be explained. As indicated in Chapter 6, this term may reflect the dampening effects of productivity growth on the rate of change of prices. Over the historical periods considered, this growth was significantly less, on average, than for the period since 1953.

As before, the Chow test was applied to equation (7.10). The equations for the subperiods 1930-39 and 1946-63 are shown in Table 7.4, together with equation (7.10), which is based on the full period 1930-39 and 1946-63. When one applies the Chow test, the value of the computed F statistic is 0.19. This compares with a critical value of the F statistic equal to 2.87, which is required to indicate a shift in the relationship at the 5 per cent level of statistical significance. Thus, the Chow test indicates no evidence of a shift of the price-level-change relationship over the period 1930 to 1963, as estimated by equation (7.10). This test was not applied to equation (7.9).

Finally, the tests for reversibility applied to the historical wage change equation were also applied to the historical price change equations. The various relationships computed to test for reversibility are shown in Table 7.6. Equations (7.9) and (7.10), based on different historical sample time periods, are repeated from Table 7.4 in order to facilitate comparisons. Equations (7.14) and (7.15) are based on the same historical sample time period as equation (7.10), namely, 1930-39 and 1946-63, while equations (7.16) and (7.17) are based on the same historical sample time period as equation (7.9). In deriving equations (7.14) and

[1] Although our views are largely based upon impression, along with a glance at the standard errors of the underlying regression equations, it seems quite likely that these variations are indicative of "real" changes in the economic structure, rather than merely sampling variability.

Table 7.6

Estimated Equations to Test for the Reversibility of the Canadian Historical Price Change Relationships

Equation Number	Sample Time Period	Dependent Variable	Constant Term	Coefficients of Explanatory Variables:					R^2	D.W.
				$\dot{W}_t$	$\dot{W}_t^+$	$\dot{W}_t^-$	$\dot{F}_t$	$\dot{P}_{t-1}$		
(7.10)	1930-39 and 1946-63	$\dot{P}_t$	-1.4387	0.58522 [4.06]	—	—	0.20626 [2.88]	0.20316 [1.94]	0.883	2.46
(7.14)	1930-39 and 1946-63	$\dot{P}_t$	-1.1338	—	0.55060 [3.61]	0.78935 [2.57]	0.20851 [2.88]	0.17295 [1.53]	0.886	2.49
(7.15)	1930-39 and 1946-63	$\dot{P}_t^+$	-1.3672	0.56260 [4.07]	—	—	0.20652 [2.74]	0.21603 [2.17]	0.845	2.80
(7.9)	1923-39 and 1946-63	$\dot{P}_t$	-1.0099	0.53886 [3.75]	—	—	0.19757 [2.73]	0.21902 [2.23]	0.848	2.12
(7.16)	1923-39 and 1946-63	$\dot{P}_t$	-0.49377	—	0.44508 [2.96]	0.82360 [2.87]	0.21732 [2.97]	0.20033 [1.94]	0.849	2.18
(7.17)	1923-39 and 1946-63	$\dot{P}_t^+$	-0.39892	0.45490 [3.11]	—	—	0.18320 [2.25]	0.20955 [2.14]	0.780	2.12

(7.16), two separate wage variables were included to explain $\dot{P}_t$. One of these, $\dot{W}_t^+$, is equal to $\dot{W}_t$ when $\dot{W}_t$ is positive and otherwise it is equal to zero; the second, $\dot{W}_t^-$, is equal to $\dot{W}_t$, when $\dot{W}_t$ is negative and is equal to zero otherwise. This means that, in equations (7.14) and (7.16), $\dot{W}_t^+$ allows for the effect on the price level of only increases in wages, while $\dot{W}_t^-$ allows separately for the effect on prices of decreases in wages. Equations (7.15) and (7.17) are simply re-estimates of equations (7.10) and (7.9), excluding all observations from each sample when the dependent variable $\dot{P}_t$ was not positive. In other words, equations (7.15) and (7.17) explain only the values of $\dot{P}_t$ when the price level was rising.

Two points of particular interest are indicated by these tests. The first is that the point estimates of the coefficients of $\dot{W}_t^-$ in both equations (7.14) and (7.16) are substantially larger than the coefficients of $\dot{W}_t^+$. Thus, there is no evidence that price changes respond more fully to wage increases than to wage reductions, contrary to what one might expect. In the case of equation (7.14), a one percentage point increase in wages gives rise to an increase of 0.55 of a percentage point in prices, abstracting from any other factors influencing price changes, whereas a one percentage point decrease in wages induces a reduction of 0.79 of a percentage point in prices. On this basis, one might conclude that the relationship between price and wage changes is not reversible. This interesting conclusion is considerably qualified, however, because of the very small number of observations during the sample period when wages actually decreased.[1] From 1930 to 1963, omitting the war years, $\dot{W}_t$ was negative three times and from 1923 to 1965, again omitting 1940-45, the wage series declined in five years. Moreover, all of the decreases in wages for the former sample period occurred in three consecutive years—1931 to 1933—during which the economy was at the trough of the Great Depression and was generally in a state of turmoil. Hence, the parameter estimate relating to increases in wages is based on much firmer evidence than that relating to decreases in wages. Because of the heavy preponderance of wage increases during each sample period, the coefficients of $\dot{W}_t^+$ in equations (7.14) and (7.16) are similar, as one would expect, to the coefficients of $\dot{W}_t$ in equations (7.10) and (7.9), respectively.

Next, we may focus on equations (7.15) and (7.17), which are based solely on observations of positive price changes for the respective sample periods. Equation (7.15) is very similar to equation (7.10), which includes five observations for which prices decreased during the sample period, and equation (7.17) is very similar to equation (7.9). In the period from which the coefficients of equation (7.9) were estimated, prices decreased seven times, generating seven negative values of $\dot{P}_t$. Accordingly, this evidence is consistent with the view that the price change relationship is reversible.

It remains to consider which of our two historical price change relationships, equations (7.9) and (7.10), based on slightly different sample periods, may be

---

[1] Computation of a formal t-ratio confirms this impression. Thus, for equation (7.16), the difference between the coefficient of positive wage changes and that of negative wage changes is only 1.31 times as great as the computed standard error of this difference. Hence, this discrepancy would not be considered statistically significant, by conventional criteria. For equation (7.14), the calculated t-ratio of the difference between the coefficients of positive and negative wage changes is only 0.75, which is also not statistically significant.

considered "better" for the purpose of estimating trade-offs between price changes and unemployment. In our view, equation (7.10) can be regarded as the "better" of the two equations for this purpose, for several reasons. First, the data for the period of the 1920's, which entered into the estimation of equation (7.9) but was excluded in estimating equation (7.10), is probably less accurate—especially prior to 1926—than the data after 1930. Secondly, the coefficient of multiple determination is slightly higher for equation (7.10) than for equation (7.9), although the Durbin-Watson statistic is closer to the null value of 2.0 for equation (7.9). (As pointed out in Chapter 5, this test for autocorrelation in the disturbance term lacks power when the lagged value of the dependent variable is included as an explanatory variable.) And, finally, the wage change relationship which incorporates unemployment as an explanatory variable is based on the same sample period as equation (7.10), namely, the years from 1930 to 1963 excluding 1940-45. It seems preferable to combine this wage change relationship with a price change relationship estimated for the same sample period.

4. Some Derived Trade-Off Relationships Based on the Historical Estimates

As in Chapter 6, estimates of the trade-offs between rates of price change and unemployment rates may be derived from equations which are obtained by substituting the estimated wage change equation for $\dot{W}_t$ in the estimated price change equation. This results in a trade-off equation, in which the percentage rate of change in consumer prices is explained by a constant, the reciprocal of the unemployment rate, the percentage rate of change in import prices and the percentage rate of change in U.S. wages. Three variants of this derived trade-off equation are shown in Table 7.7. Equations (7.18) and (7.19) are the estimated historical trade-off relationships; equation (7.20) is the most closely comparable estimate from the post-war quarterly data and is included in Table 7.7 to facilitate comparisons between the post-war quarterly results and the historical estimates. The sample period underlying equation (7.18) is necessarily a hybrid; the equilibrium price equation on which it is based, (7.9e), was estimated for the period 1923-39 and 1946-63 and the underlying wage equation was computed from observations relating to the period 1930-39 and 1946-63. The same sample period, 1930-39 and 1946-63, underlies both equations (7.1) and (7.10e), from which the trade-off equation (7.19) has been derived.

Table 7.7

Derived Trade-Off Equations for Canadian Historical Data: The Rate of Change of Consumer Prices ($\dot{P}_t$) as a Linear Function of the Indicated Explanatory Variables

Equation Number	Equations on Which Trade-Off Equation is Based		Constant Term	Coefficients of Explanatory Variables:		
				$\dot{F}_t$	$\dot{W}_{us_t}$	U_t^{-1}
	Wage	*Price*				
(7.18)	(7.1)	(7.9e)	-1.9634	0.39066	0.15898	14.316
(7.19)	(7.1)	(7.10e)	-2.8524	0.41428	0.17357	15.792
					$\dot{W}^*_{us_t}$	$(U_t^*)^{-1}$
(7.20)	(5.6e)	(5.36e)	-7.2024	0.98924	0.90753	19.89950

As in Chapter 6, various values of the price-change-unemployment trade-offs were calculated on the basis of each of the trade-off equations presented in Table 7.7. In order to make these calculations, three sets of assumptions have been made about the variables, other than the unemployment rate, affecting the rate of change of prices. Under the first set of assumptions, the rate of change of prices is set equal to zero, and U.S. wages are assumed to increase at 3 per cent annually. The second set of assumptions assumes somewhat more inflationary circumstances: import prices are assumed to increase by 1 per cent per year and U.S. wages by 4 per cent per year. The third set of assumptions assumes external conditions which might be regarded as quite inflationary; import prices are assumed to increase by 3 per cent annually and U.S. wages by 6 per cent. In Figures 7.3, 7.4 and 7.5, the trade-off estimates computed on the basis of each set of assumptions are plotted; the same information appears in Table 7.8. The trade-off curve derived from equation (7.19), based on the first (the relatively non-inflationary) set of assumptions, is also shown in Figures 7.4 and 7.5 by the dashed line, in order to enable one to make comparisons more readily.

It is evident from these results that our historical relationships imply that a substantially higher rate of unemployment is required to induce complete stability of the Consumer Price Index than do our post-war quarterly equations. The quarterly relationship implies that, under the first set of assumptions, a rate of unemployment equal to 4½ per cent of the labour force is consistent with a zero rate of change in consumer prices; our preferred historical trade-off equation (7.19) implies that an unemployment rate of 6¾ per cent is consistent with completely stable prices; and our alternative historical relationship, equation (7.18), suggests an unemployment level of 9½ per cent as consistent with a zero rate of change in consumer prices.[1]

The differences in the degree of inflation predicted by each relationship at low rates of unemployment are considerably smaller. If one postulates a 3 per cent level of unemployment and assumes a relatively non-inflationary external environment with regard to prices and wages, the quarterly trade-off relationship implies that consumer prices will increase by 2.2 per cent annually. Under these same circumstances, our preferred historical trade-off relationship implies that prices will rise at a rate of 2.9 per cent annually; and the corresponding figure for our alternative historical equation is 3.3 per cent per year.

---

[1] It is noteworthy that historical estimates of the price-change-unemployment trade-offs for the United States also imply a higher rate of unemployment "required" to achieve complete price stability than does a post-war quarterly relationship. Ronald G. Bodkin's analysis of historical U.S. data suggests that unemployment rates of 12 to 18 per cent may be required for complete price stability (Bodkin, *op. cit.*, pp. 113-121, 276-281). Bodkin notes (p. 277) that Lawrence R. Klein's wage adjustment relationship from his post-war quarterly model of the U.S. economy suggests that an unemployment rate of roughly 7 per cent is consistent with a zero rate of change in the consumer price level. The Klein-Bodkin wage-adjustment relationship for the United States, which is based on quarterly data and which was discussed in Chapter 3 above, indicates that an unemployment rate of 5.7 per cent is associated with a percentage rate of change in wages of 2½ per cent per year. If one assumes that average productivity rises at approximately this rate, these quarterly estimates suggest, as noted earlier, that the U.S. consumer price level might be expected to remain completely stable provided the rate of unemployment in the United States was held at roughly 5¾ per cent.

Figure 7.3

THREE CANADIAN TRADE-OFF CURVES, WITH A RELATIVELY NON-INFLATIONARY EXTERNAL ENVIRONMENT

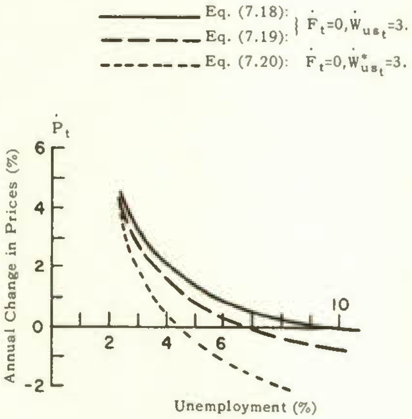


Figure 7.4

THREE CANADIAN TRADE-OFF CURVES, WITH A MILDLY INFLATIONARY EXTERNAL ENVIRONMENT

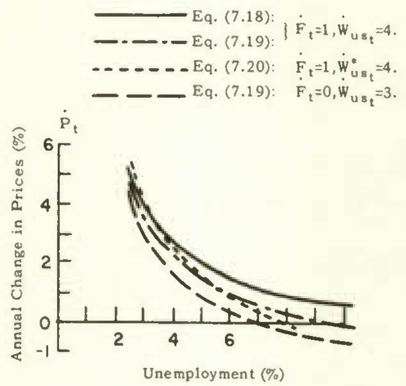


Figure 7.5

THREE CANADIAN TRADE-OFF CURVES, WITH A STRONGLY INFLATIONARY EXTERNAL ENVIRONMENT

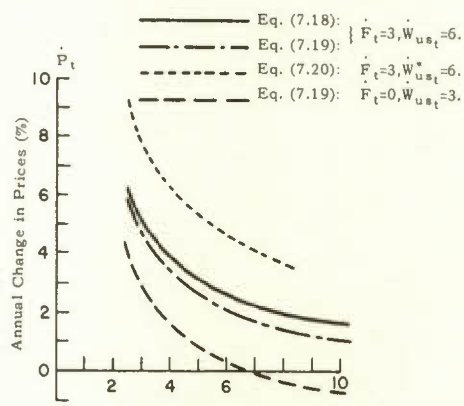


Table 7.8

Predicted Rates of Change in the Consumer Price Index, Based on Alternative Canadian Historical Trade-Off Relationships

Unemployment Rate (U_t) (Per Cent of Labour Force)	Annual Percentage Rate of Change of Consumer Prices ($\dot{P}_t$) with $\dot{F}_t = 0$ and $\dot{W}_{us_t} = 3$,			Annual Percentage Rate of Change of Consumer Prices ($\dot{P}_t$) with $\dot{F}_t = 1$ and $\dot{W}_{us_t} = 4$,			Annual Percentage Rate of Change of Consumer Prices ($\dot{P}_t$) with $\dot{F}_t = 3$ and $\dot{W}_{us_t} = 6$,		
	Equation:			Equation:			Equation:		
	(7.18)	(7.19)	(7.20)#	(7.18)	(7.19)	(7.20)#	(7.18)	(7.19)	(7.20)#
2.5	4.24	3.99	3.48	4.79	4.58	5.38	5.89	5.76	9.17
3.0	3.29	2.94	2.15	3.84	3.53	4.05	4.93	4.71	7.84
4.0	2.09	1.62	0.50	2.64	2.21	2.39	3.74	3.39	6.19
5.0	1.38	0.83	-0.50	1.93	1.42	1.40	3.03	2.60	5.19
6.0	0.90	0.31	-1.16	1.45	0.89	0.73	2.55	2.07	4.53
7.0	0.56	-0.07	-1.64	1.11	0.52	0.26	2.21	1.70	4.05
8.0	0.30	-0.35	-1.99	0.85	0.24	-0.10	1.95	1.42	3.70
9.0	0.10	-0.57	—	0.65	0.02	—	1.75	1.20	—
10.0	-0.05	-0.75	—	0.49	-0.16	—	1.59	1.02	—
Unemployment Rate Associated with $\dot{P}_t = 0$, for Same Trade-Off Equation:	9.63	6.79	4.44	None below 10%	9.08	7.70	None below 10%	None below 10%	None below 10%

Based on $(\dot{U}^*)^{-1}$ and $\dot{W}^*_{us}$.

The differences in the rate of price change predicted by each relationship for each rate of unemployment are indicated in Figure 7.3. It will be observed that the curves based on the historical equations, shown as the solid and dashed lines, are flatter, rising less steeply as unemployment decreases, than the dotted line showing the trade-off relationship for the quarterly estimates. It is also apparent that the three curves converge at lower levels of the unemployment rate.

Under the second set of assumptions, with mildly inflationary conditions regarding external prices and wages, there are smaller differences in the rates of price change predicted by the quarterly and the preferred historical relationships, at the various rates of unemployment. If the percentage rate of increase in import prices and U.S. wages is set equal to 1 and 4 per cent per year respectively, the quarterly relationship indicates that an unemployment rate of 7.7 per cent is required to induce a zero rate of change in consumer prices. Our preferred historical relationship, equation (7.19), suggests that under these circumstances the required level of unemployment is about 9 per cent. The alternative historical relationship, on the other hand, indicates that there is no level of unemployment below 10 per cent which is consistent with complete stability of the consumer price level. The amount of inflation to be expected at high levels of employment in this mildly inflationary external environment is much the same for each of the relationships. In these circumstances, the quarterly relationship indicates that, when the unemployment rate is 3 per cent, the Consumer Price Index can be expected to rise at 4.0 per cent per year; the preferred historical equation predicts that consumer prices will rise at 3½ per cent per annum and the alternative historical relationship implies that prices will rise at 3.8 per cent annually.

If, finally, one assumes quite inflationary external circumstances with import prices rising at 3 per cent annually and U.S. wages at 6 per cent per year, all our estimates suggest that there is no rate of unemployment below 10 per cent which is consistent with complete price stability. At a 3 per cent rate of unemployment, the quarterly equation suggests that Canadian consumer prices will increase by 7.8 per cent per year under these circumstances. The historical relationships, on the other hand, predict in this case a considerably lower rate of increase of consumer prices, around 4.7 or 4.9 per cent annually.

As is apparent from Figures 7.3, 7.4 and 7.5, the post-war quarterly estimates of the trade-off curve are considerably more sensitive to changes in import prices and U.S. wages than the historical estimates. This is indicated by the extent of the shift, in Figures 7.3, 7.4 and 7.5, of the trade-off curve based on equation (7.20), as compared with the degree to which the curves based on the historical evidence shifted under different assumptions about external wage and price inflation. This difference reflects similar differences in both the price and wage change relationships underlying the trade-off equations. The estimated historical wage adjustment equation (7.1) is less sensitive to U.S. wage changes than the quarterly relationship (5.6e); and the estimated historical price change equations (7.9e) and (7.10e) are less sensitive to changes in import prices than the quarterly relationship, equation (5.36e).

All of this analysis is, of course, subject to the limitations which have already been outlined in Chapters 5 and 6 in connection with our discussion of the quarterly relationships. Furthermore, our historical estimates are subject to the additional qualifications arising from the doubtful quality of much of the pre-war data employed in our analysis.

5. Concluding Comments

As indicated at the outset of this Chapter, one of the primary purposes of attempting to estimate the historical relationship between prices, wages and unemployment is to see whether the relationships between these variables can be regarded as relatively stable. The sample period which we have been mainly concerned with is the period from 1930 to 1963, excluding the war years 1940-45. This period, as noted earlier, encompasses a wide range of experience ranging from the depths of the Great Depression of the 1930's to the unprecedented prosperity of the post-war years. During this period, many sectors of the economy were virtually transformed and far-reaching and fundamental changes have occurred in many aspects of Canadian economic life as the country became considerably more highly industrialized.

The evidence on the issue of the stability of the historical relationships is mixed and inconclusive. In terms of the formal statistical tests, one could argue that both the wage adjustment and the price change relationships possess a fairly high degree of stability. Thus, application of a Chow test failed to provide any evidence of a shift in either of these relationships. The regression coefficients of some included dummy variables for selected time periods were generally statistically insignificant. A third test was provided by including a time trend and the reciprocal of this variable in both of the estimated relationships; the regression coefficients of these variables were insignificant for both the wage change and the price change relationships. In short, no formal evidence of instability or of a shift in the relationships was uncovered by these procedures.

However, the impression remains that the parameters of all three of the relationships discussed in this Chapter varied somewhat over the period under examination. In the case of the wage adjustment relationship, the fact that the rate of unemployment does not emerge as a significant explanatory variable until the data for the 1920's are excluded from the sample period may be indicative of some instability. Moreover, there is some suggestion that U.S. wage changes may have become a more important deteminant of Canadian wage changes in the post-Korean-War period than formerly, although the evidence is not unambiguous on this point. The steady state price change relationships appear to be more sensitive to changes in wages and in import prices for the more recent period, although no formal statistical test was carried out. Moreover, the derived trade-off relationship appears also to have shifted somewhat over the historical period under study; the predicted rate of change in consumer prices appears to be more sensitive to variations in the rate of unemployment, as well as to external influences, for the post-Korean-War period.

One might argue that this historical evidence gives some mild encouragement to those who wish to undertake policies to shift the trade-off curve. If the curves have shifted "naturally" over time, hopefully policies designed to improve labour markets, factor mobility, competition in product markets, and the like may also induce changes in the slope and position of the trade-off curve. Presumably, the more direct measures associated with the term "incomes policy" could also have an impact. We should not like to insist very hard on these tentative conclusions, however, because changes in structure that are induced by public policy are often qualitatively different from structural changes occurring "in nature," as pointed out in the introduction to this Chapter. In other words, the historical evidence has limitations as an indicator of the likely effectiveness of future policies consciously designed to shift the trade-off curve.

A second purpose of estimating historical relationships has been to explore whether the relationships between price changes, wage changes, and unemployment are reversible or not. Research on this question based on the techniques of regression analysis is seriously hampered because prices and wages increased in almost every year of our sample period, leaving very little experience of falling prices and wages from which to derive estimates. Nevertheless, such tests, as we have been able to make, suggest that the wage adjustment relationship is highly reversible in two senses: (1) price increases seem to have roughly the same stimulating effect on wage increases as price decreases have in retarding wage increases; and (2) rising wages are approximately equally sensitive to variations in unemployment, U.S. wage changes and consumer price changes as wage changes in both directions. As far as our tests of the reversibility of the price change relationship are concerned, these give little evidence of irreversibility. Although positive wage changes are estimated, contrary to our expectations, to have a weaker impact on changes in consumer prices than do negative wage changes, the difference in the associated regression coefficients does not appear to be statistically significant. At the same time, moreover, positive price changes are about equally sensitive to changes in wages, import price changes, and the effects of lagged price changes as are price changes in both directions.

A third feature of this analysis has been to compare our estimated historical relationships with the post-war quarterly estimates developed in Part II. Such a comparison cannot be pressed too far for several reasons. In addition to the differences in the sample period underlying the estimates (which is the subject of interest), several of the statistical series underlying each estimated relationship are different, and the formulations of the variables entering the regressions also differ. Moreover, it should again be emphasized that our finding of the lack of a significant shift in the historical relationships does not imply that the estimates for subperiods within the historical sample period will not differ somewhat from the estimates for the entire period. For the purpose of predicting the trade-off relationship in the future, we think that our quarterly estimates based on experience beginning in 1953 will prove more reliable than the historical estimates, which incorporate the period of the Great Depression, the post-World War II period of reconstruction and rehabilitation, and the Korean War period. Finally, as has been repeatedly emphasized in this Chapter, the quality of some of the statistical series from which the historical relationships have been estimated is open to some question, especially for the period of the 1930's. The quality of the data underlying the estimated quarterly relationships warrants substantially more confidence.

These important qualifications are relevant to all the comparisons of the estimated trade-off curves derived from the two sets of estimates. A number of points are indicated by such comparisons. First, both sets of estimates suggest that foreign prices and wages have a powerful influence on Canadian consumer prices. Our post-war quarterly relationship is considerably more sensitive to foreign price and wage changes than the historical estimates, but both sets of results indicate that changes in consumer prices are quite responsive to these determinants. For both the "structural" wage adjustment and price change equations and also for the derived trade-off relationships, foreign determinants of price and wage changes appear to have become quantitatively more important in recent years than historically. Nevertheless, with a highly inflationary external environment, both sets of results indicate that there is no rate of unemployment in Canada below 10 per cent of the labour force which will completely stabilize domestic prices. Secondly, both sets of estimates indicate that the rate of change of Canadian prices is responsive to the level of unemployment. Again, the post-war quarterly trade-off relationship indicates that the rate of change in consumer prices is more responsive to variations in the unemployment rate than is the case for the historical equations; however, both sets of results indicate considerable sensitivity. Thirdly, both sets of estimates suggest that, at full employment (which may tentatively be defined as an unemployment rate of 3 per cent) and with the assumptions of a stable external environment, Canadian consumer prices can be expected to increase at a rate between 2 to 3 per cent annually. The quarterly relationship predicts rates of price change at the lower end of this range, while the estimates from the historical relationships lie at the upper end of this range.

Under the assumptions of stable prices and "non-inflationary" wage behaviour abroad, the post-war quarterly trade-off relationship implies that an unemployment rate of approximately 4½ per cent is required, on average, to induce complete stability in the Canadian Consumer Price Index. This compares with the estimate of 6¾ per cent derived from the preferred historical equation. On this basis, one might argue that the conflict between the goals of full employment and price level stability appears to be greater when judged on the basis of the long-term historical experience than when judged on the basis of experience during the past decade or so. Accordingly, one interpretation might assert that recent experience, as reflected in our quarterly estimates, gives an unduly optimistic picture of the trade-offs between these objectives of economic policy. Over the long-run future, we may, in fact, experience conditions which are less favourable from the standpoint of economic policy than the quarterly estimates of the trade-off relationship suggest. A more optimistic conclusion would be that the improvement in the trade-off options in recent years, as compared with the long-term historical experience, reflects a variety of structural changes in the economy, possibly including an improvement in economic policies. These factors, in combination, may have reduced somewhat the conflict between the objectives of high employment and stability of the price level.

CHAPTER 8

ESTIMATED RELATIONSHIPS FOR THE UNITED STATES, BRITAIN, FRANCE, WEST GERMANY AND SWEDEN, FOR THE RECENT POST-WAR PERIOD

1. Introduction

In Chapter 3 of this study, the estimates made by a number of authors of the wage-change-unemployment relationship for various countries were briefly reviewed and compared with somewhat similar estimates for Canada. As noted earlier, differences in the estimating procedures, the underlying statistical series, and the sample time periods employed by the authors of these studies appreciably limit their comparability with each other. The comparability of these estimates with the estimates for Canada developed in Part II above is also limited for the same reasons. Moreover, most of the outstanding estimates for the various countries focus on the wage-change-unemployment relationship and do not consider the relationship between price changes and wage changes. Consequently, these relationships do not directly lend themselves to the calculation of trade-offs between the rate of inflation and the rate of unemployment which are readily comparable to those calculated in Chapter 6. In order to be able to make more meaningful comparisons between the price-change-unemployment trade-offs for Canada and those for other countries, it was decided to try to estimate both wage change and price change relationships for a limited selection of foreign countries, employing as far as possible the same sample period and regression equations as were used for the post-war quarterly relationships for Canada.

An additional reason for attempting to estimate wage change and price change relationships for several foreign countries was to provide a direct link between this study and a companion study by David C. Smith.[1] Smith describes and analyzes in considerable detail the various "incomes policies" that have been adopted intermittently in the United States and in several European countries. One might interpret all of these policies as attempts to shift, through governmental action, the trade-off curve between price changes and the rate of unemployment so that the curve lies closer to the axes: in other words, as attempts to reduce the conflict between the two policy objectives of high employment and price level stability.

The statistical analysis presented here may be thought of as supplementing Professor Smith's more general analysis in several ways. First, our relationships attempt to isolate statistically some of the main determinants of price and wage changes in these countries and to measure the proportion of the variation in

---

[1] *Incomes Policies: Some Foreign Experiences and Their Relevance for Canada,* Economic Council of Canada, Special Study No. 4 (Ottawa: Queen's Printer, 1966).

price and wage changes that is explained by these statistical determinants. Secondly, we estimate the price-change-unemployment trade-offs for these countries on as comparable a basis as possible in order to be able to make comparisons of the rate of inflation which these countries might be expected to experience at various rates of unemployment. Thirdly, we consider whether there is any evidence that these relationships have been consistently shifting over time in any of these countries. And finally, we apply statistical tests to determine whether the statistical evidence for these countries is consistent with the view that incomes policies either have or have not been effective in shifting the trade-off relationships in the countries where such policies have been implemented.

This analysis concentrates on five countries: the United States, Britain, France, West Germany and Sweden. These countries were selected for several reasons, including particularly the following: (1) the similarity in the degree of industrial development between these countries and Canada, (2) the important links among the economies of these countries and the many points of interdependence between each of these countries and Canada, (3) an interest in the kind of economic policies which these countries in particular have pursued in recent years and curiosity about the apparent effectiveness of these policies, and (4) the availability of statistical data necessary to estimate the relationships in question.

It remains to register several important caveats about the analysis that follows. One, already referred to, concerns the comparability of the statistical data for various countries and, in the cases of some possible explanatory variables, the lack of data. The question of the comparability of statistical data has already been reviewed in Chapter 3 and need not be further elaborated upon here, except to emphasize it again as an important limitation on our analysis. The sources of the data employed in this analysis are described in the Appendix to this Chapter. As far as possible, all the statistical series for the various countries considered are comparable. It should particularly be noted that all the unemployment data are supposedly based on U.S. definitions. However, one may entertain some justifiable reservations about how successful the attempts to place the data on a common basis have been when one observes unemployment rates for Germany, for example, equal to 0.2 per cent of the labour force for several quarters. Our analysis is further qualified by the lack, in some cases, of a satisfactory statistical series for profits per unit of output. Because of this gap in the data, we have not been able to include this variable in our parameter estimates of the determinants of European wage changes, as was done for Canada and the United States.

In addition to the problem of observational errors, which can produce biased estimates of the "true" parameter values, the standard time series problems of autocorrelated residuals and simultaneous equations bias remain with us. The presence of autocorrelated disturbances is suggested, at several points in this Chapter, by relatively low values of the Durbin-Watson (D.W.) test statistic. As pointed out in Chapter 5 above, the existence of this phenomenon generally implies that our measures of the precision of the regression coefficients (the t-ratios) are overstated, because the standard errors of the regression coefficients tend to be underestimated. In addition, the application of ordinary least squares regression methods to a single equation taken from the context of a simultaneous model will, in general, produce biased parameter estimates. Although the numerical estimates of the bias in Chapter 5 above (and also in two other studies) are small, there is no guarantee that this will always be the case. Consequently, this is still another reason for interpreting the results of this Chapter with a certain degree of caution.

A final important *caveat* is that, in estimating wage change and price change relationships for the United States and European countries, we have necessarily been forced by limitations of time to restrict ourselves to a much more limited range of experiments than we undertook for Canada. Consequently, our estimates for these five foreign countries are more tentative than for Canada.[1] In the main, our approach has been to fit our "best" relationships for Canada to quarterly data on the U.S. and European economies from 1953 or 1954 to the most recent data available, adding a few modifications to take account of any special circumstances of which we were aware and to test for a shift in these relationships over time or because of applying special incomes policies. In some cases, we have been able to supplement our own analysis with the empirical results of recent research on these questions by others.

Further experimentation along two particular lines might have been useful. The first relates to the spillover effects of wage changes in one country on wage changes in neighbouring countries, as suggested by our analysis of Canadian experience. It seems unlikely that much light can be shed on this question by U.S. experience, beyond the evidence of such domestic spillover effects as have already been studied, because of the size and the relatively self-contained nature of the U.S. economy. It is possible, however, that a somewhat similar international spillover process is to be found in Europe, especially among the Continental countries. If so, it would be interesting to try to identify this spillover effect and to evaluate its influence. Secondly, in none of our estimates of the price change relationships did we experiment with explicit variables designed to gauge the influence of excess demand as a partial determinant of price changes. In general, our price change relationships appear to be less satisfactory than our wage adjustment equations. It is possible that we might have been able to derive better estimates of the price change relationship—and, consequently, of the trade-off relationship—had more time been available to develop and test satisfactory demand variables in the price change equations.

The results for each country are briefly reported and discussed in the sections that follow. The relationships for each country are considered in the following order: United States (Section 2); Britain (Section 3); France (Section 4); West Germany (Section 5); and Sweden (Section 6). In the final section of this Chapter, some intercountry comparisons, which include Canada, are made, and some of the principal conclusions of this Chapter are reviewed.

---

[1] At the same time, however, it is probably more accurate to concede that apparent measures of statistical significance are less overstated (from applying classical formulas when in reality a number of experiments had been undertaken) than is the case for the Canadian relationships estimated in Part II above.

2. United States

i. Wage changes

For the United States, our four "best" wage adjustment relationships are presented in Table 8.1. Most of the symbols have been defined previously and have meanings analogous to those given in previous chapters; these symbols are:

$$\dot{W}_t = \frac{W_t - W_{t-4}}{W_{t-4}} \cdot 100 = \text{percentage change in wages;}$$

$(U_t^*)^{-1}$ = reciprocal of U_t^*, where $U_t^* = \frac{1}{8}U_t + \frac{1}{4}\sum_{i=1}^{3} U_{t-i} + \frac{1}{8}U_{t-4}$ and

U_t is the unemployment rate in the t-th quarter;

$$(U_t^*)^{-2} = \frac{1}{(U_t^*)^2};$$

$\dot{P}_t^* = \frac{1}{4}\sum_{i=0}^{3} \dot{P}_{t-i}$, where $\dot{P}_t = \frac{P_t - P_{t-4}}{P_{t-4}} \cdot 100$ and P_t is the Consumer Price Index;

$(^Z/Q)$ = profits per unit of output in manufacturing;

$$(^Z/Q)_t^* = \frac{1}{4}\sum_{i=0}^{3} (^Z/Q)_{t-i};$$

t = time, numbering consecutively from the first quarter of 1953 (t=1) to the fourth quarter of 1965 (t=52); and

DUM = a dummy variable with a value of 0 from 1953 to the end of 1961 and a value of 1 from the beginning of 1962 to the fourth quarter 1965.

Before focusing on the relationship between the rate of change of wages and unemployment, several comments regarding the other explanatory variables in the relationships shown in Table 8.1 may be put forward. Lagged wage changes appear to be a statistically significant variable in every equation; the direction of effect is the by-now-familiar one in which a large change in wages in the preceding year is associated with a smaller change in the current period. The unit profits variable also has a significant influence on the rate of change of wages, serving to increase the expected rate of change of wages when profit margins are high. It is interesting to observe that profit margins appear to react more rapidly on wage changes in the United States than in Canada. In the case of the United States, the values of $(^Z/Q)^*$ were introduced into several variants of the wage adjustment equation with lags of one quarter and of two quarters separately. In all cases, the numerical value of the coefficient of the profits variable falls steadily as the length of the lag is increased; moreover, the coefficients of the lagged values of profit margins are frequently not statistically significant. In Canada, by contrast, the influence of the profits variable on the rate of change of wages appeared to be at its maximum strength only after

Table 8.1

Wage Adjustment Regressions Explaining $\dot{W}_t$, United States, First Quarter 1953 through Fourth Quarter 1965

Equation Number	Constant Term	Coefficients of Explanatory Variables:							R^2	D.W.
		$(U_t^*)^{-2}$	$\dot{P}_t^*$	$(Z/Q)_t^*$	$\dot{W}_{t-4}$	DUM	DUM.t	t		
(8.1)	-2.664	28.774 [5.05]	0.22112 [1.66]	0.06248 [3.81]	-0.50896 [4.51]	—	-0.02624 [4.50]	—	0.684	1.37
(8.2)	-1.458	20.043 [3.07]	0.33739 [2.29]	0.06041 [3.52]	-0.51555 [4.23]	—	—	-0.04050 [3.78]	0.653	1.27
(8.3)	-2.142	29.120 [5.04]	0.19323 [1.43]	0.05773 [3.48]	-0.50160 [4.37]	-1.133 [4.27]	—	—	0.674	1.33
(8.4)	-3.131	30.201 [4.47]	0.15099 [0.96]	0.05688 [2.93]	-0.30622 [2.49]	—	—	—	0.545	1.02

two quarters had elapsed.[1] The feedback of changes in consumer prices on wage changes appears to be fairly weak, in comparison to the estimates emanating from previous research on the U.S. economy: the coefficient of the $\dot{P}_t^*$ variable is both small in numerical value and statistically significant, by conventional criteria, in only one case out of four.

The "best" estimate of the U.S. wage change relationship is considered by us to be equation (8.1), which explains 68 per cent of the variation in the rate of change in U.S. wages in terms of variations in the reciprocal of the square of the unemployment rate, changes in the rate of change in consumer prices, lagged wage changes, the level of profits, and DUM·t, which is discussed below. In equation (8.2), which includes the time trend variable t in place of DUM and DUM·t, all t-ratios are greater than 2.0 . However, for all variables except $\dot{P}_t^*$, the t-ratios are smaller than in equation (8.1) and the value of the coefficient of multiple determination is also appreciably smaller.

Before discussing the role of the dummy variables in these estimated relationships, it might be noted that most of our tests were run with $(U^*)^{-1}$ as well as $(U^*)^{-2}$. In general, the square of the reciprocal had a higher t-ratio than the simple reciprocal form. Another variable which was tested was the reciprocal of time, $\frac{1}{t}$. This variable was not significant unless either DUM or DUM·t was also included in the regression. Finally, it might be reported that when t

---

[1] It is interesting to compare these results with those from two very recent studies. In the Brookings model study, Schultze and Tryon *(op. cit.)* fitted, by ordinary least squares techniques, an equation of the form (8.4) (except that the unemployment variable was the simple reciprocal of the weighted average of the present and past rates of unemployment) for six sectors: contract construction, durable manufacturing, nondurable manufacturing, wholesale and retail trade, the regulated industries, and a residual sector. All of the explanatory variables were significant in a majority of the six cases: the consumer price change and the profits variables were significant in four cases out of six (if, in the case of the profits variable, one adopts a less stringent one-tailed test), while the reciprocal of the weighted average of the unemployment rate and the lagged wage changes were statistically significant (unambiguously) in five cases out of the six. The quantitative effects of variations in the unemployment rate and in lagged wage changes appear to be quite similar to those presented in Table 8.1 above, the median coefficient of lagged wage changes being roughly 0.4. In general, the consumer price change variable appeared to have a larger impact on wage changes in the Brookings estimates, as the median value of this coefficient was 0.42. (However, there was a tremendous range of variation in this coefficient, from 0.07 to 0.88.) With the information presented in the published article, it is difficult to compare the coefficients of the profits variable.

It is also possible to compare these results with the wage adjustment equation in the Office of Business Economics' recently published quarterly econometric model of the United States. (See Maurice Liebenberg, Albert A. Hirsch, and Joel Popkin, "A Quarterly Econometric Model of the United States: A Progress Report," *Survey of Current Business*, Vol. 46, No. 5 [May 1966], pp. 13-39.) This relationship differs from those of Table 8.1 in that the dependent variable is the rate of change of wages in the private sector, in that the relationship was fitted by the two-stage least squares method, and in that this relationship was fitted to a slightly different time period (1953-64). Otherwise, the relationship is very similar to those of the current study: the rate of change of wages is explained as a linear function of a constant, the reciprocal of a four-quarter average of the unemployment rate, a four-quarter average of the rate of change of consumer prices, a corporate profits variable, and the rate of change of wages four quarters prior to the current period. The direction of effect of all of these (significant) variables is the same as for the variables of Table 8.1. Moreover, the quantitative impact of the unemployment variable and of the lagged change in wages is roughly similar. The profits variable utilized by the Office of Business Economics group is not directly comparable to ours, since they use the absolute change in corporate profits as their profits variable. The one point of difference in the parameter estimates is the influence of the change in consumer prices on wage changes, which they estimate to be two and a half to six times as large as the coefficients of Table 8.1. Finally, it may be observed that the Office of Business Economics group did not attempt to test for the influence of the guideposts in their wage adjustment relationship.

and either DUM or DUM·t entered the equation together, t was not statistically significant.

An interesting feature of U.S. experience in recent years is the issue of whether the wage and price "guide posts" of the U.S. President's Council of Economic Advisers (C.E.A.) had any appreciable influence on the wage settlements occurring after this policy was enunciated. We have tested for this possibility in several ways. First, a dummy variable was introduced for the period during which the guideposts are presumed to have been operative. Alternatively, a time trend was introduced into the wage-adjustment relationship; the negative sign of this time trend might be interpreted as reflecting developments after the first quarter of 1962. Finally, a hybrid variable, the product of the DUM and the time trend variables, was introduced as an alternative variable to capture the effects of introducing the guideposts into the U.S. scene. This variable is zero until the first quarter of 1962; after that date, it begins to have a gradually increasing influence (one that increases linearly with the passage of time). The idea behind the introduction of such a variable is the common-sense notion that a policy, such as the guideposts, may require some time before the ideas take hold and become an effective factor conditioning the environment in which wage changes are negotiated.

As can be seen from Table 8.1 , all of the variables intended to capture the influence of the change in the wage price environment after 1962 are statistically significant in the wage adjustment relationships. Moreover, the direction of effect is the expected one (towards a dampening of wage increases) and the quantitative impact appears to be substantial: the impact of the dummy variable is to reduce wage increases by 1.1 to 1.3 percentage points per year. This does not, of course, prove that the CEA guideposts were the factor inducing the downward shift in the wage adjustment equation, but it is at least consistent with the hypothesis that the guideposts had some effect. It is still possible that some unidentified third factor (e.g., changes in expectations or the slow nature of the 1962–65 recovery) was responsible for the abatement of wage pressures during this period.[1]

---

[1] Another possibility is that the guideposts policy might merely postpone the occurrence of high wage and price increases, so that the policy would appear to be effective temporarily but would eventually break down. Events in the United States during the current calendar year (1966) are consistent with this possible reservation. If this interpretation is the correct one, then the coefficient of the dummy variable in the regression does in fact measure the effects of the guideposts policy with regard to the *timing* of wage increases, but the computation of a steady state relationship is probably not legitimate, as this influence is (under this view) entirely a transient one.

It is interesting to observe that two other studies have come to a similar conclusion with regard to wage changes in the United States during this period. Frank Brechling, in a paper read at the June 1966 meetings of the Canadian Political Science Association entitled, "Some Empirical Evidence of the Effectiveness of Price and Incomes Policies," comes to a similar conclusion with regard to his fitted wage adjustment equation for the United States. George Perry, in some unpublished notes, has employed his published wage adjustment relationship (which was discussed in Chapter 3 above) to predict U.S. wage changes during a period for which the guideposts policy was in force, from the first quarter of 1962 through the fourth quarter of 1965. The relationship overpredicts by increasing amounts (the residuals are generally negative, growing in absolute value over time), suggesting an increasingly stronger influence of the guideposts policy (at least over this period). Perry also has some supplementary evidence regarding wage bargains in "visible" versus "invisible" industries and regarding a reduced degree of dispersion of wage changes for two-digit industries during the guideposts period, both of which he views as confirming the hypothesis of the effectiveness of the guideposts policy.

Table 8.2

The Relationship between $\dot{W}_t^e$ and U_t^* for the Steady State Wage Adjustment Relationship at Various Values of the Profits, Price Change, and DUM.t Variables

Unemployment Rate (U_t^*) (Per Cent of Labour Force)	Annual Percentage Rate of Change of Wages ($\dot{W}_t^e$) for the Following Values of the Profits, Price Change, and DUM.t Explanatory Variables:							
	DUM.t = 0, $(Z/Q)^*$ = 113.33		DUM.t =51 $(Z/Q)^*$ = 113.33		$\dot{P}_t^*$ = 0, $(Z/Q)^*$ = 123.33		$\dot{P}_t^*$ = 0, $(Z/Q)^*$ = 103.33	
	($\dot{P}_t^*$ = 0)	($\dot{P}_t^*$ = 3)	($\dot{P}_t^*$ = 0)	($\dot{P}_t^*$ = 3)	(DUM.t = 0)	(DUM.t = 51)	(DUM.t = 0)	(DUM.t = 51)
2.5	5.98	6.42	5.09	5.53	6.39	5.51	5.56	4.68
3.0	5.05	5.49	4.16	4.60	5.46	4.57	4.63	3.75
4.0	4.12	4.56	3.23	3.67	4.53	3.65	3.71	2.82
5.0	3.69	4.13	2.80	3.24	4.10	3.22	3.28	2.39
6.0	3.46	3.90	2.57	3.01	3.87	2.98	3.04	2.16
7.0	3.32	3.76	2.43	2.87	3.73	2.84	2.90	2.02
8.0	3.23	3.67	2.34	2.78	3.64	2.75	2.81	1.92

Consider equation (8.1). By techniques similar to those employed in Chapter 6, one can calculate a steady state wage adjustment (indicated by the suffix "e", as before). Performing the computations, one obtains:

$$(8.1e)\ \dot{W}_t^e = -1.7654 + 0.04141\ (Z/Q)_t^* - 0.01739\ DUM \cdot t + 19.069\ (U_t^*)^{-2} + 0.1465\ \dot{P}_t^*\ .$$

Equation (8.1e) is represented in numerical form in Table 8.2 and in graphical form in Figures 8.1 and 8.2. It is clear from these representations that the rate of change of wages is most sensitive to variations in the rate of unemployment and to the shifting wage price environment, with variations in the rate of change of consumer prices and in the level of profit margins having only a secondary impact on wage changes.

Table 8.3

Price Change Equations (Regressions Explaining $\dot{P}_t$), United States, First Quarter 1953 through Fourth Quarter 1965

Equation Number	Constant Term	Coefficients of Explanatory Variables:					R^2	D.W.
		$\dot{W}_t$	$\dot{F}_t$	$\frac{1}{t}$	DUM	$\dot{P}_{t-1}$		
(8.5)	-0.44941	0.17807 [2.98]	–	–	–	0.85684 [11.89]	0.748	1.63
(8.6)	-0.51534	0.19810 [2.94]	0.04049 [1.31]	-0.13623 [0.226]	–	0.86830 [11.99]	0.760	1.76
(8.7)	-0.66682	0.21580 [3.41]	0.03773 [1.33]	–	0.19800 [1.13]	0.87728 [12.25]	0.766	1.81
(8.8)	-0.65576	0.20977 [3.30]	–	–	0.23881 [1.38]	0.86813 [12.08]	0.758	1.72
(8.9)	-0.50264	0.19122 [3.21]	0.04337 [1.55]	–	–	0.86958 [12.16]	0.760	1.74

ii. Price changes and trade-offs

The best price change regressions that we estimated for the period 1953-I through 1965-IV are shown in Table 8.3. Although a number of alternative explanatory variables were tried, none was statistically significant. The percentage rate of change of import prices generally had a small positive coefficient which was not statistically significant, reflecting the largely closed nature of the U.S. economy.[1] The time trend variables, t and $\frac{1}{t}$, were also never statistically significant. The DUM variable and DUM·t, when introduced into a regression like (8.5), had perverse (positive) coefficients, which were not, however, statistically significant.[2] Even if one interprets the dummy variable as measuring the effects of the CEA guideposts, this does not mean that the guideposts had

[1] This variable was defined as $\dot{F}_t = \frac{F_t - F_{t-4}}{F_{t-4}} \cdot 100$, where F_t is the import price index.

[2] In our estimates for Britain discussed below, DUM also had a positive direction of effect and was a statistically significant variable. Possible reasons for this result are considered in the section in which the estimates for Britain are reviewed.

STEADY STATE RELATIONSHIPS BETWEEN WAGE CHANGES AND THE RATE OF UNEMPLOYMENT, UNITED STATES, 1953-65, GROUP A

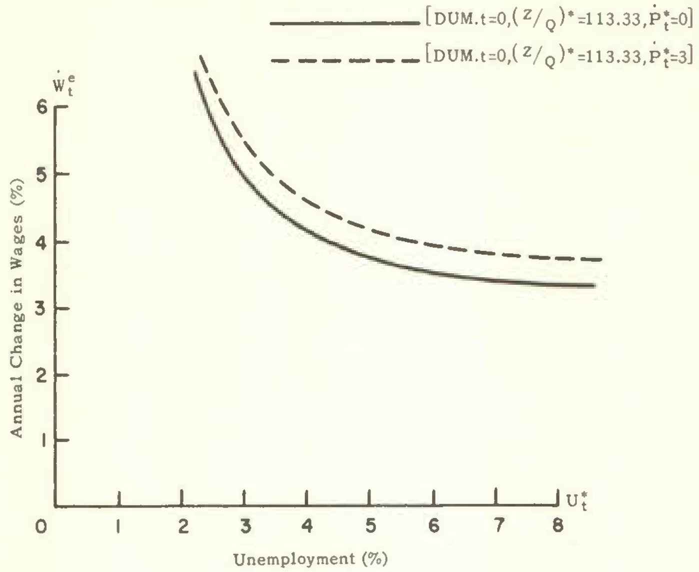
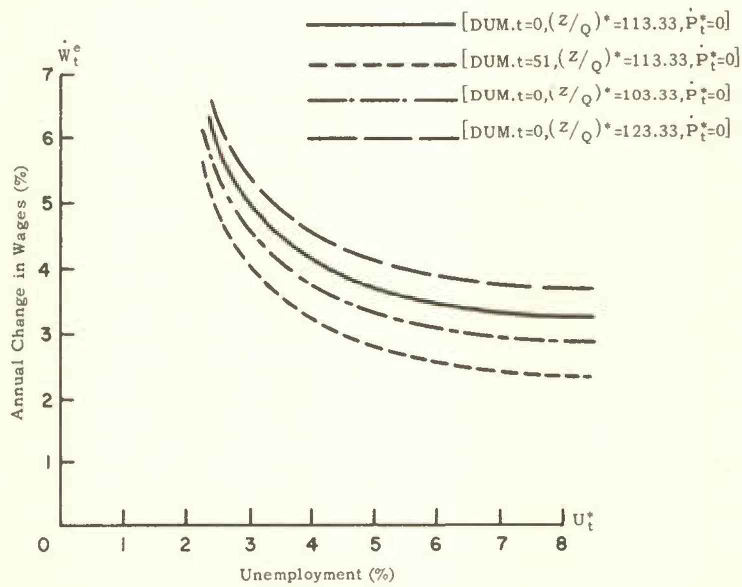


Figure 8.2

STEADY STATE RELATIONSHIPS BETWEEN WAGE CHANGES AND THE RATE OF UNEMPLOYMENT, UNITED STATES, 1953-65, GROUP B



no effect (or a perverse effect) on the rate of change of prices. Rather, it suggests that the major effects of the guideposts policies on the rate of change of prices are channeled through the wage adjustment relationship, instead of working on price formation (or profits) directly. If true, this factor might well explain the unpopularity of this policy with trade union leaders, particularly if the policy increased the property share and reduced the share of wages.

In the time available, it was not possible to develop a satisfactory demand variable for inclusion in our tests. From the work done in other studies, it appears that such a variable might considerably improve our estimate of the price change relationship. Such demand variables are included in estimated relationships for the United States made by Schultze and Tryon for inclusion in the Brookings model,[1] in the model published by the Office of Business Economics[2] and in the recent study by Frank Brechling.[3] It is also true, however, that demand variables did not perform well in our estimates for Canada. Moreover, both the Brookings study and the Office of Business Economics model explain the *level* of prices rather than the percentage rate of change in prices. In our experiments designed to explain the *level* of prices for Canada, some of the demand variables proved statistically significant; they were no longer significant when we attempted to use them to explain variations in the rate of change in prices. In any event, there is sufficient evidence to suggest that it would have been worth the effort to try a demand variable in our estimated price change relationship, had there been sufficient time to do so. One point that can be said in favour of our estimates, as shown in Table 8.3, is that the coefficients for the $\dot{W}_t$ and $\dot{P}_{t-1}$ variables appear to be very stable for the various estimates made.

The equilibrium form of equation (8.5) is:

$$\text{(8.5e)} \quad \dot{P}_t = -3.139 + 1.244\ \dot{W}_t\ .$$

If we substitute equation (8.1e) for $\dot{W}_t$ in equation (8.5e), we obtain the following trade-off relationship:

$$\text{(8.10)} \quad \dot{P}_t = -6.524 + 0.06299\ (^Z/Q)^* - 0.02645\ \text{DUM}\cdot t + 29.009\ (U_t^*)^{-2}\ .$$

As an alternative to this relationship, we have derived another relationship which is based on the simple Weintraubian mark-up equation discussed in Chapter 2. In terms of the notation of this Chapter, this mark-up relationship is as follows:

$$\text{(2.6)} \quad \dot{P}_t = \dot{W}_t - \dot{A}_t\ .$$

This relationship states that the percentage change in prices is equal to the difference between the percentage change in wages and that of productivity.

---

[1] *Op. cit.*

[2] *Op. cit.*

[3] *Op. cit.*

Accepting the estimate of productivity growth embodied in the CEA guideposts and substituting equation (8.1e) into equation (2.6), with $\dot{A}_t = 3.2$, we obtain the following relationship:

$$(8.11)\quad \dot{P}_t = -5.818 + 0.04852\,(Z/Q)^*_t - 0.02037\ \text{DUM}\cdot t + 22.342\,(U^*_t)^{-2}\ .$$

Some estimated trade-off curves derived from equation (8.10) are shown in Table 8.4 and Figure 8.3. Similar estimates derived from equation (8.11) are shown in Table 8.5 and Figure 8.4. In both sets of estimates, three assumptions have been made about unit profits: $(Z/Q)^*$ = mean value for the period; $(Z/Q)^*$ = 10 index points below the period mean value; $(Z/Q)^*_t$ = 10 index points above this mean value. The estimates are also shown for alternative assumptions regarding the value of the dummy variable: DUM=1 and DUM=0.

Table 8.4

Estimated Relationship between Price Changes and the Rate of Unemployment, Based on the Estimated Trade-Off Equation (8.10)

Unemployment Rate (U^*_t) (Per Cent of Labour Force)	Annual Percentage Rate of Change of Consumer Prices ($\dot{P}^c_t$), at Indicated Values of $(Z/Q)^*$ and DUM.t Variables:			
	$(Z/Q)^*$ = 113.33		$(Z/Q)^*$ = 123.33	$(Z/Q)^*$ = 103.33
	(DUM.t=0)	(DUM.t=51)	(DUM.t=0)	(DUM.t=0)
2.5........................	5.26	3.91	5.89	4.63
3.0........................	3.84	2.49	4.47	3.21
4.0........................	2.43	1.08	3.06	1.80
5.0........................	1.77	0.43	2.40	1.15
6.0........................	1.42	0.07	2.05	0.79
7.0........................	1.21	-0.14	1.84	0.58
8.0........................	1.07	-0.28	1.70	0.44
Rate of Unemployment (U^*_t) Associated with $\dot{P}_t$ = 0, under Given Circumstances:	None below 8%	6.29	None below 8%	None below 8%

Both sets of results suggest that the rate of price change in the United States is quite sensitive to the level of unemployment. It is estimated to be more sensitive on the basis of equation (8.10) than on the basis of equation (8.11). According to the former relationship, if one assumes mean unit profits and a zero value for DUM, there is no rate of unemployment below 8 per cent of the labour force at which the predicted change in prices is zero, and at a 3 per cent rate of unemployment, consumer prices may be expected to rise by 3.8 percent per year. According to the latter relationship, under the same assumptions, there is also no rate of unemployment below 8 per cent at which prices can be expected to be completely stable and the expected rate of rise of prices at a 3 per cent rate of unemployment is 2.2 per cent per year.

Both relationships are fairly insensitive to changes in unit profits, equation (8.11) being rather less sensitive even than equation (8.10). For equation (8.11) a 10-index-point reduction in profits results in a reduction in the predicted rate

Figure 8.3

TRADE-OFF CURVES, BASED ON ALTERNATIVE VALUES OF THE PROFITS AND DUMMY VARIABLES, FOR THE UNITED STATES, OVER THE PERIOD 1953-65, FROM EQUATION (8.10)

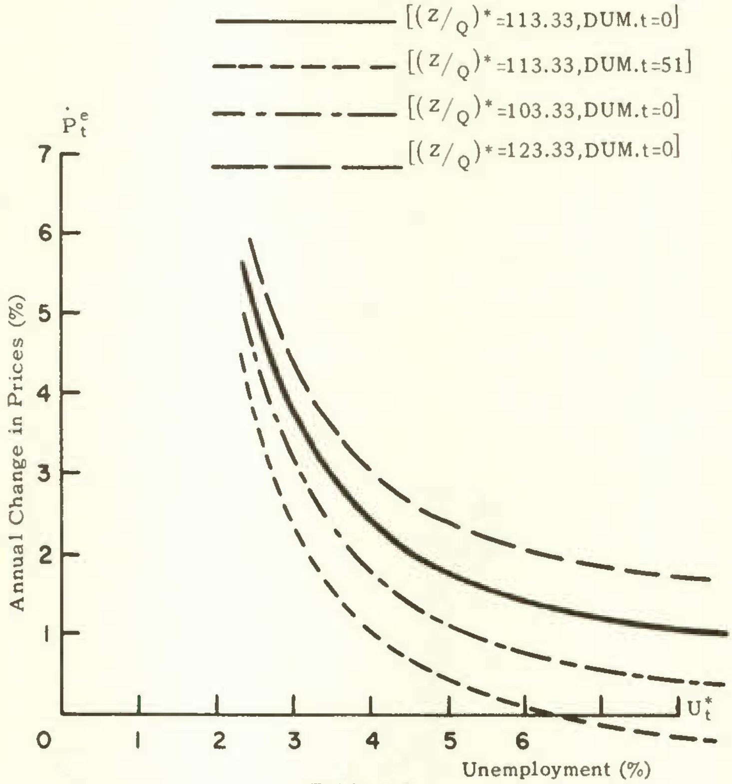


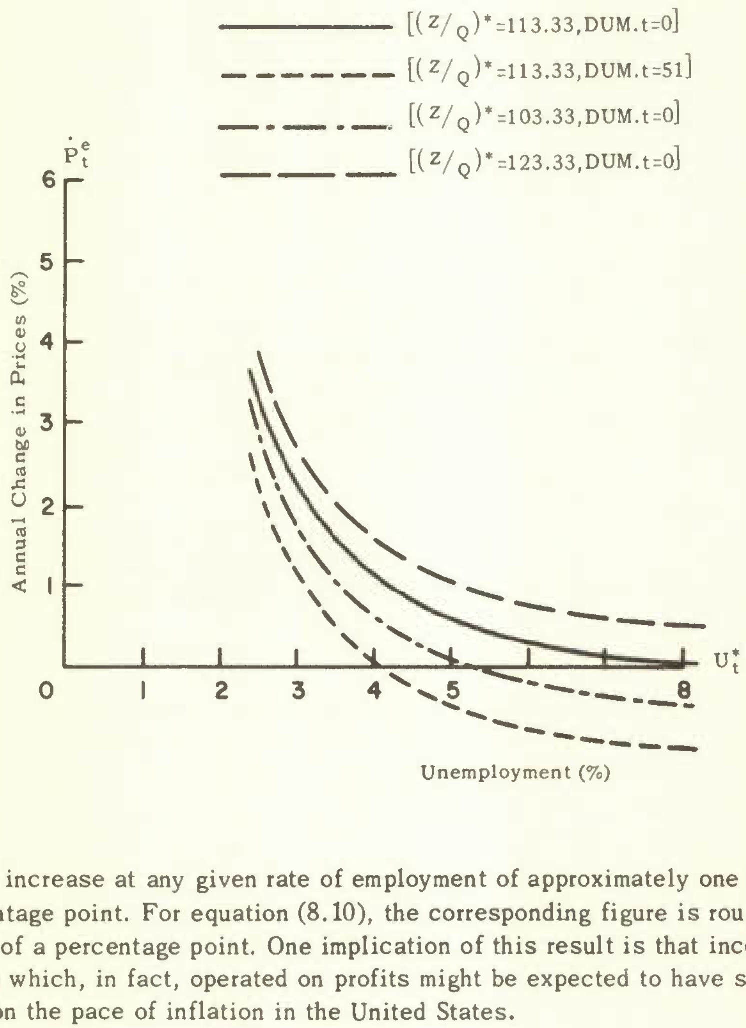
Table 8.5

Estimated Relationship between Price Changes and the Rate of Unemployment, Based on the Estimated Trade-off Equation (8.11)

Unemployment Rate (U_t^*) (Per Cent of Labour Force)	Annual Percentage Rate of Change of Consumer Prices ($\dot{P}_t^e$) at Indicated Values of $(Z/Q)^*$ and DUM.t Variables:			
	$(Z/Q)^* = 113.33$		$(Z/Q)^* = 123.33$	$(Z/Q)^* = 103.33$
	(DUM.t = 0)	(DUM.t = 51)	(DUM.t = 0)	(DUM.t = 0)
2.5	3.26	2.22	3.74	2.77
3.0	2.16	1.12	2.65	1.68
4.0	1.08	0.04	1.56	0.59
5.0	0.57	-0.46	1.06	0.09
6.0	0.30	-0.74	0.79	-0.18
7.0	0.14	-0.90	0.62	-0.35
8.0	0.03	-1.01	0.52	-0.46
Rate of Unemployment (U_t^*) Associated with $P_t = 0$, under Given Circumstances:	None below 8%	4.06	None below 8%	5.27

Figure 8.4

TRADE-OFF CURVES, BASED ON ALTERNATIVE VALUES OF THE PROFITS AND DUMMY VARIABLES, FOR THE UNITED STATES, OVER THE PERIOD 1953-65, FROM EQUATION (8.11)



of price increase at any given rate of employment of approximately one half of a percentage point. For equation (8.10), the corresponding figure is roughly five eighths of a percentage point. One implication of this result is that incomes policies which, in fact, operated on profits might be expected to have some modest impact on the pace of inflation in the United States.

Finally, there is the question of the sensitivity of the relationship to changes in the value of the DUM.t variable. If one assumes that unit profits are equal to their mean value for the sample period, a change in the value of DUM from 0 to 1 implies a downward shift in the trade-off curve. This estimated downward shift in the expected rate of change in the Consumer Price Index (at all rates of unemployment) is on the order of 1.3 percentage points per year for equation (8.10) and 1.0 percentage points per year for equation (8.11).

If one is willing to attribute the apparent shift in the relationship beginning in 1962 to the wage-price guidelines implemented at that time, one would conclude that these policies had, in fact, had a rather considerable effect in restraining the rate of increase in the U.S. consumer price level since that date. It has sometimes been suggested by advocates of these policies that these measures have served to restrain the rate of price increase in the United States by perhaps half a percentage point per year. On the basis of these results, one might argue that the evidence is consistent with the view that these policies have had a substantially larger effect than this. As has already been emphasized, however, the shift in the relationship beginning in 1962 may conceivably be explained by developments other than the advent of incomes policies. Moreover, even if the shift is really attributable to the guideposts policy, it is quite possible that these measures are merely temporary palliatives, serving only to postpone the unavoidable increases in wages and prices. We have made no attempt to examine these issues. Moreover, although a belief that they have had some effect is a necessary condition for favouring incomes policies, this is not a sufficient condition. The wide-ranging implications of incomes policies for the long-run growth of productivity, the equitable distribution of income and many other objectives of public policy should all be taken into account. Somewhat greater price stability can presumably be bought at too high a cost in terms of the other objectives of economic policy. But these questions lead well beyond the terms of reference for this study.

3. Britain

i. Wage changes

Our "best" estimates of the wage change relationship for Britain are shown in Table 8.6. Three of the variables ($\dot{W}_t$, $(U^*)^{-1}$, and $\dot{P}_t^*$) which enter these relationships are defined as before. DUM is a dummy variable with a value of zero from 1954 to the second quarter of 1961, a value of unity from the third quarter 1961 to the second quarter of 1962, a value of zero from the third quarter of 1962 to the third quarter of 1964, and a value of unity from the fourth quarter of 1964 to the fourth quarter of 1965. These dates, which were taken from the already-cited paper by Frank Brechling, coincide with the times at which incomes policies were applied and withdrawn in Britain.

Table 8.6

Wage Adjustment Equations (Regressions Explaining $\dot{W}_t$), Britain, 1954-I – 1965-IV

Equation Number	Constant Term	Coefficients of Explanatory Variables:				R^2	D.W.
		$\dot{P}_t^*$	$(U_t^*)^{-1}$	DUM	$\dot{W}_{t-4}$		
(8.12)	-1.0006	0.33055 [2.49]	10.758 [5.66]	-1.0338 [2.52]	–	0.644	1.62
(8.13)	-0.93751	0.38730 [2.79]	11.892 [5.73]	-1.2165 [2.83]	-0.15440 [1.31]	0.657	1.58

According to equation (8.12), 64 per cent of the variation in wage changes in Britain can be explained in terms of variations in consumer price changes, the reciprocal of the unemployment rate, and a dummy variable. This dummy variable allows for shifts in the relationship corresponding to the periods when incomes policies were applied and withdrawn. The coefficient of the dummy is negative and statistically significant in both regressions. This evidence, therefore, is consistent with the view that incomes policies have played a role in Britain in restraining the rate of increase in wages. If one attributes this shift in the relationship to incomes policies, then equation (8.12) suggests that these policies have reduced the percentage rate of increase in wages below what it otherwise would have been by 1.03 percentage points per annum.[1]

In the experiments from which these estimates emerged, $(U_t^*)^{-2}$, $\frac{1}{t}$, t , and DUM·t were tested as explanatory variables. The simple reciprocal form of the unemployment variable performed somewhat better than the reciprocal of the square of the unemployment rate. The coefficients for time (t) and the reciprocal of time were both insignificant, thus providing no evidence of a continuous shift in the wage change relationship over time. The DUM·t variable is simply the product of DUM , as defined above, and t representing time. DUM by itself allows for a discrete shift in the intercept whenever the value of DUM changes. DUM·t, on the other hand, allows for a continuous shift in the value of the intercept when DUM is equal to unity. The reason for including this variable, as already explained, was to allow for the possibility that the full impact of incomes policies may not have been felt at once but may have built up over time. On the basis of our tests, DUM by itself proved to be a much more significant explanatory variable than DUM·t . On this basis, one might say that our evidence is consistent with the view that incomes policies had their full effect almost immediately and that they did not tend to grab harder the longer that society was conditioned to their existence.

Table 8.7 and Figure 8.5 indicate the rates of wage increase at various levels of unemployment in 1965, as predicted by equation (8.12) under two assumptions about price stability. One assumption is that consumer prices remain unchanged; the second is that they rise at 3 per cent per year. A value of unity is also assumed for DUM · The range of observations on the rate of unemployment (not adjusted for seasonality) on which these estimates are based extend from a minimum unemployment rate of 1.4 per cent and a high of 5.0 per cent. During this period unemployment averaged 2.4 per cent. In Figure 8.5 , the curves are projected beyond the range of unemployment on which the estimates are based, as indicated by the dashed extensions of the curves. Such projections are necessarily open to considerable suspicion and are not likely to be very reliable.

[1] F. Brechling *(op. cit.*, p. 10) has estimates which indicate that, in 1961-62, incomes policies may have reduced the annual rate of increase in wages by one percentage point and, in the 1964-65 period, by roughly two percentage points. The earlier reservations with regard to these regression estimates are worth recalling at this point. In particular, these results are consistent with the possibility that these incomes policies merely postponed the occurrence of rapid wage increases to a later date, so that, over a moderately long period (say a decade or so), exactly the same amount of wage and price level rises would be experienced, regardless of whether an incomes policy was in force during part of this long period.

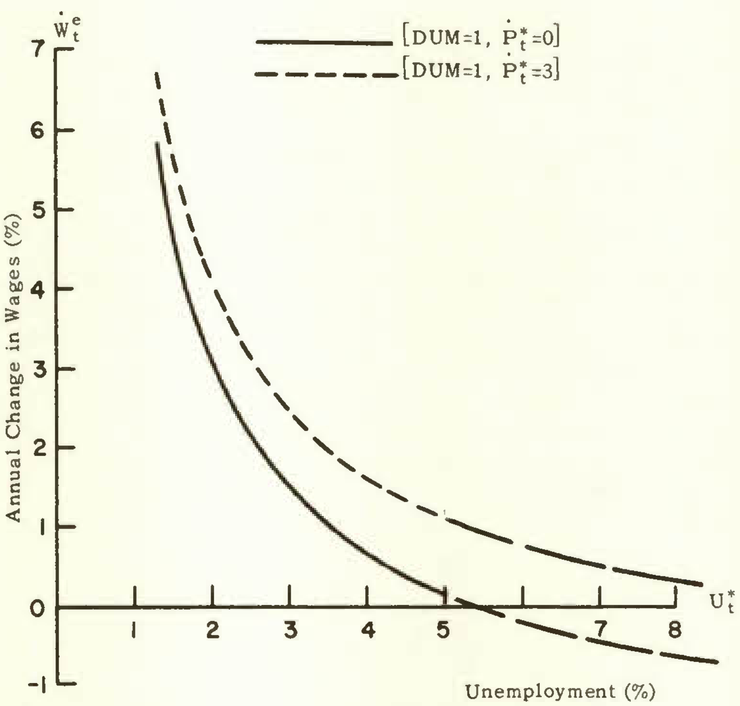
Table 8.7

The Relationship between Wage Changes ($\dot{W}_t$) and the Rate of Unemployment (U_t^*) for British Wage Adjustment Relationship (8.12) in 1965, at Various Rates of Change of Consumer Prices

Unemployment Rate (U_t^*) (Per Cent of Labour Force)	Annual Percentage Rate of Change of Wages ($\dot{W}_t$) Predicted by Equation (8.12), with DUM = 1 and: ($\dot{P}_t^*$ = 0)	($\dot{P}_t^*$ = 3)
1.4	5.65	6.64
2.0	3.34	4.34
2.5	2.27	3.26
3.0	1.55	2.54
4.0	0.65	1.65
5.0	0.12	1.11
6.0	−0.24	0.75
7.0	−0.50	0.49
8.0	−0.69	0.30

Figure 8.5

THE RELATIONSHIP BETWEEN WAGE CHANGES AND THE RATE OF UNEMPLOYMENT, BRITAIN, 1965



From Table 8.7 and Figure 8.5, it appears that British wages are highly sensitive to variations in the unemployment rate. At a 5 per cent rate of unemployment with unchanged consumer prices, wages are predicted to remain unchanged and at a 1.4 per cent level of unemployment they might be expected to increase at over 5 ½ per cent per year. With regard to the effect of price changes on wage changes, our estimates indicate that approximately one third of each percentage point increase in consumer prices becomes incorporated in the rate of increase in wages.

ii. Price changes and trade-offs

Our attempts to derive a reasonably satisfactory estimate of the price change relationship for Britain met with indifferent success. A variety of experiments were made and some of the more interesting results are shown in Table 8.8.

Lagged price changes and the DUM variable are statistically significant in every test reported in Table 8.8. Wage changes are significant in three of the tests reported. Surprisingly, the coefficients for import price changes, both in the current period and with a three-quarter lag, are consistently small and insignificant. This result must be regarded as highly suspect and seems more likely to suggest that the data or our procedures are inadequate than that British prices are not significantly influenced by foreign prices.

Table 8.8

Price Change Equations (Regressions Explaining $\dot{P}_t$), Britain, 1954–I – 1965–IV

Equation Number	Constant Term	Coefficient of Explanatory Variables:					R^2	D.W.
		$\dot{W}_t$	$\dot{F}_t$	$\dot{F}_{t-3}$	DUM	$\dot{P}_{t-1}$		
(8.14)	0.60991	0.15546 [1.25]	–	0.05861 [1.28]	–	0.59479 [5.06]	0.542	1.94
(8.15)	0.24081	0.28867 [2.39]	–	0.04363 [1.04]	1.5118 [3.19]	0.42533 [3.56]	0.630	2.04
(8.16)	0.38631	0.19212 [1.51]	-0.00114 [0.02]	–	–	0.60990 [5.12]	0.525	2.03
(8.17)	0.80589	0.51162 [3.69]	-0.00659 [0.10]	–	–	–	0.243	1.01
(8.18)	0.38886	0.19145 [1.57]	–	–	–	0.60996 [5.18]	0.525	2.02
(8.19)	0.97248	–	0.01799 [0.35]	–	–	0.69786 [6.62]	0.501	2.03
(8.20)	1.10151	–	–	0.07145 [1.59]	–	0.66251 [6.13]	0.526	1.95
(8.21)	0.34700	0.52185 [4.57]	–	0.04953 [1.05]	2.2628 [4.74]	–	0.521	1.41

Perhaps equally surprisingly, our results, though attesting to the significance of the dummy variable, show a positive coefficient for DUM. If this variable is assumed to reflect the impact of incomes policies, these results suggest that incomes policies have stepped up the rate of price increase, at given rates of increase of wages and import prices and for given lagged price changes. This is the exact opposite of the effect which such policies are expected to have. One possible rationalization of this result, but one that seems somewhat questionable, is that when the Government applied incomes policies, these policies were applied in the first instance mainly to wages; and producers immediately raised their prices in anticipation of the subsequent extension of incomes policies to product markets. If this is actually what happened, our evidence suggests that the real criticism of incomes policy in Britain is not that it was ineffective but that it was perverse. A second possible reason for this apparent perverse effect of incomes policies, and one that also is somewhat questionable, is that incomes policies had a perverse effect on short-term productivity growth. A third, and perhaps the most plausible, explanation of our result is that incomes policies were imposed in response to sharply rising prices and tended to be relaxed when the pressure on prices was reduced. In other words, rising prices may have been a determinant of incomes policy, rather than incomes policies being a determinant of price changes, as implied by the form of the estimated relationship.

A further puzzle arising from all these estimates is the positive and sizeable coefficient for the constant term. This suggests that, even if wages and import prices had remained constant, prices might have been expected to rise appreciably. Under these circumstances, one would think that even the small rise in annual productivity experienced in Britain since 1953 would have sufficed, at the least, to hold price changes to zero and might even have resulted in small price reductions.

None of our price change relationships warrant much confidence as a basis for calculating trade-off relationships. However, in order to give some idea of the outcome of combining our estimated wage adjustment relationship with the price change equations, three sets of trade-off curves are presented in Table 8.9 and Figure 8.6. These assume either no change in import prices or an increase in import prices of 2 per cent per year and that DUM is equal either to zero or to unity. These estimates are based on the steady state relationship for equation (8.15), which is then combined with (8.12) to form equation (8.22). The results are:

$$(8.15e) \qquad \dot{P}_t^e = 0.41904 + 0.50232\,\dot{W}_t + 2.6307\,DUM + 0.07592\,\dot{F}_{t-3}\ .$$

$$(8.22) \qquad \dot{P}_t^e = -0.10023 + 0.09104\,\dot{F}_{t-3} + 2.5318\,DUM + 6.4796\,(U_t^*)^{-1}\ .$$

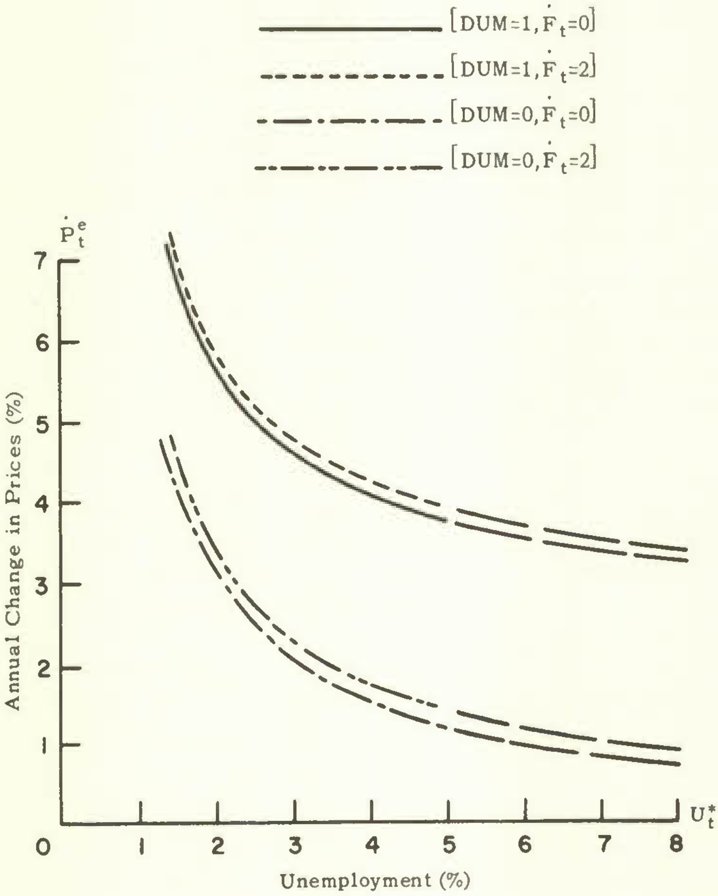
Our failure to estimate a satisfactory price change relationship for Britain may reflect a wide variety of factors.[1] It suggests that a more careful and detailed

[1] Frank Brechling (*op. cit.*, pp. 10-14) reports two price change equations estimated in log-linear form. These equations explain the change in the implicit GNP deflator in terms of a demand variable, import prices and seasonal variables. These equations also exhibit several curious characteristics. For example, the demand variable in Brechling's equation (7) has a negative sign, implying that rising demand gives rise to falling prices (which Brechling attempts to explain, unconvincingly in our view, in terms of lags over the cycle). One also finds a peculiar lag structure for the effect of import price changes, implying that import price changes four quarters earlier affect price changes, while import price changes in the intervening quarters do not (see his equation (8)).

analysis is required than has been feasible for this study. Our results, or lack thereof, may also be indicative of the basic difficulties which have beset the British economy during the post-war period and the inability of anyone to identify very satisfactorily the sources of these difficulties, let alone to suggest methods of coping with them.

Figure 8.6

FOUR TRADE-OFF CURVES FOR BRITAIN, BASED ON DATA FOR THE PERIOD 1954-65



In order to arrive at more satisfactory estimates of the trade-off relationship, an attempt was made to combine our estimated wage adjustment relationship with a price change relationship estimated by L.A. Dicks-Mireaux.[1] The Dicks-Mireaux relationship is as follows:

(8.23) $$\dot{P}'_t = 1.95 + 0.35\,\dot{W}'_t + 0.20\,\dot{F}'_t - 0.52\,(\dot{A})'_t \quad , \quad R^2 = .952 ,$$

[1] L.A. Dicks-Mireaux, "The Interrelationship Between Cost and Price Changes, 1946-59: A Study of Inflation in Postwar Britain," *op. cit.*

Table 8.9

Estimated Trade-Off Curves for the British Economy, Based on Trade-Off Relationship (8.22)

Unemployment Rate (U_t^*) (Per Cent of Labour Force)	Annual Percentage Rate of Change of Consumer Prices ($\dot{P}_t^e$), at Various Values of the Dummy Variable and the Rate of Change of Import Prices:			
	DUM = 1		DUM = 0	
	($\dot{F}_t$ = 0)	($\dot{F}_t$ = 2)	($\dot{F}_t$ = 2)	($\dot{F}_t$ = 0)
1.4	7.06	7.24	4.71	4.53
2.0	5.67	5.85	3.32	3.14
2.5	5.02	5.21	2.67	2.49
3.0	4.59	4.77	2.24	2.06
4.0	4.05	4.23	1.70	1.52
5.0	3.73	3.91	1.38	1.20
6.0	3.51	3.69	1.16	0.98
7.0	3.36	3.54	1.01	0.83
8.0	3.24	3.42	0.89	0.71
Unemployment Rate (U_t^*) Associated with $\dot{P}_t$ = 0, under Given Conditions:	None below 8%	None below 8%	None below 8%	None below 8%

where

$\dot{P}'_t$ = final prices (at factor cost): annual percentage change between 12-month averages;

$\dot{W}'_t$ = average wages and salaries per person employed: annual percentage change between 12-month averages;

$\dot{F}'_t$ = import prices: annual percentage change between 12-month averages, with a 3-month lag implicitly built in; and

$(\dot{A})'_t$ = output per man: annual percentage change between 12-month averages.

This relationship was fitted to annual data for the period 1946 to 1959, which differs substantially from the sample period for our wage adjustment relationship. Moreover, the variables entering equation (8.23) are defined somewhat differently from those entering our wage change relationship, though there is a considerable similarity. In any event, when equation (8.12) is substituted into equation (8.23), one obtains the following trade-off relationship:

$$(8.24) \qquad \dot{P}_t = 1.81 + 4.26\,(U_t^*)^{-1} - 0.41\,\text{DUM} + 0.23\,\dot{F}'_t - 0.59\,(\dot{A})'_t\ .$$

Trade-off curves derived from this relationship are shown in Table 8.10 and Figure 8.7. Two assumptions are made about the rate of change of import prices ($\dot{F}'$= 0 and $\dot{F}'$= 2.0) and about DUM (DUM=0 and DUM=1). $\dot{A}'_t$ is assumed to be equal to the average value for this variable from 1953 to 1959, which is 1.98 per cent per annum.

It will be observed that the estimates derived from equation (8.24) are rather similar to the estimates derived from equation (8.22) when DUM is set equal to zero. The big difference between the two relationships arises from the role played by the dummy variable in the estimated price change equation (8.15). As already suggested, the coefficient of the dummy variable in equation (8.15) seems questionable and accordingly the estimates of the trade-off curve based on equation (8.22) with DUM=1 should be given little weight.

Table 8.10

Estimated Trade-Off Curves for the British Economy, Based on Trade-Off Relationship (8.24)

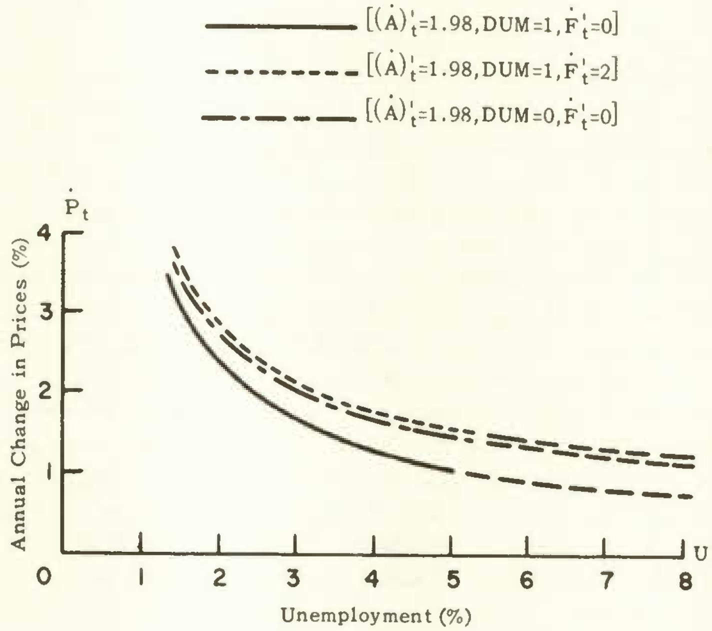
Unemployment Rate (U_t^*) (Per Cent of Labour Force)	Annual Percentage Rate of Change of Consumer Prices ($\dot{P}_t$) at the Given Rate of Productivity Growth and Various Values of the Dummy Variable and the Rate of Change of Import Prices:		
	DUM = 1 and $\dot{F}'_t = 0$	DUM = 1 and $\dot{F}'_t = 2$	DUM = 0 and $\dot{F}'_t = 0$
1.4	3.27	3.73	3.68
2.0	2.36	2.82	2.77
2.5	1.94	2.40	2.35
3.0	1.65	2.11	2.06
4.0	1.30	1.76	1.71
5.0	1.08	1.54	1.49
6.0	0.94	1.40	1.35
7.0	0.84	1.30	1.25
8.0	0.76	1.22	1.17
Unemployment Rate (U_t^*) Associated with $\dot{P}_t = 0$, under Given Conditions:	None below 8%	None below 8%	None below 8%

With regard to these hybrid trade-off curves, interesting points appear. First, there seems to be no rate of unemployment in Britain within the realm of recent experience or slightly beyond, which might be expected to achieve complete stability of the price level. When the unemployment rate is 2½ per cent, which is close to the average for the sample period, and when one assumes a zero change in import prices and DUM=0, an annual rate of price change equal to roughly 2½ per cent per year is implied by both trade-off relationships. Secondly, contrary to a commonly held view, the rate of change in domestic prices in Britain does not appear to be very sensitive to changes in import prices. An additional one percentage point increase in import prices, according to equation (8.24), results in a further increase in domestic prices of roughly one quarter of a percentage point beyond the rise which would have occurred in any event.

According to Figure 8.7, the shifts in the relationship associated with the dummy variable imply that, at a given rate of unemployment, the predicted rate of increase in consumer prices was roughly half a percentage point less than it would otherwise have been. If these shifts are associated with the adoption of incomes policies, the implication, in this case, is that they succeeded in restraining the rate of increase in the consumer price level by approximately half a percentage point per year.

Figure 8.7

THREE TRADE-OFF CURVES FOR BRITAIN, BASED ON POST-WAR DATA



4. **France**

i. Wage changes

The "best" estimates of the wage adjustment relationship for France are shown in Table 8.11. In this Table, the variables have the usual definitions except for the dummy variable, which is dated in relation to the implementation of incomes policies in France.

All the explanatory variables included in equations (8.25) and (8.26) are statistically significant by conventional standards, although the presence of autocorrelated residuals (indicated by the very low values of the Durbin-Watson statistic) would lead one to take these tests of significance with a certain degree of scepticism. According to these regressions, slightly less than 40 per cent of the variation in the rate of change in French wages can be explained by variations in the reciprocal of the square of the unemployment rate, the reciprocal of time, lagged wage changes and either a dummy variable by itself or an interaction variable in which this dummy is multiplied by the time trend.

Table 8.11

Wage Adjustment Equations (Regressions Explaining $\dot{W}_t$), France, 1954-I – 1965-IV

Equation Number	Constant Term	Coefficients of Explanatory Variables:					R^2	D.W.
		$(U_t^*)^{-2}$	$\frac{1}{t}$	DUM	DUM.t	$\dot{W}_{t-4}$		
(8.25)	11.073	13.561 [2.87]	−31.309 [3.25]	–	−0.5623 [3.55]	−0.40365 [2.75]	0.387	0.42
(8.26)	10.945	13.598 [2.85]	−30.569 [3.15]	−2.6005 [3.38]	–	−0.39542 [2.671]	0.375	0.42

The difference between equations (8.25) and (8.26) is in the form of the dummy variable: the form of the dummy in equation (8.26) allows for a once-and-for-all change in the intercept term at the beginning of the fourth quarter of 1963; the form of the interaction variable in equation (8.25) allows for a continuing shift over time in the intercept term, beginning at the fourth quarter of 1963.[1] In both cases, the dummy variable has been included to take account of the implementation of a fairly vigorous incomes policy in France, which commenced in September 1963.[2] The inclusion of the dummy variable by itself implies that these policy measures had their full impact immediately after their introduction; combining the dummy variable with the time trend implies that the effectiveness of this policy increased over time once the measures were put into effect. The t-ratio for the DUM.t variable is slightly higher than for the straight dummy variable and the coefficient of multiple determination is somewhat higher for equation (8.25) than for equation (8.26). Accordingly, equation (8.25) appears to have a slight edge over equation (8.26). In any event, equations (8.25) and (8.26) are both consistent with the view that the incomes policies adopted by France in 1963 had the effect of dampening down the rate of increase in wages, although the earlier reservations are also applicable here.

The negative sign for the coefficient of the reciprocal of time in these regressions implies that there has been an upward shift over time in the wage adjustment relationship for France but that this upward shift has occurred at a diminishing rate.

Other variables which were included in the experiments leading up to these estimates included $(U_t^*)^{-1}$, which did not perform quite as well as $(U_t^*)^{-2}$, as judged on the basis of the t-ratios. In addition, t, rather than the reciprocal of t, was tested and this variable proved to be insignificant. However, the most interesting variable which did not prove to be statistically significant is $\dot{P}_t^*$, the rate of change in the Consumer Price Index. The reasons for this result are not clear; it seems very doubtful that one can accept the conclusion that changes in French wages

[1] The dummy variable has a value of zero from 1953 to the third quarter of 1963 and a value of unity from the fourth quarter of 1963 to the fourth quarter of 1965. As before, the time trend variable was equal to 1 for the first quarter of 1953 and increased by 1 unit for each quarter elapsed after that date.

[2] For a review of these policy measures, see Smith, *op. cit.*, Chapter 9.

have not, in fact, been influenced by changes in consumer prices. We have some suspicions that this result may reflect the inadequacies of the French Consumer Price Index as a reasonably accurate indicator of actual changes in consumer prices: however, there has not been an opportunity to explore this possibility adequately.[1]

The steady state form of equation (8.25) is:

$$(8.25e) \qquad \dot{W}_t^e = 7.889 + 9.6610\,(U_t^*)^{-2} - 22.305\,\frac{1}{t} - 0.04006\ \text{DUM}\cdot t.$$

Table 8.12 and Figure 8.8 show estimates of the French wage-change-unemployment relationship at various levels of unemployment, for the fourth quarter of 1965. Within the range of observations from 1954 to 1965, the rate of wage increase was very sensitive to variations in the level of unemployment. During this period, the unemployment rate (not adjusted for seasonality) ranged from a low of 1.4 per cent to a high of 3.7 per cent and averaged 2.5 per cent, on the basis of North American definitions. If one projects the estimates beyond this range—which of course is a very risky procedure—it is evident that the rate of wage change becomes fairly insensitive to the level of unemployment. This projection is indicated in Figure 8.8 by the dashed portion of the curves.

Table 8.12

The Relationship between Annual Percentage Change of Wages ($\dot{W}_t^e$) and the Rate of Unemployment (U_t^*) for the Steady State Wage Adjustment Relationship for France, Fourth Quarter 1965

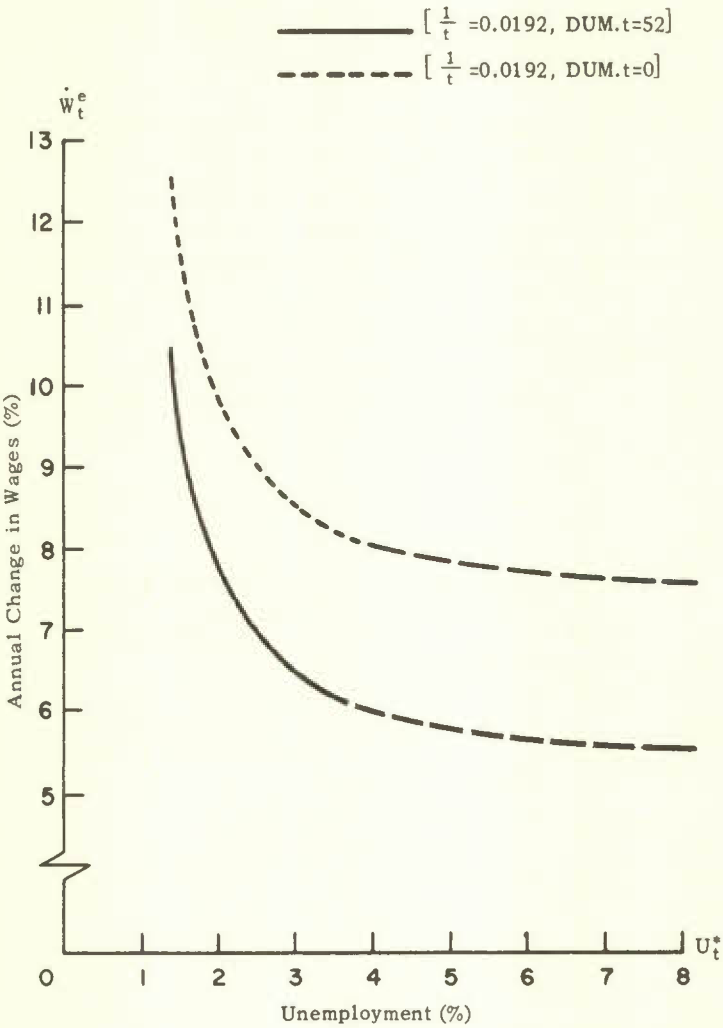
Unemployment Rate (U_t^*) (Per Cent of Labour Force)	Annual Percentage Rate of Change of Wages ($\dot{W}_t^e$) Predicted by Equation (8.25e) with:	
	$\frac{1}{t}$ = 0.0192 and DUM.t = 52	$\frac{1}{t}$ = 0.0192 and DUM.t = 0
1.4	10.31	12.39
2.0	7.79	9.88
2.5	6.92	9.01
3.0	6.45	8.53
4.0	5.98	8.06
5.0	5.76	7.85
6.0	5.65	7.73
7.0	5.57	7.66
8.0	5.53	7.61

[1] The presence of autocorrelated residuals and the relatively low coefficient of multiple determination suggest the possibility that one or more relevant explanatory variables have been omitted. A more appropriate measure of changes in French consumer prices might conceivably improve the relationship.

See also the discussion in Chapter 3 above on the French Consumer Price Index, in connection with the international comparability of consumer price level measures and also with the Klein-Bodkin result for France.

Figure 8.8

THE RELATIONSHIP BETWEEN WAGE CHANGES AND THE RATE OF UNEMPLOYMENT, FRANCE, FOURTH QUARTER 1965



ii. Price changes and trade-offs

The most satisfactory estimates which we have been able to derive for the French price change relationship are shown in Table 8.13. As the parameter estimates indicate, when lagged price changes are included as an explanatory variable, the coefficient on the wage change variable ceases to be statistically significant. When the steady state form of equation (8.27) is computed, the result is:

$$(8.27e) \qquad \dot{P}_t^e = -2.9709 + 0.69279\,\dot{W}_t + 0.61983\,\dot{F}_t\,.$$

It is interesting to observe that the steady state value of the coefficient of $\dot{W}_t$ in this equation is close to the value of the regression coefficient on $\dot{W}_t$ in equation (8.28).

Table 8.13

Price Change Equations (Regressions Explaining $\dot{P}_t$), France, 1954–I – 1965–IV

Equation Number	Constant Term	Coefficients of Explanatory Variables: $\dot{W}_t$	$\dot{F}_t$	$\dot{P}_{t-1}$	R^2	D.W.
(8.27)	−0.81280	0.18954 [1.22]	0.16958 [2.50]	0.72641 [8.78]	0.742	1.40
(8.28)	−2.74591	0.73780 [3.18]	0.28103 [2.57]	–	0.290	0.48
(8.29)	−0.54093	0.19404 [1.19]	–	0.76496 [8.91]	0.706	1.28
(8.30)	0.58291	–	0.17056 [2.50]	0.76729 [10.08]	0.733	1.40

On the basis of equation (8.27), our results suggest that approximately three quarters of the variation in the rate of change in French prices can be explained in terms of changes in French wages, import prices and lagged price changes. It may be remarked that even the introduction of the lagged dependent variable does not suffice to eliminate the apparent autocorrelation in the residuals, as judged by the Durbin-Watson test statistic. Other possible explanatory variables which were tested included time, the reciprocal of time, and a dummy variable in both the forms included in the wage equation. None of these variables was statistically significant.

In order to compute a trade-off relationship, equation (8.25e) was substituted for the $\dot{W}_t$ variable in equation (8.28) to yield equation (8.31):

$$(8.31) \quad \dot{P}_t = 3.07462 + 0.28103\ \dot{F}_t + 7.12791\ (U_t^*)^{-2} - 16.45675\ \frac{1}{t} - 0.02956\ \mathrm{DUM}\cdot t.$$

Estimates of the trade-off curve for the fourth quarter of 1965, derived from this relationship, are shown in Table 8.14 and Figure 8.9. These estimates are based on two alternative assumptions about the rate of change of import prices: $\dot{F}_t = 0$ and $\dot{F}_t = 2.0$.

As is evident from Figure 8.9, the rate of change of consumer prices in France appears sensitive to variations in the rate of unemployment, which reflects the sensitivity of wage changes to unemployment levels, in the range of our observations. At the same time, French prices do not seem particularly sensitive to changes in import prices: an additional one percentage point increase in import prices can apparently be expected to increase consumer prices by 0.28

of a percentage point above the increase that would have occurred in the absence of this rise.[1]

Table 8.14

Derived Trade-Off Curves Based on the Estimated Trade-Off Relationship (8.31), France, Fourth Quarter 1965

Unemployment Rate (U_t^*) (Per Cent of Labour Force)	Annual Percentage Rate of Change of Consumer Prices ($\dot{P}_t^e$), with:		
	DUM.t = 52, $\dot{F}_t = 0$, and $\frac{1}{t} = 0.0192$	DUM.t = 52, $\dot{F}_t = 2$, and $\frac{1}{t} = 0.0192$	DUM.t = 0, $\dot{F}_t = 0$, and $\frac{1}{t} = 0.0192$
1.4	4.86	5.42	6.40
2.0	3.00	3.57	4.54
2.5	2.36	2.92	3.90
3.0	2.01	2.58	3.55
4.0	1.67	2.23	3.20
5.0	1.51	2.07	3.04
6.0	1.42	1.98	2.96
7.0	1.37	1.93	2.90
8.0	1.33	1.89	2.87
Unemployment Rate (U_t^*) Associated with $\dot{P}_t = 0$, under Given Conditions:	None below 8%	None below 8%	None below 8%

If one is prepared to assume that the DUM.t variable reflects the effect of incomes policies, equation (8.31) implies that the immediate impact of these policies was to reduce the annual rate of change in consumer prices by 1.31 percentage points compared to how fast this index would have grown in the absence of the incomes policy and that, at the end of 1965, these policies reduced the rate of growth in prices by 1.54 percentage points per year.

Finally, at an average unemployment rate of 2.5 per cent of the labour force, which was the mean level of unemployment in France from 1953 to 1965, the rate of change in French consumer prices, predicted by the trade-off relationship under the assumptions of no incomes policy and stable foreign prices, is roughly 4 per cent per year. There would appear to be no rate of unemployment in France below 8 per cent which would secure a zero rate of change in consumer prices, even with the presence of incomes policy measures similar to those adopted recently.

5. West Germany

i. Wage changes

The "best" estimates of the German wage adjustment relationship which evolved from our tests are shown in Table 8.15. The variables are defined in the

[1] This conclusion is qualified by the observation that if the trade-off relationship had been based on the steady state price change equation (8.27e), the coefficient on import price changes would have been appreciably larger (0.62).

Figure 8.9

THREE TRADE-OFF CURVES FOR FRANCE, FOURTH QUARTER 1965

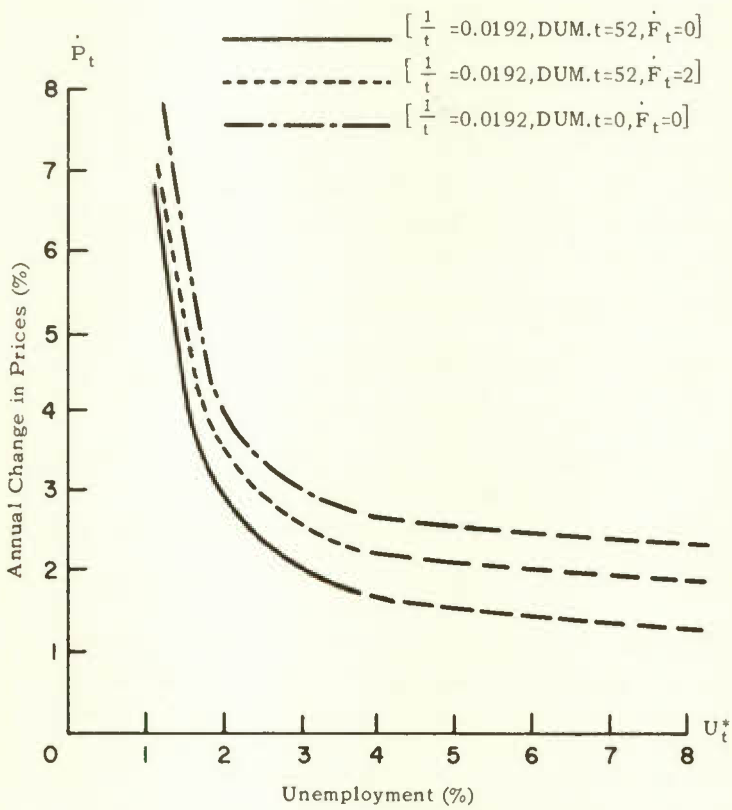


Table 8.15

Wage Adjustment Equations (Regressions Explaining $\dot{W}_t$), West Germany, 1954–I – 1965–II

Equation Number	Constant Term	Coefficients of Explanatory Variables: $(U_t^*)^{-1}$	$\dot{P}_t^*$	$\dot{W}_{t-4}$	$\frac{1}{t}$	DUM.t	R^2	D.W.
(8.32)	7.9927	2.1667 [2.65]	1.2324 [1.91]	-0.31937 [2.10]	-27.871 [2.64]	-0.08237 [2.51]	0.494	1.17
(8.33)	6.3966	1.5224 [3.04]	0.30382 [0.44]	-0.09788 [0.59]	–	–	0.278	0.72
(8.34)	6.0900	1.4710 [3.01]	0.11670 [0.19]	–	–	–	0.272	0.75

usual manner. DUM.t is the product of time and a dummy variable with a value equal to zero from 1953 to 1961 and a value of unity from 1962 onwards. The rationale for including a dummy variable for West Germany, which has not adopted an incomes policy, is outlined below.

The reciprocal of the unemployment rate is a statistically significant variable, by conventional criteria, for all parameter estimates presented in Table 8.15. The rate of change in the Consumer Price Index falls short of being significant in equation (8.32)[1] and is highly insignificant in the other estimates. In equation (8.32), lagged wage changes, the reciprocal of time and DUM.t were substituted separately and in combination. When the $\frac{1}{t}$ and DUM.t variables were included in equation (8.32) separately, the coefficients of $\dot{P}_t$ and $\dot{W}_{t-4}$ ceased to be significant. Several experiments were made with $(U_t^*)^{-2}$ instead of $(U_t^*)^{-1}$ as the unemployment variable. The values of the t-ratios and the coefficients of multiple determination suggested that the formulation in terms of $(U_t^*)^{-1}$ is the preferable one.

The steady state form of equation (8.32) is as follows:

$$(8.32e)\quad \dot{W}_t^e = 6.05797 + 1.64223\,(U_t^*)^{-1} + 0.93407\,\dot{P}_t^* - 21.12444\,\frac{1}{t} - 0.06243\ \mathrm{DUM{\cdot}t}.$$

The relationship between wage changes and the rate of unemployment, during the second quarter of 1965, is shown in Table 8.16 and Figure 8.10. These estimates are based on two alternative assumptions about consumer price changes: $\dot{P}_t^* = 0$ and $\dot{P}_t^* = 3.0$.

Although equation (8.32) may be regarded as a tolerable relationship from a technical standpoint, it is somewhat puzzling as an explanation of German wage changes for several reasons. One reason is the significant importance of DUM.t. This variable, along with the straight dummy variable by itself, was included in our experiments to test for any evidence of a significant shift in the intercept term after 1962. Around this time, France, Britain and the United States embarked on incomes policies of various kinds, as already noted. Our tests for any evidence of the effectiveness of these policies have consisted mainly of attempts to see whether there is any evidence of a shift, at roughly the same point in time, in the wage change and price change relationships. Even if one finds significant evidence of such a shift, it does not follow that this shift necessarily reflects the influence of incomes policies. A variety of other factors could presumably explain the shift. Some of these other factors might be international in scope, influencing several countries in much the same way. If so, one might expect the influence of these factors to be apparent in countries which had not adopted incomes policies as well as those that had. And if, in fact, one found this to be the case, one might have serious doubts about attributing to incomes policies the shift in the price change and wage adjustment relationships in countries which

[1] By standard tests, $\dot{P}_t^*$ is a significant variable, if one employs a less rigorous one-tailed test. However, the presence of autocorrelated residuals (as indicated by the low value of the Durbin-Watson statistic) suggests the level of statistical significance is likely to be overstated by the t-ratios.

had adopted such policies. Such an indirect test is, of course, subject to many serious qualifications and, at best, can only be suggestive for further research. In the German case there was in fact one special influence, which may account for the apparent shift, in which case the above ambiguity would be mitigated. The appreciation of the Deutsche mark (in 1961) reduced the cost of imports, and thus probably eased demand for domestic output and reduced pressures on domestic prices and wages. Thus, the German wage and price structure may have shifted due to a factor specific to Germany and unrelated to incomes policy.[1]

The negative sign of the coefficient of the reciprocal of time in equation (8.32) implies an upward shift over time at a diminishing rate in the wage change relationship. This is similar to our results for France.

In addition, as is evident from Table 8.16 and Figure 8.10, the wage adjustment relationship estimated for Germany implies a very flat wage-change-unemployment curve at unemployment rates greater than 3 per cent. In other words, beyond a 3 per cent rate, variations in the level of unemployment have very little effect on the rate of wage change. Moreover, more rapid changes in consumer prices induce an additional increase in wages of 0.93 of a percentage point per year, at given values of other influences affecting wage changes. It would, of course, be a mistake to make too much of these results without exposing them to much more extensive tests than we have been able to undertake. It seems evident that the German labour market exhibits certain peculiarities, which have important implications and which have not been fully explored here.

Table 8.16

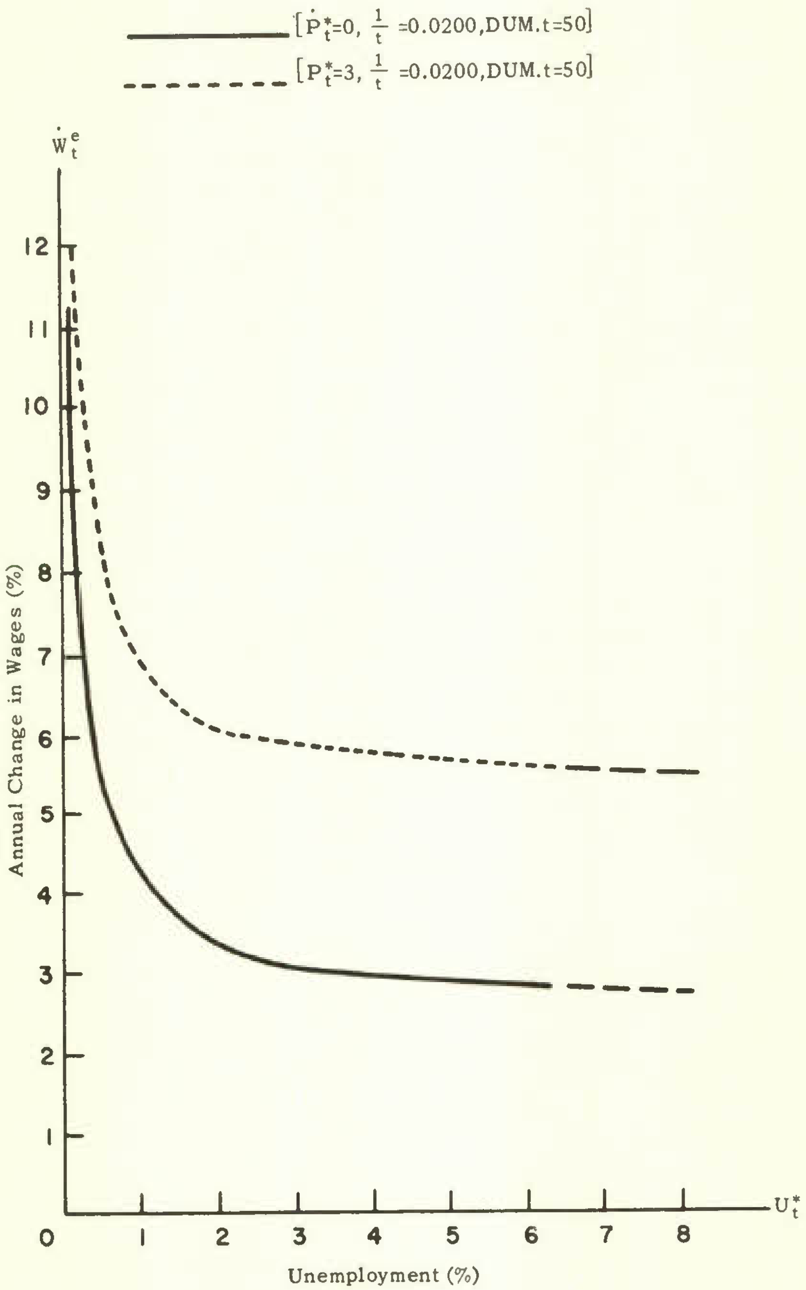
The Relationship between Wage Changes ($\dot{W}_t^e$) and the Rate of Unemployment (U_t^*) Derived from the Steady State Wage Adjustment Relationship for West Germany, Second Quarter 1965

Unemployment Rate (U_t^*) (Per Cent of Labour Force)	Annual Percentage Rate of Change of Wages ($\dot{W}_t^e$) Estimated from Equation (8.32e) with $\frac{1}{t}$ = 0.0200, DUM.t = 50, and: $\dot{P}_t^* = 0$	$\dot{P}_t^* = 3$
0.2	10.73	13.53
1.0	4.16	6.96
2.0	3.34	6.14
3.0	3.06	5.86
4.0	2.92	5.73
5.0	2.84	5.64
6.0	2.79	5.59
7.0	2.75	5.55
8.0	2.72	5.52

[1] Presumably, such price and income effects could be captured in the unemployment and price change variables of the fitted wage adjustment equation. However, these variables may not fully account for all of the ramifications of an extraordinary event such as a shift in the exchange rate.

Figure 8.10

THE RELATIONSHIP BETWEEN WAGE CHANGES AND THE RATE OF UNEMPLOYMENT, WEST GERMANY, SECOND QUARTER 1965



One factor which, in all likelihood, has had a considerable influence on wage changes during the sample period has been the large and variable influx of labour into the industrial occupations from Eastern and Southern Europe and from rural areas within Germany. Because of this, a wage adjustment type of analysis may not be very applicable to West Germany. An underlying assumption of this type of analysis is that the rate of unemployment is a reasonable indicator of variations in the level of excess demand for labour. If, however, variations in the level of demand are reflected in the labour market mainly through variations in the rate of inflow of industrial workers rather than in the rate of unemployment, the unemployment rate may prove very inadequate as an indicator of variations in the demand for labour. As a consequence, one may find that unemployment has only a minor effect on wage changes except at extremely low or high levels of unemployment. This view of the German labour market would be consistent with our empirical results, which do in fact indicate that, except for very low levels of unemployment, German wage changes are quite insensitive to variations in the unemployment rate. Moreover, the relatively rapid rate of wage increase irrespective of the unemployment level may simply reflect the rapid rate of increase in industrial wages normally required to provide the economic incentive for the inflow of industrial workers necessary to sustain the rapid growth which the German economy experienced during this period. These, and other questions on this subject, remain to be answered.

Finally, it should also be recognized that the average rate of unemployment in Germany since 1954 has consistently been very low, and that for the most part the economy has been operating at levels of unemployment which are in the ranges of the curves shown in Figure 8.10 which slope upward quite steeply. On the basis of North American definition, the average level of unemployment from 1954 to 1965 was 1.9 per cent and the individual quarterly rates ranged from a high of 6.4 per cent to a low of 0.2 per cent–a rate of "full employment" which is considered inconceivable for North America by virtually all economists and was not attained in North America even during the tightest labour market conditions of World War II. In addition to suggesting quite different labour market conditions between Germany and North America, these figures may also emphasize again the differences in the statistics on unemployment in North America and Europe and the inadequacies of the methods which have been employed to derive unemployment figures on a consistent basis.

ii. Price changes and trade-offs

Table 8.17 reports the "best" estimates of the price change relationship for Germany. Lagged price changes are significant in each relationship shown.[1] Wage changes and import price changes are significant in equations which they enter separately with $\dot{P}_{t-1}$, but are not significant when both are included in the relationship with $\dot{P}_{t-1}$. When $\dot{P}_{t-1}$ is omitted and $\dot{W}_t$ and $\dot{F}_t$ are the only explanatory variables, $\dot{W}_t$ is significant and $\dot{F}_t$ is not. These results are not considered to be particularly

[1] It is interesting to observe also how the introduction of lagged price changes reduces the apparent autocorrelation of the residuals; as pointed out earlier, this test statistic lacks power in this situation. For equation (8.36), the residuals are significantly autocorrelated at the 5 per cent level, although they are barely not significantly autocorrelated at the 1 per cent level, according to the Theil-Nagar tables.

satisfactory—an impression which is enhanced by the low value of R^2 for all of the regressions computed.

Table 8.17

Price Change Equations (Regressions Explaining $\dot{P}_t$), West Germany, 1954-I – 1965-II

Equation Number	Constant Term	Coefficients of Explanatory Variables:			R^2	D.W.
		$\dot{W}_t$	$\dot{F}_t$	$\dot{P}_{t-1}$		
(8.35)	0.47110	0.11325 [1.97]	–	0.34878 [2.54]	0.256	1.97
(8.36)	0.99940	0.14513 [2.49]	0.05831 [1.30]	–	0.180	1.44
(8.37)	0.67928	0.8601 [1.48]	0.07499 [1.78]	0.38269 [2.82]	0.306	2.10
(8.38)	1.23521	–	0.09137 [2.22]	0.45491 [3.55]	0.271	2.00

In arriving at these results, a variety of other variables were tested. These included t, $\frac{1}{t}$, DUM, and DUM.t, all of which have already been defined. None of these was statistically significant at the 5 per cent level of confidence.

For our purposes we focus mainly on equations (8.35) and (8.37), the steady state forms of which are as follows:

$$(8.35e) \quad \dot{P}_t^e = 0.72341 + 0.17390\ \dot{W}_t\ .$$

$$(8.37e) \quad \dot{P}_t^e = 1.10039 + 0.13933\ \dot{W}_t + 0.12148\ \dot{F}_t\ .$$

The small coefficients of $\dot{W}_t$ and $\dot{F}_t$ in these equations indicate a low sensitivity of German price changes to wage and import price changes. According to the figures, an additional one percentage point increase in wages will raise consumer prices by only 0.14 to 0.17 of a percentage point, in addition to the change which would have occurred anyway; and the corresponding effect of an additional one percentage point change in import prices is 0.12 of a percentage point. Moreover, according to these estimates, if German wages and import prices remained unchanged, German consumer prices could be expected to rise by 0.72 to 1.1 percentage points per year.

The trade-off relationships derived from the estimated wage change and price change equations are as follows:

$$(8.39) \quad \dot{P}_t^e = 2.12148 + 0.34096\ (U_t^*)^{-1} - 4.38595\ \frac{1}{t} - 0.01297\ \text{DUM}\cdot t.$$

$$(8.40) \quad \dot{P}_t^e = 2.23536 + 0.13965\ \dot{F}_t + 0.26304\ (U_t^*)^{-1} - 3.38361\ \frac{1}{t} - 0.0100\ \text{DUM}\cdot t.$$

Table 8.18 and Figure 8.11 show the trade-off curves calculated from these relationships for the second quarter of 1965. In the calculations for equation (8.40), two alternative assumptions have been made about the rate of change in import prices: $\dot{F}_t = 0$ and $\dot{F}_t = 2.0$.

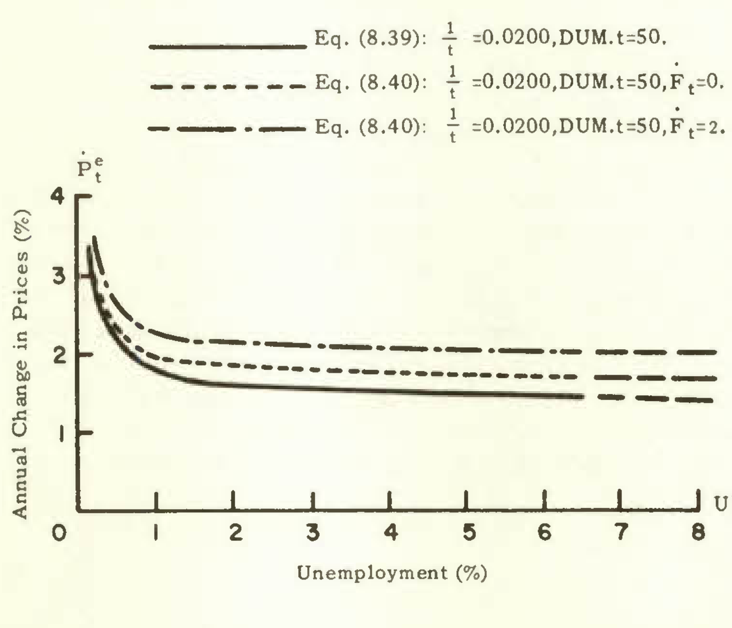
Table 8.18

Trade-Off Curves Derived from Estimated Trade-Off Relationship for West Germany, Second Quarter 1965

Unemployment Rate (U_t^*) (Per Cent of Labour Force)	Annual Rate of Change of Consumer Prices ($\dot{P}_t^e$) with $\frac{1}{t} = .0200$ and DUM.t = 50 and, where appropriate, $\dot{F}_t = 0$ or $\dot{F}_t = 2$: Equation (8.39)	Equation (8.40) ($\dot{F}_t = 0$)	Equations (8.40) ($\dot{F}_t = 2$)
0.2	3.09	2.98	3.26
1.0	1.73	1.93	2.21
2.0	1.56	1.80	2.08
3.0	1.50	1.76	2.03
4.0	1.47	1.73	2.01
5.0	1.45	1.72	2.00
6.0	1.44	1.71	1.99
7.0	1.43	1.71	1.98
8.0	1.43	1.70	1.98
U_t^* Associated with $\dot{P}_t = 0$, for the Particular Trade-Off Curve:	None below 8%	None below 8%	None below 8%

Figure 8.11

THREE TRADE-OFF CURVES FOR WEST GERMANY, SECOND QUARTER 1965



As is apparent from Figure 8.11, the differences in the trade-off curves derived from equation (8.39) and equation (8.40) are very slight. Whichever estimate is used, German price changes appear to be highly insensitive to unemployment rates above 1 per cent. Even at an unemployment rate of 0.2 per cent, the annual rate of price increase is only about 1¼ to 1½ percentage points more than when unemployment is 2.0 per cent. The estimates suggest that, at unemployment rates above 2.0 per cent, German consumer prices can be expected to rise at roughly 1½ to 2 per cent annually irrespective of the rate of unemployment. The trade-off curve for Germany, more clearly than the curve for any other country considered in this survey, approximates the curve that one would associate with a situation in which price increases arise largely from cost-push factors, rather than from demand-pull forces, as outlined in Chapter 2.

These results must be viewed with considerable scepticism. As already noted, it is questionable whether the unemployment variable is a satisfactory proxy to indicate changes in the demand for labour in Germany. In order to proceed further with an analysis of the relationships among German wage changes, price changes, and unemployment rates, one would wish to consider alternative variables to reflect variations in the level of aggregate demand. Moreover, it might be desirable to test for a direct influence of demand pressures in the price change equation, especially since this relationship is unsatisfactory in a number of respects. It has not been possible to pursue the analysis further along these lines for purposes of this study.

6. Sweden

i. Wage changes

The "best" wage adjustment equation for Sweden, fitted to the period 1954-I through 1965-IV, is as follows:

$$(8.41)\quad \dot{W}_t = 3.5888 + \underset{[5.40]}{13.755(U_t^*)^{-1}} + \underset{[3.17]}{0.45127\,\dot{P}^*} - \underset{[2.91]}{0.07543t} - \underset{[4.59]}{0.54512\,\dot{W}_{t-4}}$$

$$R^2 = 0.575,\quad D.W. = 1.43.$$

The variables included in this relationship have the same definitions as elsewhere in this Chapter. Other variables tested in fitting this equation were $\frac{1}{t}$, DUM I and DUM II: none of these was statistically significant. DUM I was set equal to zero from 1954 through 1955 and equal to unity from 1956 onwards in order to allow for the re-establishment of national wage bargaining in 1956 as outlined in Professor Smith's study.[1] DUM II had a value of zero from 1954 to 1961 and a value of unity from 1962 onwards. DUM II was added to test for any evidence of a shift in the relationship beginning in 1962, for a country which did *not* initiate an income policy at that time. As already outlined in the discussion of a similar test for West Germany, this was intended to provide a rather weak test of the validity of attributing to the effect of incomes policies a shift in the wage adjustment and price change relationships at approximately that time in countries adopting such measures. If DUM II had been significant in the Swedish relationship, as it was

[1] Smith, *op. cit.*

for West Germany, this result might have reinforced the suggestion that there were general international economic forces at work beginning in 1962 which shifted the wage adjustment relationship: accordingly, one might have had more reason for questioning the validity of attributing the observed shift in other countries to the influence of incomes policies. Since DUM II, however, proved to be an insignificant variable, it detracts from the importance of our findings for Germany as a qualification on the evidence relating to the effectiveness of incomes policies in other countries.

In the experiments leading to equation (8.41), $(U_t^*)^{-2}$ was substituted as an explanatory variable in place of $(U_t^*)^{-1}$. Judging from the value of the t-ratios and the coefficients of multiple determination we concluded that $(U_t^*)^{-2}$ was a less satisfactory form of the unemployment variables than $(U_t^*)^{-1}$ for the estimated wage adjustment relationship for Sweden.

The steady state relationship derived from equation (8.41) is:

$$(8.41e) \quad \dot{W}_t^e = 2.3227 + 8.9021\,(U_t^*)^{-1} + 0.29206\,\dot{P}_t^* - 0.04882\,t.$$

The relationship between Swedish wage changes and unemployment rates for this steady state relationship is shown in Table 8.19 and Figure 8.12. These curves are based on two sets of assumptions regarding consumer price changes: $\dot{P}_t^* = 0$ and $\dot{P}_t^* = 3.0$. The estimates are derived for the fourth quarter of 1965, for which the time trend variable t was equal to 52.

Table 8.19

The Relationship between Wage Changes ($\dot{W}_t^e$) and Unemployment Rate for the Steady State Wage Adjustment Relationship for Sweden, Fourth Quarter 1965

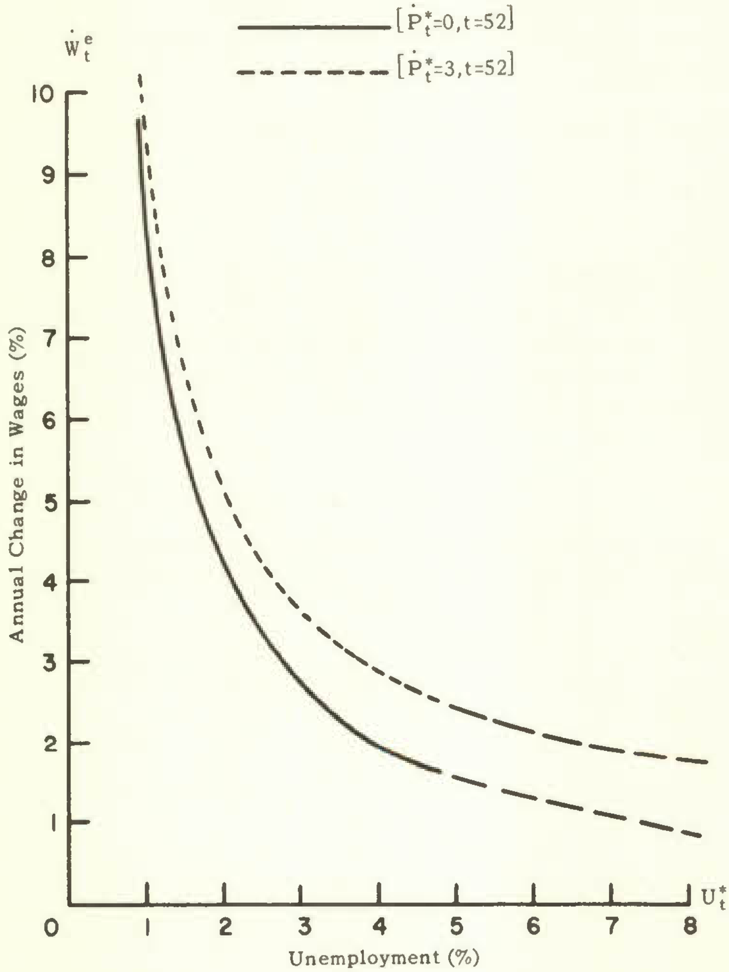
Unemployment Rate (U_t^*) (Per Cent of Labour Force)	Annual Rate of Change in Wages ($\dot{W}_t^e$) Estimated from Equation (8.41e) with t = 52 and:	
	$\dot{P}_t^* = 0$	$\dot{P}_t^* = 3$
0.6	14.62	15.50
1.0	8.69	9.56
2.0	4.24	5.11
3.0	2.75	3.63
4.0	2.01	2.89
5.0	1.56	2.44
6.0	1.27	2.14
7.0	1.06	1.93
8.0	0.90	1.77

ii. Price changes

We were unsuccessful in our attempts to estimate a statistically significant relationship between Swedish wage changes and price changes. Some of our more interesting price change equations are shown in Table 8.20. In addition to the explanatory variables shown in Table 8.20, several tests were also run on the variables $\frac{1}{t}$, DUM I and DUM II. (These last two variables have already been defined in this Section.) These variables were consistently not significant.

Figure 8.12

THE RELATIONSHIP BETWEEN THE RATE OF CHANGE IN WAGES AND THE RATE OF UNEMPLOYMENT, SWEDEN, FOURTH QUARTER 1965



The "best" estimate, in our view, of the determinants of Swedish price changes is equation (8.42), which explains changes in Swedish prices in terms of a constant, import price changes, and lagged price changes. The t-ratios for the wage change variable in the equations reported in Table 8.20 are consistently well below 1.0, indicating little statistical significance. Time is also far from significant.

The steady state version of equation (8.42) is:

$$(8.42e) \quad \dot{P}_t^e = 3.403 + 0.28189\,\dot{F}_t\,.$$

Table 8.20

Price Change Equations (Regressions Explaining $\dot{P}_t$),
Sweden, 1954-I – 1965-IV

Equation Number	Constant Term	Coeffieients of Explanatory Variables:				R^2	D.W.
		$\dot{W}_t$	$\dot{F}_t$	t	$\dot{P}_{t-1}$		
(8.42)	0.97205	–	0.08052 [2.01]	–	0.71436 [7.20]	0.546	1.89
(8.43)	1.1687	-0.06402 [0.61]	0.08784 [2.02]	0.00699 [0.50]	0.72353 [6.66]	0.551	1.92
(8.44)	1.2439	-0.04989 [0.49]	0.08812 [2.04]	–	0.73221 [6.89]	0.548	1.93
(8.45)	0.96939	0.02340 [.24]	–	–	0.69106 [6.40]	0.505	1.81

According to this relationship, Swedish consumer prices can be expected to rise at an annual rate of 3.4 per cent if import prices are constant. Each increase of one percentage point in the annual rate of change in foreign prices increases the rate of price change by 0.28 of a percentage point, beyond to 3.4 per cent annual rate of increase.

The failure of wage changes to be a significant determinant of the rate of change in consumer prices may, of course, reflect the inadequacies of our tests or the inadequacies of the statistics on which they are based, or both.[1] An alternative explanation is that wage changes have not been a significant determinant of price changes in Sweden and that the large constant term reflects the very high level of aggregate demand which has generally characterized the Swedish economy since 1954. Unemployment rates since 1960, for example, have been at 1½ per cent or below, based on North American definitions.[2] To test this proposition, our tests should be rerun with a demand variable explicitly included to take this factor into account. Specifying such a variable satisfactorily, however, poses several difficult problems and there has not been sufficient time to develop a satisfactory demand variable, for Sweden or for any of the other countries considered in this survey.

The influence of import prices on Swedish price changes is what one would expect, due to the very open nature of the Swedish economy. Indeed, in view of the importance of foreign prices as a determinant of Canadian domestic prices and the openness of both the Canadian and Swedish economies, one might have expected import prices to have had a somewhat greater influence on Swedish prices than equation (8.42) indicates. The relative smallness of this influence for Sweden suggests, once again, that the level of domestic demand since 1954 may

---

[1] It has been suggested to us that the impact of wage changes on price changes in Sweden is heavily influenced by whether or not the particular industry under consideration is exposed to international competition. In the time allotted for this study, we were unable to investigate this possibility by disaggregating in some appropriate fashion.

[2] For a fuller outline of the conditions of this period, see Smith, *op. cit.*, Chapter 8. From 1954 to 1965, the unadjusted unemployment rate in Sweden averaged 2.0 per cent and ranged from 0.6 per cent to 4.4 per cent.

have been so high that the effect of changes in foreign prices through changes in the cost of imported inputs and competitive pressures on the product prices of import-competing domestic industries has been greatly diluted.

Because of the absence of a statistically significant wage change term in any of the price change equations, no attempt has been made to compute a trade-off relationship for Sweden.

7. Comparisons and Conclusions

i. Prologue

As stated at the outset and reiterated at various points in this Chapter, this analysis is subject to a number of important qualifications arising from a lack of comparable data for the countries considered, the limitations of our analytical techniques, and a shortage of time to pursue more detailed tests for each country. In general, our attempts to estimate wage adjustment relationships for the five foreign countries in question have met with greater success than our efforts to estimate price change relationships. We have some confidence in most of the wage change relationships: in our view the estimates for Germany and France are probably the most questionable. We have less confidence in the estimated price change relationships and in the derived trade-off relationships.

In the Figures that follow, the wage-change-unemployment and the trade-off curves for Canada and the five countries considered in this Chapter are superimposed on each other to facilitate comparisons. The assumptions made about variables other than the unemployment rate entering these relationships are shown in detail in the accompanying Tables. These may generally be characterized as non-inflationary and as inflationary. It may be noted that, in these Figures, the curves for each country are drawn only for the range of the unemployment rate actually experienced in each country from 1953 (or 1954) to 1965. These Figures should be considered in conjunction with the Tables, which show the percentage rate of increase in wages and in prices for the six countries, as indicated by our estimated relationships, under four assumptions about the rate of unemployment and under the same set of non-inflationary or inflationary assumptions for the other variables as underlie the charts.

We may present some words of explanation with regard to the unemployment assumptions on which these Tables are based. The four rates assumed are the minimum level of unemployment experienced by each country since 1953 (or 1954), the maximum level of unemployment in each country since that date, the mean level of unemployment in each country over the sample period, and a common rate of unemployment of 3 per cent for all countries. For two reasons, at least, it seems useful to base our comparisons on more than the simple assumption of a common rate of unemployment for all countries. First, although the unemployment data used in this analysis are supposed to be adjusted to North American definitions, the accuracy of this adjustment is open to some question, as suggested earlier. Secondly, even if the figures are fully comparable, it is possible that, for purposes of policy analysis, it is more interesting to compare the rates of wage and price change implied by the range of unemployment rate in which the countries' economies have actually been operating. Given the economic and political structure of each country, government policy in some countries may be circumscribed in such a way that the possibility of the unemployment rate rising beyond the range experienced in the post-war period is largely irrelevant. In other words, a 3 per cent rate of unemployment in Canada may be quite different from a 3 per cent level in Western Europe, not only because of different statistical definitions but also because of a difference in the tolerance of the population for this amount of unemployment and because of a difference in the structure of the economies.

The final introductory point to be presented before proceeding to a comparison of the relationships relates to the estimates shown as Canada I and Canada II. The estimates denoted as Canada I in all Figures and Tables in this Section are based on arbitrary assumptions, as noted in each instance, about wage and price changes in the United States. Canada II estimates incorporate the predicted values of U.S. wage and price changes at various rates of unemployment in the United States, based on the U.S. wage change and price change relationships reported in Section 2 above. This was done by substituting the U.S. wage adjustment relationship, equation (8.1e), for $\dot{W}^*_{us_t}$ in the Canadian wage adjustment relationship, equation (5.1e). After some algebraic manipulations, the following Canadian wage change relationship is derived, with the U.S. variables shown as lower case letters to distinguish them from the same variables for Canada which are shown as capital letters:

$$(8.46) \quad \dot{W}_t = -4.3356 + 0.43603\,\dot{P}^*_t + 0.05536\,(Z/Q)^*_{t-2} + 16.529\,(U^*_t)^{-2}$$

$$+ 0.01081\,(z/q)^*_t - 0.00454\,\text{DUM}\cdot t + 4.9768\,(u^*_t)^{-2} + 0.03824\,\dot{p}^*_t.$$

Similarly, by substituting the U.S. wage adjustment relationship, equation (8.1e), for $\dot{W}^*_{us_t}$ in the Canadian trade-off relationship, equation (6.7), we can derive the following trade-off relationship for Canada in which the U.S. variables again are shown as lower case letters:

$$(8.47) \quad \dot{P}^e_t = -15.424 + 1.0378\,\dot{F}_t + 0.11441\,(Z/Q)^*_{t-2} + 34.161\,(U^*_t)^{-2}$$

$$+ 0.02234\,(z/q)^*_t - 0.00938\,\text{DUM}.t + 10.285\,(u^*_t)^{-2} + 0.07902\,\dot{p}^*_t\,.$$

If, in addition, we substitute equation (8.11) in place of $\dot{p}^*_t$ in equation (8.47), we can derive the following trade-off relationship, which is employed for the Canada II estimates:

$$(8.48) \quad \dot{P}^e_t = -15.884 + 1.0378\,\dot{F}_t + 0.11441\,(Z/Q)^*_{t-2} + 34.161\,(U^*_t)^{-2}$$

$$+ 0.02617\,(z/q)^*_t - 0.01099\,\text{DUM}.t + 12.051\,(u^*_t)^{-2}\,.$$

By means of equations (8.46) and (8.48), we can directly link Canadian wage and price changes to the determinants of U.S. wage and price changes and thus avoid simply assuming particular values for U.S. wage changes. In calculating the Canada II estimates for the following Figures and Tables, the same values have been assumed for the U.S. determinants as were assumed in the corresponding estimates for the United States shown in these Figures and Tables.

ii. Wage changes

Some of the main points suggested by Figures 8.13 and 8.14, together with Tables 8.21 and 8.22, may be summarized as follows:

First, it is evident that the degree of sensitivity of wage changes to unemployment rates differs from country to country. Within the range of post-war experience, wages appear to be most sensitive to unemployment in France, Britain, and Sweden. In Germany, wage changes are highly sensitive to unemployment rates below roughly 1½ per cent but quite insensitive to unemployment rates above 1½ per cent. U.S. wages appear to be slightly more sensitive to unemployment than Canadian wages. The Canada II curve is more sensitive to variations in the unemployment rate than the Canada I curve, as the U.S. wage change is implicitly allowed to vary in the former case, by setting the U.S. unemployment rate equal to the Canadian rate of unemployment. Which of these curves should be considered the more relevant one depends on the question that one wishes to answer. If one wishes to know what effect a variation in Canadian unemployment rates would have on Canadian wage changes, *given* external circumstances, the Canada I curve is more relevant. If, on the other hand, one wishes to know what effect a variation in unemployment rates in *both* Canada and the United States would have on Canadian wage changes, the Canada II curve gives the more appropriate estimates.

Secondly, one of the most striking points indicated by a comparison of Figures 8.13 and 8.14 is the very high sensitivity of wage changes in Canada and West Germany to inflationary economic conditions, in comparison to Sweden, Britain, and the United States.[1] For Germany, this result reflects mainly the relatively high sensitivity of German wage changes to changes in consumer prices. This is also an important factor explaining Canada's relatively high sensitivity, but another important factor is the sensitivity of Canadian wage changes to those in the United States.

Thirdly, if one assumes the mean rate of unemployment experienced by each country over the sample period and non-inflationary conditions, the annual rate of wage change predicted for each country in Table 8.21 is: Sweden, 4.2 per cent; West Germany, 3.3 per cent; Canada, 2.9 or 3.0 per cent; the United States, 2.8 per cent; and Britain, 2.3 per cent. If one assumes the more inflationary conditions underlying Table 8.22, this ranking changes somewhat. The ranking becomes: France, 6.9 per cent; West Germany, 6.1 per cent; Canada, 5.0 to 5.6 per cent; Sweden, 5.1 per cent; the United States, 3.6 per cent; and Britain, 3.4 per cent.

---

[1] A relationship for France is not shown in Figure 8.13 since $\dot{P}_t^*$ is not included in the French wage adjustment relationship. In view of the inflationary character of the French economy during most of our sample period, it was thought that the French relationship might more suitably be grouped with the curves based on "moderately inflationary" conditions.

Table 8.21

The Relationships between Wage Changes ($\dot{W}^e_t$) and the Rate of Unemployment (U^*_t), Derived from Steady State, Post-War Wage Adjustment Relationships for Various Countries, Based on Four Assumptions about U^*_t and on "Non-Inflationary" Values of the Other Determinants of Wage Changes

Country	Assumptions about U^*_t:				Annual Rate of Wage Change Implied by the Various Unemployment Assumptions:			
	I	II	III	IV	I	II	III	IV
	(minimum)	(mean)	(maximum)					
Canada I	2.9	5.2	7.5	3	4.3	3.0	2.7	4.2
Canada II	2.9	5.2	7.5	3	4.7	2.9	2.5	4.5
United States	2.8	5.1	6.8	3	4.5	2.8	2.5	4.2
Britain	1.6	2.5	3.7	3	4.7	2.3	0.9	1.6
West Germany	0.4	2.0	5.2	3	6.6	3.3	2.8	3.1
Sweden	1.3	2.0	2.9	3	6.6	4.2	2.9	2.8

I = minimum level of unemployment variable for country during sample period.
II = mean rate of unemployment for country during sample period.
III = maximum level of unemployment variable for country during sample period.
IV = 3 per cent rate of unemployment common to all countries.

Country	Equation Number	Assumptions about Other Determinants of Wage Changes:						
		$\dot{P}^*_t$	$(Z/Q)^*$	$\dot{W}^*_{us}$	DUM	t	DUM. t	$\frac{1}{t}$
Canada I	(5.1e)	0	97.75	3.2	–	–	–	–
Canada II	(8.46)	0	97.75	U.S. estimate#	–	–	–	–
United States	(8.1e)	0	113.33	–	–	–	51	–
Britain	(8.12)	0	–	–	1	–	–	–
West Germany	(8.32e)	0	–	–	–	–	50	0.0200
Sweden	(8.41e)	0	–	–	–	52	–	–

Values of U.S. variable in equation (8.46) are as shown in the line below (for equation (8.1e)).
The U.S. unemployment rate is set equal to its values in the third line of the first part of this Table.

Figure 8.13

A COMPARISON OF THE RELATIONSHIP BETWEEN WAGE CHANGES AND THE RATE OF UNEMPLOYMENT, UNDER "NON-INFLATIONARY" CONDITIONS, BRITAIN, CANADA, SWEDEN, UNITED STATES, AND WEST GERMANY, FOR A RECENT POST-WAR PERIOD

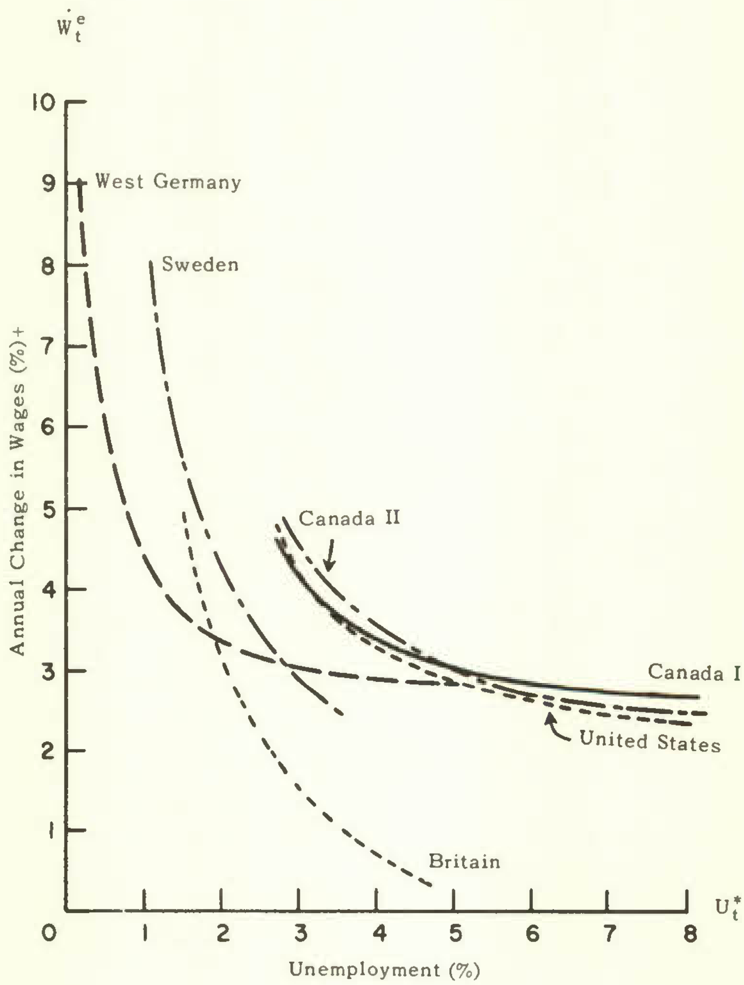


Table 8.22

Relationships between Wage Changes ($\dot{W}_t^e$) and the Rate of Unemployment (U_t^*), Derived from Steady State, Post-War Wage Adjustment Relationships for Various Countries, Based on Four Assumptions about U_t^* and on "Moderately Inflationary" Values of the Other Determinants of Wage Changes

Country	Assumptions about U_t^*:				Annual Rate of Wage Change Implied by the Various Unemployment Assumptions:			
	I	II	III	IV	I	II	III	IV
	(minimum)	(mean)	(maximum)					
Canada I	2.9	5.2	7.5	3	6.9	5.6	5.3	6.8
Canada II	2.9	5.2	7.5	3	6.8	5.0	4.6	6.5
United States	2.8	5.1	6.8	3	5.3	3.6	3.3	5.0
Britain	1.6	2.5	3.7	3	5.7	3.3	1.9	2.5
France	1.7	2.5	3.2	3	8.7	6.9	6.3	6.5
West Germany	0.4	2.0	5.2	3	9.4	6.1	5.6	5.9
Sweden	1.3	2.0	2.9	3	7.5	5.1	3.7	3.6

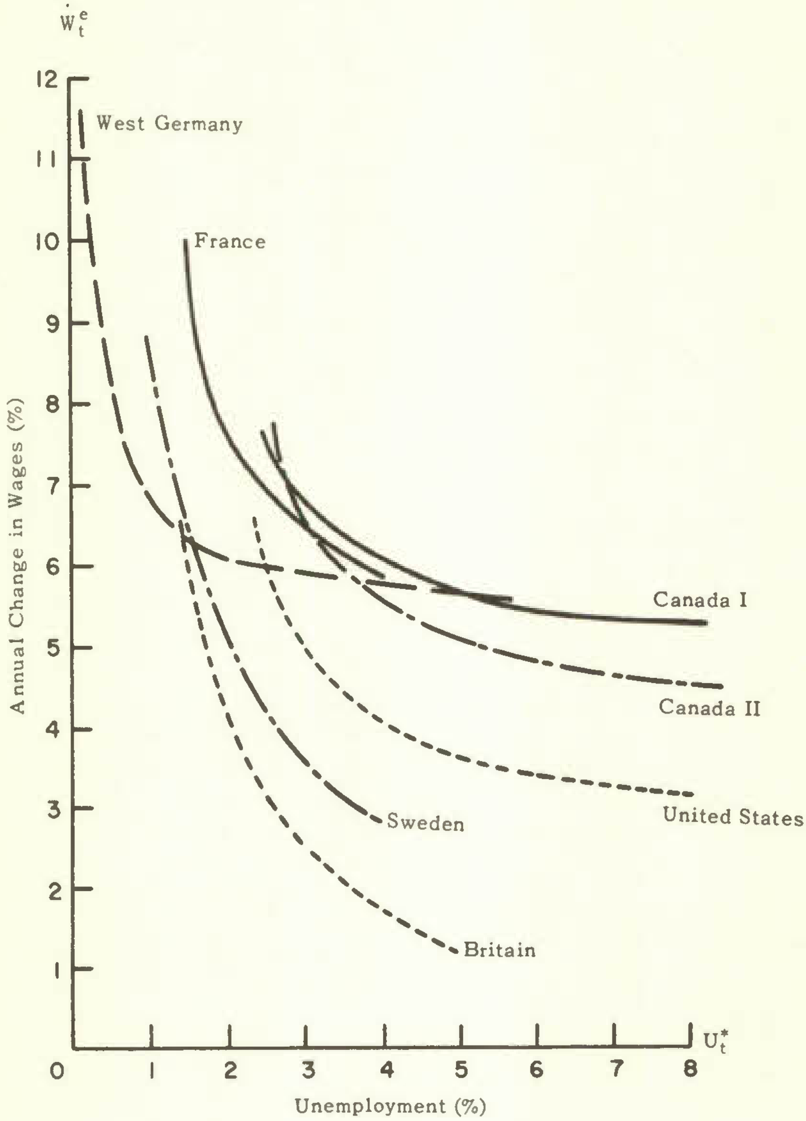
I = minimum level of unemployment variable for country during sample period.
II = mean rate of unemployment for country during sample period.
III = maximum level of unemployment variable for country during sample period.
IV = 3 per cent rate of unemployment common to all countries.

Country	Equation Number	Assumptions about Other Determinants of Wages:						
		$\dot{P}_t^*$	$(Z/Q)^*$	$\dot{W}_{us}^*$	DUM	t	DUM.t	$\frac{1}{t}$
Canada I	(5.1e)	3	107.75	6.0	–	–	–	–
Canada II	(8.46)	3	107.75	U.S. estimate#	–	–	–	–
United States	(8.1e)	3	123.33	–	–	–	51	–
Britain	(8.12)	3	–	–	1	–	–	–
France	(8.25)	–	–	–	–	–	52	0.0192
West Germany	(8.32e)	3	–	–	–	–	50	0.0200
Sweden	(8.41e)	3	–	–	–	52	–	–

Values of U.S. variables in equation (8.46) are as shown in the line below (for equation 8.1e)). The U.S. unemployment rate is set equal to its values in the third line of the first part of this Table.

Figure 8.14

A COMPARISON OF THE RELATIONSHIP BETWEEN WAGE CHANGES AND THE RATE OF UNEMPLOYMENT, UNDER "MODERATELY INFLATIONARY" CONDITIONS, BRITAIN, CANADA, FRANCE, SWEDEN, UNITED STATES, AND WEST GERMANY, FOR A RECENT POST-WAR PERIOD



If one assumes non-inflationary conditions and a common rate of unemployment, Canada and the United States can be expected to have the largest increases in wages, followed by West Germany, Sweden and Britain (see Table 8.21). If a common 3 per cent rate of unemployment and more inflationary conditions are assumed (Table 8.22), Canada and France can expect the largest increases, followed by West Germany, the United States, Sweden, and Britain.

Finally, it is of some interest to compare the wage adjustment relationships derived from our estimates with those presented in Table 3.21 of Chapter 3, which are based on the estimates of previous studies. Figures derived from the relationships estimated in this Chapter (and, for Canada I, Chapter 5) are shown in Table 8.23 on the same basis as the figures shown in Table 3.21. Generally speaking, the estimates for Canada and the United States shown in Table 8.23 are of the same order of magnitude as those shown in that earlier Table. The differences in the estimates for Britain are somewhat greater, and the largest differences are in the estimates for France and West Germany.[1] The relationships derived in this Chapter suggest that these two countries are likely to experience a much higher rate of wage increase at all rates of unemployment. Moreover, because of the nonlinear formulation underlying our relationships, in contrast to the linear assumptions underlying the estimates for France and West Germany discussed in Chapter 3, the estimates of this Chapter suggest that wage changes in these two countries are less responsive to variations in the unemployment rate beyond a certain (low) level of unemployment.

iii. Price changes and trade-offs[2]

Figures 8.15 and 8.16, together with Tables 8.24 and 8.25, relate to the relationships between the rate of change in prices and the rate of unemployment over the range of unemployment experienced by each country since 1953, under two alternative sets of assumptions (one relatively non-inflationary and one relatively inflationary) with regard to the other variables in the trade-off relationship. The following are particularly noteworthy points.

First, according to Figure 8.15, only Canada and the United States can hope to achieve a zero rate of price change by maintaining a moderately high rate of unemployment. For both countries, the implied rate of unemployment to achieve this objective is in the range of 4 to 5 per cent when other conditions are non-inflationary. Even in non-inflationary circumstances, the European countries apparently cannot look to maintaining a moderately high rate of unemployment as a means of completely stablizing prices if policy is limited to keeping unemployment rates within their conventional ranges.

Secondly, when more inflationary values are assumed for the other determinants of changes in consumer prices as in Figure 8.16, the curve for Canada moves upward very sharply. The French, British and U.S. curves, on the other hand, shift only moderately, while the West German curve hardly moves upward at all. It is evident once again that inflationary conditions, particularly those originating outside Canada, have a very appreciable impact on the expected rate of change in the Canadian Consumer Price Index.

---

[1] As before, the estimated wage changes for France are assumed to be most comparable to those for the other countries discussed here under relatively inflationary conditions. Hence we have placed these estimates in the last two columns of Table 8.23, despite the fact that we have no explicit estimate of the effect of consumer price changes on French wage changes.

[2] The discussion of this Section excludes Sweden, for which we were unable to derive a trade-off relationship.

Table 8.23

An International Comparison of Wage Adjustment Relationships, Post-War Period

(Unemployment Adjusted to a Common Definition)

Country	Equation Number	Rate of Unemployment (Per Cent of Labour Force) Associated with an Annual Percentage Change in Wages of 2 1/2%	Annual Rate of Change in Wages: Associated with No Change in Prices and an Unemployment Rate of: 3%	6%	Associated with a 3 Per Cent per Year Change in Prices and an Unemployment Rate of: 3%	6%
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Canada I	(5.1e)	none under 10%	4.21	2.83	6.80	5.42
Canada II	(8.46)	7.07	4.46	2.67	6.54	4.75
United States	(8.1e)	6.44	4.16	2.57	5.01	3.42
Britain	(8.12)	2.37	1.55	-0.24	2.54	0.75
France	(8.25e)	none under 8%	—	—	6.45	5.65
West Germany	(8.32e)	none under 8%	3.06	2.79	5.86	5.59
Sweden	(8.41e)	3.28	2.75	1.27	3.63	2.14

Assumptions about Other Determinants of Wages:

Country	Equation Number	$(Z/Q)^*$ when $\dot{P}_t^* = 0$	$(Z/Q)^*$ when $\dot{P}_t^* = 3$	$\dot{W}_{us}^*$	DUM	t	DUM.t	$\frac{1}{t}$
Canada I	(5.1e)	97.75	107.75	3.2 or 6.0	—	—	—	—
Canada II	(8.46)	97.75	107.75	U.S. estimate#	—	—	—	—
United States	(8.1e)	113.33	123.33	—	—	—	51	—
Britain	(8.12)	—	—	—	1	—	—	—
France	(8.25e)	—	—	—	—	—	52	0.0192
West Germany	(8.32e)	—	—	—	—	—	50	0.0200
Sweden	(8.41e)	—	—	—	—	52	—	—

For these estimates, the U.S. unemployment rate is assumed to be the same as the Canadian figure.

Table 8.24

The Relationship between Price Changes ($\dot{P}^e_t$) and Unemployment Rates (U^*_t), Derived from Trade-Off Relationships for Various Countries, Based on Four Assumptions about U^*_t and on "Non-Inflationary" Values of the Other Explanatory Variables

Country	Assumptions about U^*_t:				Annual Rate of Price Change Implied by the Various Unemployment Assumptions:			
	I	II	III	IV	I	II	III	IV
	(minimum)	(mean)	(maximum)					
Canada I	2.9	5.2	7.5	3	2.5	-0.3	-1.0	2.2
Canada II	2.9	5.2	7.5	3	3.3	-0.6	-1.4	2.8
United States	2.8	5.1	6.8	3	1.5	-0.5	0.9	1.1
Britain	1.6	2.5	3.7	3	2.9	1.9	1.4	1.7
France	1.7	2.5	3.2	3	3.7	2.4	1.9	2.0
West Germany	0.4	2.0	5.2	3	2.3	1.8	1.7	1.8

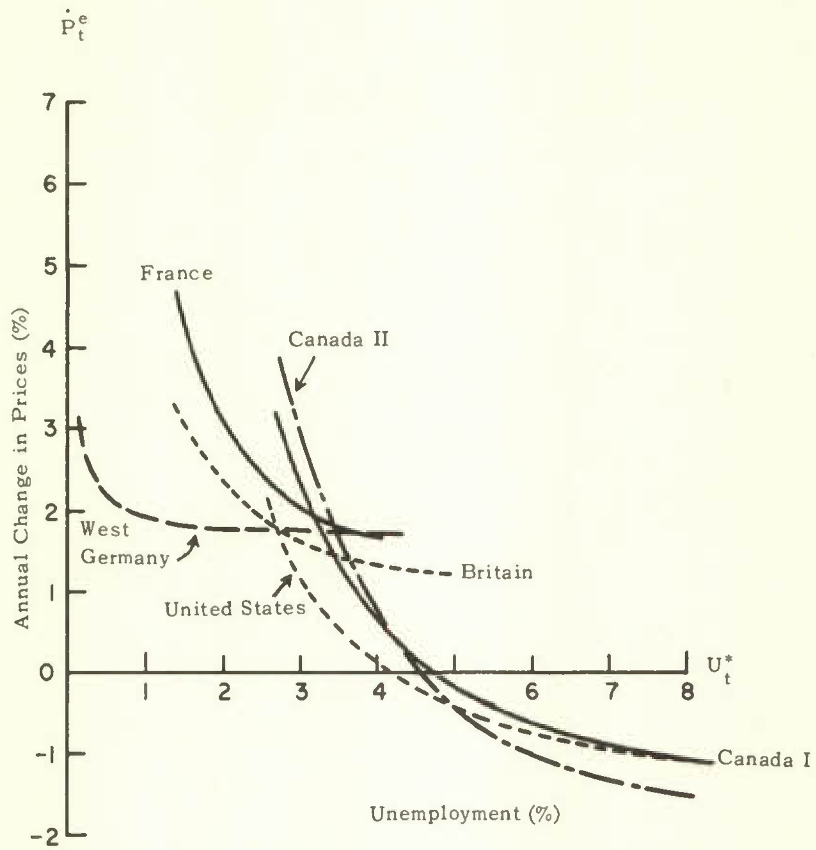
I = minimum level of unemployment variable for country during sample period.
II = mean rate of unemployment for country during sample period.
III = maximum level of unemployment variable for country during sample period.
IV = 3 percent rate of unemployment common to all countries.

Country	Equation Number	Assumptions about Other Determinants of Price Changes:						
		DUM.t	$\dot{F}_t$	$(Z/Q)^*$	$(\dot{A})'_t$	$\dot{W}^*_{us}$	DUM	$\frac{1}{t}$
Canada I	(6.7)	–	0	97.75	–	3.2	–	–
Canada II	(8.48)	–	0	97.75	–	U.S. estimate#	–	–
United States........	(8.11)	51	–	113.33	–	–	–	–
Britain	(8.24)	–	0	–	1.98	–	1	–
France	(8.31)	52	0	–	–	–	–	0.0192
West Germany	(8.40)	50	0	–	–	–	–	0.0200

Values of U.S. variables in equation (8.48) are as shown in the line below.
The U.S. unemployment rate is set equal to the values shown in the third line of the first part of this Table.

Figure 8.15

TRADE-OFF CURVES, UNDER "NON-INFLATIONARY" CONDITIONS, BRITAIN, CANADA, FRANCE, UNITED STATES, AND WEST GERMANY, FOR A RECENT POST-WAR PERIOD



If one assumes non-inflationary circumstances and the mean rate of unemployment experienced in each country over the sample period, the estimates in Table 8.24 suggest that prices might be expected to decline slightly in Canada and in the United States, and to rise perceptibly in Europe. When non-unemployment conditions are assumed to be inflationary, the predicted rate of price increases at the mean rate of unemployment, in Table 8.25, will be greater in Canada and France than in Britain and West Germany, while the expected rate of change in U.S. consumer prices, even with the relatively high value of the profits variable, is still approximately zero.

Finally, if the unemployment rate is assumed to be 3 per cent in all countries, with non-inflationary values of the other explanatory variables, consumer prices in Canada can be expected to rise somewhat more rapidly than in Europe, with the lowest expected rate of inflation occurring in the United States. If, however, other

Table 8.25

The Relationship between Price Changes ($\dot{P}_t^e$) and Unemployment Rates (U_t^*), Derived from Trade-Off Relationships for Various Countries, Based on Four Assumptions about U_t^* and on "Moderately Inflationary" Values of the Other Explanatory Variables

Country	Assumptions about U_t^*:				Annual Rate of Price Change Implied by the Various Unemployment Assumptions:			
	I (minimum)	II (mean)	III (maximum)	IV	I	II	III	IV
Canada I	2.9	5.2	7.5	3	7.2	4.4	3.8	7.0
Canada II	2.9	5.2	7.5	3	6.8	2.9	2.1	6.3
United States	2.8	5.1	6.8	3	2.0	0.0	-0.4	1.6
Britain	1.6	2.5	3.7	3	3.4	2.4	1.8	2.1
France	1.7	2.5	3.2	3	4.2	2.9	2.5	2.6
West Germany	0.4	2.0	5.2	3	2.6	2.1	2.0	2.0

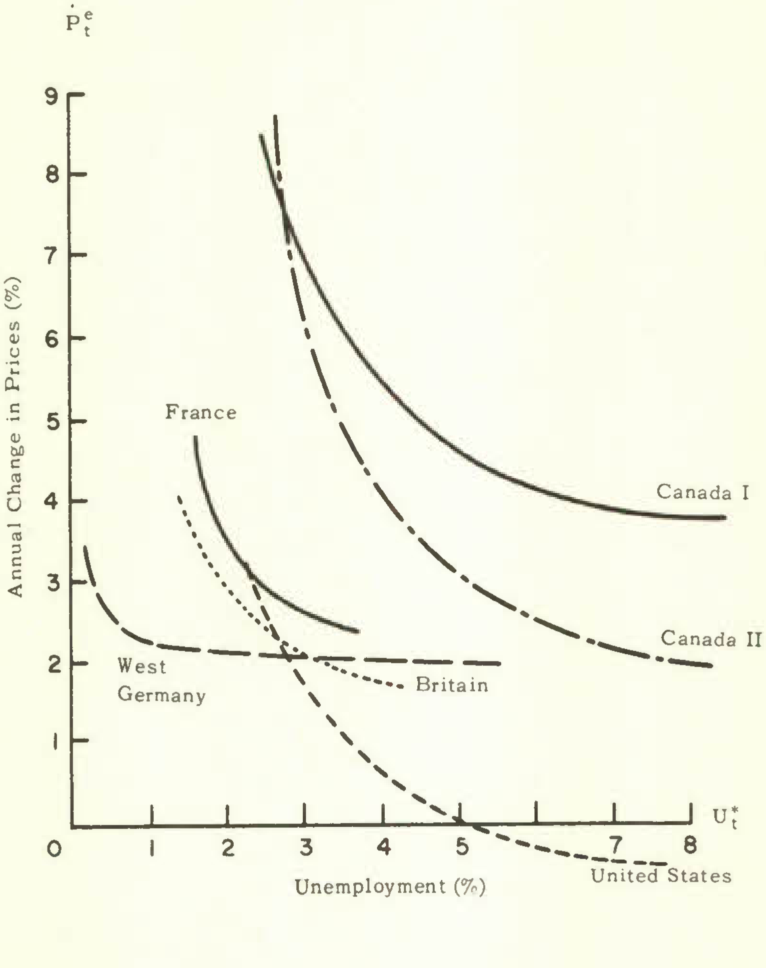
I = minimum level of unemployment variable for country during sample period.
II = mean rate of unemployment for country during sample period.
III = maximum level of unemployment variable for country during sample period.
IV = 3 per cent rate of unemployment common to all countries.

Country	Equation Number	Assumptions about Other Determinants of Wage Changes:						
		$\dot{F}_t$	$(Z/Q)^*$	$(\dot{A})'_t$	$\dot{W}^*_{us}$	DUM	DUM·t	$\frac{1}{t}$
Canada I	(6.7)	2	107.75	–	6.0	–	–	–
Canada II	(8.48)	2	107.75	–	U.S. estimate#	–	–	–
United States	(8.11)	–	123.33	–	–	–	51	–
Britain	(8.24)	2	–	1.98	–	1	–	–
France	(8.31)	2	–	–	–	–	52	0.0192
West Germany	(8.40)	2	–	–	–	–	50	0.0200

Values of U.S. variables in equation (8.48) are as shown in the line below.
The U.S. unemployment rate is set equal to the values shown in the third line of the first part of this Table.

Figure 8.16

TRADE-OFF CURVES, UNDER "MODERATELY INFLATIONARY" CONDITIONS, BRITAIN, CANADA, FRANCE, UNITED STATES, AND WEST GERMANY, FOR A RECENT POST-WAR PERIOD

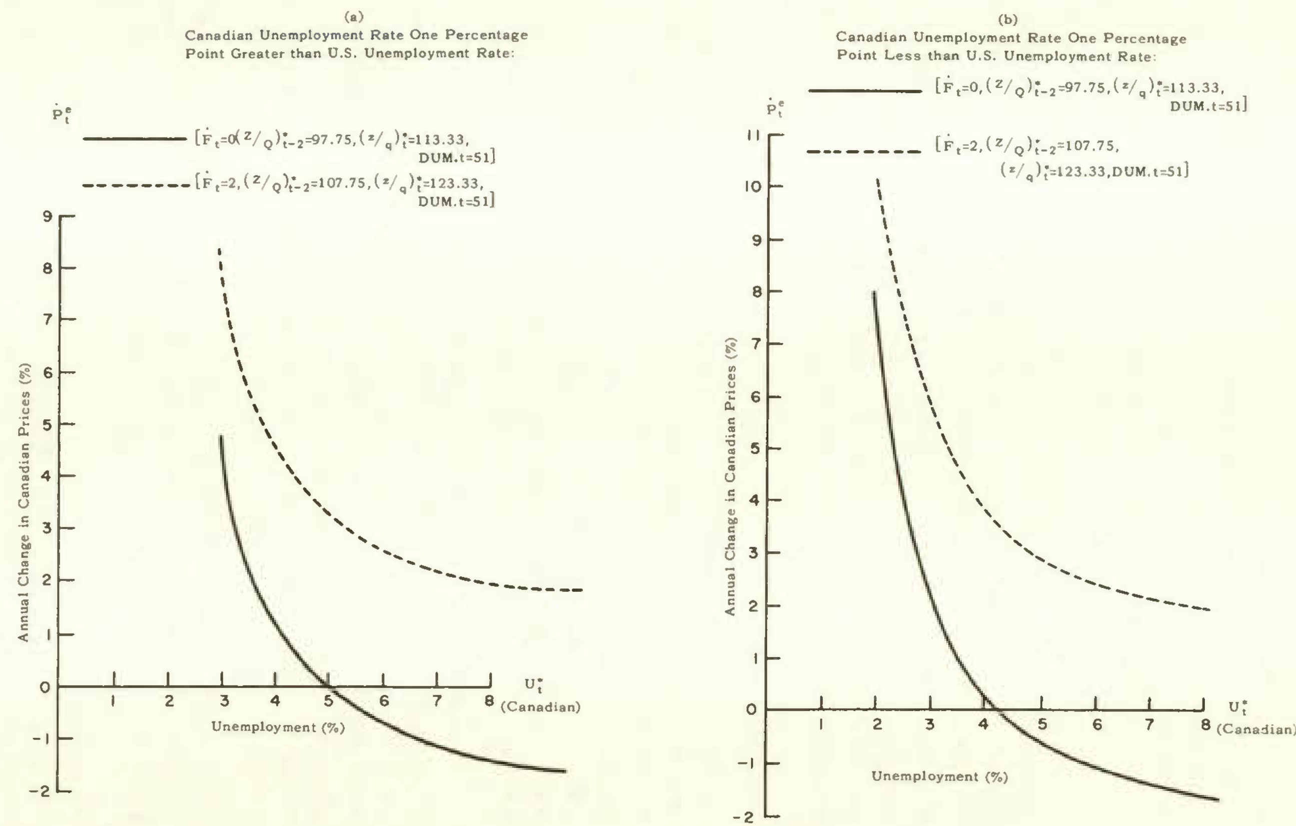


circumstances are inflationary, prices can be expected to rise substantially more in Canada at a 3 per cent rate of unemployment than in the other countries, with the expected rate of inflation in the United States still slightly less than that of the European countries.

In general, the foregoing analysis has been based on the assumption that unemployment rates in Canada and in the United States move together at approximately the same levels. Although unemployment rates in Canada have generally been of the same order of magnitude as in the United States, they have differed by as much as 1½ percentage points during particular quarters since 1953. This raises the question as to how the trade-off curves are affected when such differentials in unemployment rates occur. This question can be directly answered from equation (8.48). The curves shown in Figure 8.17 have been derived from this equation

Figure 8.17

CANADIAN TRADE-OFF CURVES, BASED ON EQUATION (8.48), THIRD QUARTER 1965, UNDER THE ASSUMPTION THAT UNEMPLOYMENT RATES IN CANADA AND IN THE UNITED STATES DIFFER BY ONE PERCENTAGE POINT



under the assumption that the U.S. unemployment rate is either one percentage point higher or lower than the Canadian rate, with alternatively non-inflationary or inflationary values assumed (as before) for the other explanatory variables. In both parts of Figure 8.17, the Canadian unemployment rate is measured on the horizontal axis, as in the earlier charts. In part (a), this unemployment rate is associated with a U.S. rate one percentage point below the Canadian figure; in part (b), the Canadian rate is one percentage point below the associated U.S. rate. From these curves it is evident that the more unemployment in Canada exceeds unemployment in the United States, the flatter will the Canadian trade-off curve be; and conversely. Moreover, Figure 8.17 emphasizes again that the rate of unemployment in Canada "required" for complete stability of the price level depends on the rate of unemployment in the United States. Other calculations from equation (8.48) indicate that an unemployment rate of 4½ per cent in both countries is consistent with complete price level stability in Canada (under the assumption of non-inflationary values of the other variables). If, however, the U.S. rate of unemployment is assumed to be 4 per cent, the implied rate of unemployment "required" for complete stability of the Consumer Price Index is 4.7 per cent. Alternatively, if the U.S. unemployment rate is 5 per cent, the implied unemployment rate in Canada for an expected zero change in consumer prices decreases to approximately 4⅓ per cent.

iv. Incomes policies

In the foregoing sections, we have found evidence that is generally consistent with the view that the incomes policies adopted in the United States, Britain, and France have had some effect (at least in the short run) in restraining the rate of increase in wages. We have found no evidence supporting the view that these policies have restrained the rate of rise in consumer prices through any channels apart from the lessening of price pressures due to the relatively indirect effects arising from the restraint on wage increases.

Two additional points remain to be made on this issue. The first is that, if incomes policies have in fact had an effect on U.S. wage changes, according to some of the results of Chapter 5, they will also have had an impact on Canadian wage and price changes. Equations (8.46) and (8.48) suggest that the maximum effect of these policies may have been to reduce the rate of increase in Canadian wages by approximately one quarter of a percentage point per year and in Canadian consumer prices by roughly one half of a percentage point per year.[1]

Finally, it can scarcely be overemphasized that our empirical evidence does *not prove* that incomes policies have been effective nor that they are desirable even if they have been effective. Conceivably, the shifts in the relationships

[1] It should be pointed out that the estimated effects, which are discussed in this paragraph, of the U.S. guideposts on Canadian wage and price changes, are not strictly comparable; the latter is based on a higher degree of reduction than the former. Thus, changes in the U.S. Consumer Price Index (and also in the Canadian Consumer Price Index) explicitly appear as an explanatory variable in the wage adjustment equation (8.46), while this variable (along with the Canadian consumer price changes, of course) is eliminated as an explanatory variable in the trade-off equation (8.48). This means that the Canadian price change relationship, equation (8.48), has been carried to a higher degree of reduction, in the sense of being expressed in terms of the "ultimate" (or "truly" exogenous) determinants of wage and price level changes.

indicated by our statistical evidence may be explained by factors other than incomes policies. Moreover, even if the shifts in these wage adjustment relationships were induced by incomes policies, the possibility that these shifts were only transient, so that the immediate reduction in wage increases (and hence in pressures on the level of prices) was (or will be) completely offset by more rapid increases later on, cannot be dismissed out of hand. Furthermore, even if these incómes policies are judged to be "permanently" effective, there are other important questions to be considered before one could assert that such policies have been desirable for the countries which have adopted them or that these policies should be adopted by Canada. These are important issues, but they are not ones to which we have addressed ourselves.

APPENDIX ON STATISTICAL DATA
Sources, Definitions and Explanations

1. Consumer and Commodity Import Prices

The sources of these series were the two International Monetary Fund publications, *International Financial Statistics* and the 1964-1965 *Supplement*, and *Monthly Bulletins of Statistics* by the Statistical Office of the United Nations. (This latter publication was used mainly for the earlier years.)

2. Wages

The wage series were also constructed from figures given in *International Financial Statistics* and the 1964-1965 *Supplement*. The coverage and conceptual type for the wage series for the five countries is as follows:

a. France: hourly earnings in manufacturing, construction, communications, and some branches of transportation and other services.

b. Sweden: hourly earnings in mining and manufacturing.

c. Britain: weekly rates in mining, manufacturing, construction, and some branches of transportation and other services.

d. United States: hourly earnings for an industrial composite.

e. West Germany: hourly earnings in mining, manufacturing, construction and in some branches of services (for some of the years). (Wages in the Saar are excluded for all years prior to 1959.)

3. Unemployment Rates

a. France: The principal source of the unemployment data is the Organization for European Co-operation and Development (OECD) publication, *Manpower Statistics*. As the repatriates from North Africa are presumed to affect the figures from late 1962 onward, the factor converting to equivalent U.S. unemployment rates was computed from an average for the 1959-61 period. The rates of unemployment given in Neef[1] and in *Manpower Statistics* are roughly comparable for this period when unadjusted; hence, Neef's conversion factor (multiplying the raw French rates by 2.08) was employed for the entire period to convert to U.S. definitions. Given these annual rates, the quarterly pattern was obtained by adjusting a quarterly series of unemployment rates in France so that their annual average would be the rate for the year according to U.S. definitions. (The sources of this quarterly series are the OECD's *Annual Survey of France* (1965) and the INSEE's *Bulletin Mensuel de Statistique*, No. 7 (July 1965).) The French

[1] A.F. Neef, "International Unemployment Rates, 1960-1964," *Monthly Labor Review*, March 1965.

quarterly series is deficient in that it excludes repatriates from North Africa. The preliminary rate for the year 1965 (2.8) was taken from A.M. Ross' data on adjusted unemployment rates.[1]

b. Sweden: The figures for the years 1954 and 1955 were taken from Angus Maddison, *Economic Growth in the West,* p.220. The OECD publication, *General Statistics,* was used for the figures from 1956 onward. Maddison's figures for 1954 and 1955 were adjusted upward by a factor of 1.07, which is the degree of understatement of his unemployment rates in comparison to those in *General Statistics* for the period of overlap (1956-60). The series was then adjusted upward by the Neef conversion factor for 1961-63 (1.20), which is unchanged from the earlier adjustment factor presented by Myers.[2] The preliminary rate for 1965 (1.2) was taken from A.M. Ross' figures.[3]

c. Britain: The sources included the OECD publication, *General Statistics,* and the International Labour Office (ILO) *Quarterly Bulletin,* selected issues for 1965. Neef's adjustment factor (1.44), which was based on the 1959-63 period, was employed to adjust the data to the U.S. concepts. The preliminary rate for 1965 (2.2) was derived from A.M. Ross' figures.[4]

d. United States: The figures for 1964 and 1965 were taken from the *Economic Report of the President,* January 1966. The rates for the prior quarters were obtained from the Department of Commerce's 1965 publication *Business Statistics,* which is a supplement to the *Survey of Current Business.*

e. West Germany: The sources are the OECD publication, *General Statistics,* and the ILO *Quarterly Bulletin,* selected issues for 1965. Beginning in July 1959, these rates include the Saar. The raw data were adjusted to the U.S. concept by multiplying by A.F. Neef's adjustment factor (0.62), which is based on the 1959-63 period. The preliminary rate for 1965 (0.4) was taken from the adjusted unemployment rates of A.M. Ross.[5]

4. Corporate Profits per Unit of Output (Manufacturing Sector) in the United States

The sources of this series were twofold: first, the March 1966 issue of the *Survey of Current Business;* secondly, the Department of Commerce's 1965 supplement to the *Survey, Business Statistics.*

---

[1] A.M. Ross, "Guideline Policy – Where We are and How We Got There," (U.S. Department of Labor, Mimeographed, 1966).

[2] Robert J. Meyers, *op. cit.*, in Joint Economic Committee of U.S. Congress, *Measuring Employment and Unemployment* (1963).

[3] A.M. Ross, *op. cit.*

[4] *Ibid.*

[5] *Ibid.*

CHAPTER 9

THE TRADE-OFF OPTIONS OPEN TO CANADIAN ECONOMIC POLICY: SOME CONCLUSIONS AND POLICY IMPLICATIONS

1. A Brief Résumé

The object of this study has been to evaluate the degree of conflict between two key objectives of economic policy in Canada: high employment and a stable price level. In order to accomplish this object, empirical wage change and price change relationships were estimated for Canada. Our "best" wage change relationship indicates that about five sixths of the variation in the rate of wage increase in Canada can be explained by variations in the unemployment rate, the rates at which U.S. wages rise, the level of unit profits in manufacturing, the rate of change in consumer prices, and lagged wage movements. Our "best" price change relationship suggests that a slightly larger proportion of the variation in Canadian price changes since 1953 can be explained by variations in wage changes, import price fluctuations and lagged price changes. These two relationships can then be reduced to a derived trade-off relationship, which is the basis of our estimates of the degree to which these two goals conflict, under varying conditions.

Part I of this study, consisting of the first three chapters, discussed the concepts of a wage adjustment and price-change-unemployment trade-offs and the relevance of these concepts to policy formulation and evaluation. Also in Part I was a review of various empirical studies of these relationships made by other investigators for a variety of countries, including Canada. In Part II, the heart of this study, wage and price change relationships for Canada were estimated on the basis of quarterly data for a sample period running from 1953 to 1965. This process began by testing the predictive power of three earlier estimates of these relationships for Canada in order to assess how well these relationships forecasted developments beyond the period to which they were fitted. The second step was to develop our own estimates of these relationships for Canada, drawing as far as possible on what we had been able to learn from our review of other studies. And the third step was to use our "best" results to derive the empirical trade-off relationship between the level of unemployment and the rate of inflation, which was the primary objective of this study. Part III provided evidence which supplements the post-war results for Canada in two ways. The first set of evidence was the reworking of the Canadian relationship for a longer historical period extending back to the 1920's. The primary purpose of this investigation was to ascertain the degree of stability that our estimated quarterly relationships for the post-war period might possess. The second line of supplementary inquiry attempted to develop rough estimates of the wage change, price change, and derived trade-off relationships for the United States, Britain, France, West Germany, and Sweden, and to compare these estimates with those for Canada.

In the course of our discussion, we have mentioned various limitations of our analysis arising because of imperfections in the statistical data available to us, the limitations of our techniques, and the time constraints circumscribing the range of tests that could be undertaken. In principle, it would have been desirable to estimate all of the price and wage change relationships considered here within the framework of an aggregative econometric model in which all direct and indirect effects could be taken into account simultaneously. In fact, this has not been feasible. How much different our estimates would have been had they emerged as part of such a model is unclear, although the results of some trial calculations employing the method of two-stage least squares, which were reported in the Appendix to Chapter 5, suggest that the amount of what single equation bias may be present is not very great.

No attempt here will be made to summarize in detail the conclusions emerging from this study, most of which have already been briefly recapitulated in the final sections of the chapters in which these conclusions have been developed. Instead, the remainder of this Chapter will focus directly on the key question posed by this study: the price-stability-unemployment trade-off options to be faced in formulating Canadian economic policy.

The first point can be stated quite emphatically: there is almost certainly a conflict between the objectives of price stability and high employment, unless the conflict is resolved by defining it out of existence.[1] No vestige of evidence has been found for Canada or any other country that suggests that within the range of experience under consideration, which is the range relevant in the formulation of economic policy in this country, these two objectives are complementary rather than conflicting.[2]

The second point can also be made quite firmly: the relationship between the rate of unemployment and the rate of change in the domestic price level in

[1] For example, some have suggested that "reasonably" full employment and "reasonable" price level stability are compatible. In our view, which is based on the evidence of this and other studies, this statement is true only if the words "reasonably" and "reasonable" are given *unreasonable* interpretations.

[2] Some may perhaps consider this point so obvious as not to warrant separate mention. The point, however, is far from obvious to everyone. In 1958, no less a person than the Governor of the Bank of Canada declared that the idea of a conflict between these objectives is "in danger of becoming the great economic fallacy of the day." (Bank of Canada, *Annual Report*, 1958, pp. 9-10.)

A more sophisticated variant of this criticism is the argument that the apparent ability of policy-makers to trade off reductions in the unemployment rate against a more rapid rate of inflation is illusory, or at least confined to a very short period. In this view, the effects of driving the rate of unemployment below its "equilibrium" value (defined, say, as the point at which unfilled job vacancies equal numbers unemployed) are exhausted within a year, while the harmful effects of inflation are permanent, because the public adjusts to the new (and faster) rate of change of the price level. Hence, this reasoning would lead to the assertion that the intermediate-term trade-off curve is vertical at this "equilibrium" rate of unemployment; in this respect, it would resemble the "pure demand-pull" trade-off curve of Section 5 of Chapter 2. The argument appears to depend crucially on a neo-classical type of theory of unemployment, with the full employment of the labour force representing a unique point in terms of the unemployment rate and with labour market forces playing the predominant role in determining not only the real wage but also this unique rate of unemployment. While we do not doubt that a consistent model embodying this line of reasoning can be constructed on a theoretical plane, we remain somewhat sceptical of its applicability to any "real world" economy, among the developed countries.

Canada is greatly complicated by the openness of the Canadian economy and the magnitude and pervasiveness of the influence of foreign, especially U.S., price and wage changes on Canadian wages and prices. Given this external influence and given the limitations constraining public policies, it is not likely that price changes in Canada can deviate very much from price changes in the United States. This is all the more likely as long as this country adheres to a fixed rate of foreign exchange. In this connection, it is interesting to note that interregional variations in changes in the Consumer Price Index within the United States since 1920 have, on the average, exceeded the differences in consumer price changes between Canada and the United States, regardless of the exchange rate system or the rate itself which Canada has happened to have adopted during this period.[1]

2. The Price Level Objective

From the evidence presented in this and other studies, it seems apparent that Canadian objectives regarding the rate of unemployment and the rate of inflation can be sensibly defined only in relation to the external conditions influencing Canadian wages, price and unemployment, and the ability and willingness of governments to contain or offset these external influences. If one assumes a fixed rate of exchange and also that no post-war government in Canada would find it possible to allow the unemployment level to rise and to fluctuate by whatever extent might be necessary to offset external price influence, the scope for public action to offset external price changes would seem to be restricted.

How, then, should the objective or target value (ϕ) of the rate of change in the consumer price level be defined, for purposes of Canadian public policy, if it is considered unrealistic simply to aim at some target level (k) in the rate of change in consumer prices ($\dot{P}$), irrespective of external circumstances and the limitations on domestic policy? In formal terms, this policy strategy can be expressed as follows:

$$\dot{P} = \phi_1 = k \tag{9.1}$$

If this is not a realistic policy, what then might be considered realistic and appropriate?

One approach, suggested by the close association in the past between changes in Canadian and U.S. prices, might be to define Canada's price level objective in terms of changes in the U.S. Consumer Price Index. Thus one might define this policy objective as aiming to keep the rate of change in Canadian consumer prices equal to the rate of change in U.S. prices, or, alternatively, to keep Canadian consumer price changes above or below the rate of change in U.S. prices by a certain specified amount. In symbols, this strategy can be represented as:

$$\dot{P} = \phi_2 = \dot{p} \pm x\ , \tag{9.2}$$

[1] G. L. Reuber, *The Objectives of Monetary Policy* (Ottawa: Queen's Printer, December 1962), pp. 190-192. This phenomenon is all the more striking if one eliminates the years immediately after World War II, when there were differences in the rate at which wartime controls were removed in the two countries.

where $\dot{p}$ is the rate of change in U.S. consumer prices and x is the desired number of percentage points above or below the rate of change in U.S. prices. Although this approach may be viewed as more realistic than the first approach (that indicated by equation (9.1)), it is also too simple and relies on an impressionistic relationship between U.S. and Canadian price changes. It implies that U.S. price changes are a prime determinant of Canadian consumer price changes. Our "best" estimates, as presented in Chapters 5 and 6, suggest otherwise (although U.S. price changes do show up in an alternative estimate of the Canadian price change relationship, discussed in the Appendix to Chapter 6). Secondly, this definition of the price level objective completely ignores import price changes and U.S. wage changes as external determinants of Canadian price changes. The bulk of our results have pointed to these factors as highly significant determinants of Canadian wage and price changes.

As these comments suggest, a more realistic approach would be to define Canada's price level objective in such a way that the external determinants of Canadian price changes, as estimated in the earlier chapters, are explicitly taken into account. One such definition, based on the tentatively "best" estimate of the trade-off relationship, equation (6.7), might be the following:

$$[\dot{P} - 1.04\dot{F} - 0.54\dot{W}^{*}_{us}] = \phi_3 = k' . \qquad (9.3)$$

This implies defining Canada's price objective in terms of the change in the Consumer Price Index *less* the amount of this change accounted for by changes in import prices and U.S. wages. On this basis, all the external influence on domestic price levels would be accepted as given and policy would be geared entirely towards controlling that portion of the change in prices which could be attributed to domestic factors – the level of unemployment, unit profits and a constant factor.

It does not seem any more feasible, however, for the government simply to back off and to accept fully whatever external influence is exerted on domestic price levels than to try to offset fully the effect of external influences. It is doubtful whether public tolerance of inflation is so great that any present-day government in Canada would wish to adopt this policy strategy.

A more appropriate policy strategy appears to be to define Canada's price level objective in a way which avoids both of these extremes, allowing for some resistance to external influences but not aspiring to offset these external influences completely. Such a definition might be represented as follows:

$$[\dot{P} - \beta(1.04\dot{F} + 0.54\dot{W}^{*}_{us})] = \phi_4 = k'' . \qquad (9.4)$$

As a matter of definition, the value of β varies inversely with the degree of external influence that is offset. Equation (9.1) is simply equation (9.4) with $\beta = 0$; equation (9.3) is equation (9.4) with $\beta = 1.0$. In the framework of the more fundamental theory of the optimum policy combination, which was discussed in Section 6 of Chapter 2, β is an intermediate construct, being determined itself by the shape and position of the trade-off curve, the nature of the family of community indifference curves, and (possibly) the sensitivity of the trade-off curve to external influences. These points will be developed in the Appendix to this Chapter, in which it will be argued that, in general, β lies between the limiting values of zero and unity. The parameter β may be a constant or its magnitude may vary.

It is beyond the scope of this study to suggest an exact value (or exact values) for β. We have, however, asserted that this value is likely to be less than one and greater than zero if the only options open to the public policy are to increase unemployment or to allow prices to rise rapidly. In order to emphasize this point further, some illustrative calculations are presented in Table 9.1. The results are based on the "best" trade-off relationship of this study and show the amount of unemployment "required", according to our estimates, for each year since 1953 in order to achieve the price level objective as defined in three different ways. In all cases, it is assumed that the declared general price level objective is to limit the "target" rate of price increases to no more than 1½ percentage points per year. (In symbols, k, k', and k" are set equal to 1½.) The three definitions of this general goal are specified by assuming three different values of β in equation (9.4): $\beta = 0$; $\beta = 0.5$; $\beta = 1.0$. In all cases, it has been assumed that unit profits remain at their mean level throughout the period.

Columns (2) through (5) of Table 9.1 show the actual annual values for $\dot{P}$, $\dot{F}$, $\dot{W}_{us}$ and U from 1953 to 1965. Columns (6), (7), and (8) present the hypothetical percentage rates of change in consumer prices ($\dot{P}$) implied by our three definitions of the price level objective ϕ. These definitions are based on equation (9.4), with the value of β being varied as indicated. Columns (9), (10), and (11) show the rates of unemployment implied by each of these definitions of the price level target, given a mean level of unit profits and the actual external influences affecting Canadian prices in each year.

As is evident from columns (6) and (9), if Canada's price level objective is defined in terms of holding price increases to a fixed value of 1½ per cent per year regardless of external circumstances, not only can the rate of unemployment be expected to be very high on occasion, but also sharp fluctuations in employment can be expected. Indeed, in some years, no amount of unemployment will suffice, according to the fitted relationships, to keep price changes at the predetermined value. Given the variation in external influences experienced since 1953 and making the other assumptions underlying column (9), one might expect Canadian unemployment rates to range, on this definition of the price level objective, from a low of 3.4 per cent to a high of 15.1 per cent, excepting 1956, 1957 and 1962 when no level of unemployment, according to the estimated relationships, would have achieved the price target. The average rate of unemployment from 1953 to 1965 (excluding these three years) would have been 5.6 per cent of the labour force.

Columns (8) and (11) show similar hypothetical estimates with $\beta = 1.0$. This value for β implies that the price goal is defined in terms of the domestic component of price changes only and that the external influences on domestic price changes will be fully absorbed. In this case, as indicated by column (11), the implied rate of unemployment remains constant at 2.67 per cent, under the assumption of mean unit profits. However, the implied rate of change in the

Table 9.1

Illustrative Estimates of the Rate of Unemployment in Canada Associated with Various Definitions of a General Price Objective (ϕ), Expressed in Terms of Holding Increases in the Consumer Price Level to $1\frac{1}{2}$ Percentage Points per Year

Year	Actual Values:				Hypothetical Annual Percentage Point Changes in Consumer Price Index ($\dot{P}$) Implied by Alternative Values of β, Given $k'' = 1\frac{1}{2}$, $\dot{F}$ = Actual $\dot{F}$, and $\dot{W}^*_{us}$ = Actual $\dot{W}_{us}$: #			Hypothetical Unemployment Rates Required to Maintain $k'' = 1\frac{1}{2}$, for Alternative Values of β Given $\dot{F}$ = Actual $\dot{F}$, $\dot{W}^*_{us}$ = Actual $\dot{W}_{us}$ and $(Z/Q)^* = 97.75$ (its Mean Value over the 1953–65 Sample Period): ##		
	$\dot{P}$	$\dot{F}$	$\dot{W}_{us}$	U	$\beta = 0$	$\beta = 0.5$	$\beta = 1.0$	$\beta = 0$	$\beta = 0.5$	$\beta = 1.0$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1953	−0.86	0.10	5.81	3.04	1.5	3.12	4.74	4.69	3.28	2.67
1954	0.61	0.32	2.75	4.58	1.5	2.41	3.32	3.39	2.97	2.67
1955	0.20	0.86	4.45	4.41	1.5	3.15	4.80	4.78	3.30	2.67
1956	1.50	3.28	5.11	3.43	1.5	4.59	7.67	none	4.47	2.67
1957	3.16	2.65	4.62	4.65	1.5	4.13	6.75	none	3.97	2.67
1958	2.63	1.58	3.10	7.07	1.5	3.16	4.82	4.81	3.30	2.67
1959	1.14	−0.59	4.26	5.99	1.5	2.34	3.19	3.32	2.94	2.67
1960	1.21	0.97	3.13	6.99	1.5	2.85	4.20	4.04	3.15	2.67
1961	0.92	3.02	2.79	7.19	1.5	3.82	6.15	15.12	3.72	2.67
1962	1.18	4.13	2.73	5.96	1.5	4.38	7.27	none	4.23	2.67
1963	1.76	2.79	3.09	5.59	1.5	3.79	6.07	12.29	3.69	2.67
1964	1.79	1.79	2.79	4.71	1.5	3.18	4.87	4.89	3.32	2.67
1965	2.36	0.24	3.54	3.95	1.5	2.58	3.66	3.60	3.03	2.67
Mean Values, 1953–65	1.35	1.63	3.71	5.20	1.5	3.35	5.20	5.58	3.41	2.67

Calculated from equation (9.4): $k'' = \dot{P}_t - \beta(1.04\ \dot{F}_t + 0.54\ \dot{W}^*_{us_t})$.

Calculated from equation (9.4) after substituting equation (6.7) for $\dot{P}_t$:
$k'' = [-14.472 + 1.0378\ \dot{F}_t + 0.11441\ (Z/Q)^*_{t-2} + 0.53937\ \dot{W}^*_{us_t} + 34.161\ (U^*_t)^{-2}] - \beta(1.0378\ \dot{F}_t + 0.53937\ \dot{W}^*_{us_t})$.

Consumer Price Index is relatively high, averaging 5.2 per cent per year from 1953 to 1963. Moreover, this rate of change fluctuates considerably, ranging from 3.2 per cent to 7.1 per cent. In columns (7) and (10), similar estimates based on an intermediate definition of the price level objective are presented. It is here assumed that $\beta = 0.5$. On this definition of the price level objective, variations in aggregate demand, as reflected in unemployment rates, are geared to a policy of offsetting half of the impact of external influences on domestic price changes. The results in Table 9.1, based on this definition of the policy objective, suggest that the unemployment rate would have averaged 3.4 per cent from 1953 to 1965 and that the rate of change in consumer prices would have averaged about 3.4 per cent per year. Under these assumptions, unemployment rates would have ranged from a low of 2.9 per cent to a high of 4.5 per cent, and annual changes in consumer prices would have ranged from 2.3 per cent to 4.6 per cent.

There can be no question that how one defines the price level objective of Canadian economic policy is no less important than the numerical value which one associates with this goal. What may appear to be a very modest goal may in fact be quite unrealistic, because of the external influences bearing on domestic price levels and the constraints limiting economic policy.

One of these constraints which has already been pointed up is the tolerance of the population for unemployment and for inflation. In addition, policy is constrained by the inadequacies of the instruments available, by our knowledge regarding the effectiveness of these instruments and by the lags associated with their use. Moreover, it is evident that the balance of international payments may impose important constraints on policy. Because of the sensitivity of Canadian price changes to external factors, it is evident that if Canadian prices rise more or less than prices abroad, compensating adjustments are likely to occur in the current account of the balance of payments, which, in turn, will necessarily require compensating adjustments in capital flows, exchange rates, or domestic aggregate demand and unemployment conditions. Suppose that Canadian prices consistently rise more rapidly than prices abroad. As a consequence, Canadian imports might be expected to increase and exports to decrease as domestic production became less competitive with foreign production. No attempt will be made here to trace out the process of adjustment and to identify in any detail the policy constraints arising in connection with this process. Suffice it to say that it seems unlikely that such differential price movements could long be sustained by increased capital imports. Moreover, the effectiveness of an exchange rate devaluation in restoring the competitiveness, relative to foreign competition, of Canadian production is likely to be limited unless it were strongly reinforced by domestic policies restricting aggregate demand. This is so because of the large feedback on domestic prices of the increase in foreign prices, which would follow devaluation. The size of this feedback is suggested by the large estimates of the coefficients of $\dot{F}$ in the price change and trade-off relationships. In short, although there is some scope for Canada to pursue an independent policy in regard to a price level objective, this scope can be viewed as relatively narrow. Almost inevitably, price changes in Canada can be expected to be rather similar to international price changes, especially those in the United States.

All these observations are, of course, based on the assumption that the trade-off relationship remains fixed and that policy-makers are faced with a stable relationship between the rate of change in prices and their determinants. This leads to the issue of what, if any, policies might be adopted which would reduce the conflict between the objectives of high employment and price stability, thus shifting the trade-off curve closer to the axes. Among the policies which might be considered in this context are labour market policies, product market policies, and income policies.

The main focus of this study has not been this issue. Empirical evidence which is directly relevant to these questions has, however, been provided in two forms. First, our examination of the historical wage change and price change relationships for Canada, which extend back to inter-war years, indicates that these relationships have remained fairly stable despite all the changes which have occurred in the economy over the years. There is some suggestion, however, that the trade-offs between the rate of inflation and the level of unemployment have become slightly more favourable since 1953 than historically, given the influence of the other determinants of price changes. At the same time, our evidence suggests that Canadian price changes have become substantially more sensitive to external influences since 1953 than during the longer historical period. Nevertheless, it is still an open question whether these are genuine changes or illusions reflecting fortuitous circumstances. At all events, our evidence generally suggests that the price and wage change relationships in Canada are somewhat resistant to changes in the structure of the economy as well as to changes in economic conditions and policies of the type employed in the past.

Secondly, our examination of the wage change relationships for five foreign countries indicates the *possibility* that incomes policies may have had some effect in shifting the trade-off relationships in those countries which have adopted these policies. Even if it is conceded that incomes policies have had this effect, it remains an open question, which can only be answered with the passage of time, whether these policies have resulted in a temporary or a permanent shift in the trade-off relationship. In addition, there is the further important question of what the implications of these policies are for other important objectives of economic policy, such as allocative efficiency, distributive equity, economic growth, and balanced regional economic development.

Aside from these issues, there remains the fundamental issue of how to determine the optimum combination of the rate of price change and the rate of unemployment, an issue raised in Section 6 of Chapter 2. What is the appropriate value of k'' in our earlier example if one abstracts from the effect of external influences on Canadian prices?[1] And if one takes external influences into account, as one must, what is the appropriate value not only of k'' but also of β ? As was pointed out for the parameter β when this construct was introduced, the appropriate (or "socially optimal") values of k'' and of β are mutually determined by

[1]The "socially optimal" value of k'' is, according to the theory of Section 6 of Chapter 2, the rate of price change at point Q in Figure 2.3, page 28. The curve AA' in that Figure abstracts (as it is drawn) from external influences on Canadian consumer price changes.

the empirical trade-off relationship between price changes and its determinants, including the rate of unemployment, and by the relative valuation placed by policy-makers, representing the community, on the costs of inflation and of unemployment. In this study, our attention has focused exclusively on estimating the empirical trade-off relationships. No attention has been given to the other part of this policy issue. As is evident from the Appendix that follows, the greater the cost associated with inflation in comparison to unemployment, the lower the value of k'' and of β which will be chosen by policy-makers in defining the goals of economic policy.

It is appropriate that this study should conclude by posing more questions than it has answered. Perhaps the most valuable functions which an empirical study such as this can serve are to clarify and to define the policy issues which must be faced and to provide objective evidence which will allow difficult and important decisions to be made on a more informed and rational basis.

APPENDIX

Diagrammatic Presentation of the Derivation of β, in the Theory of the Optimum Policy Combination

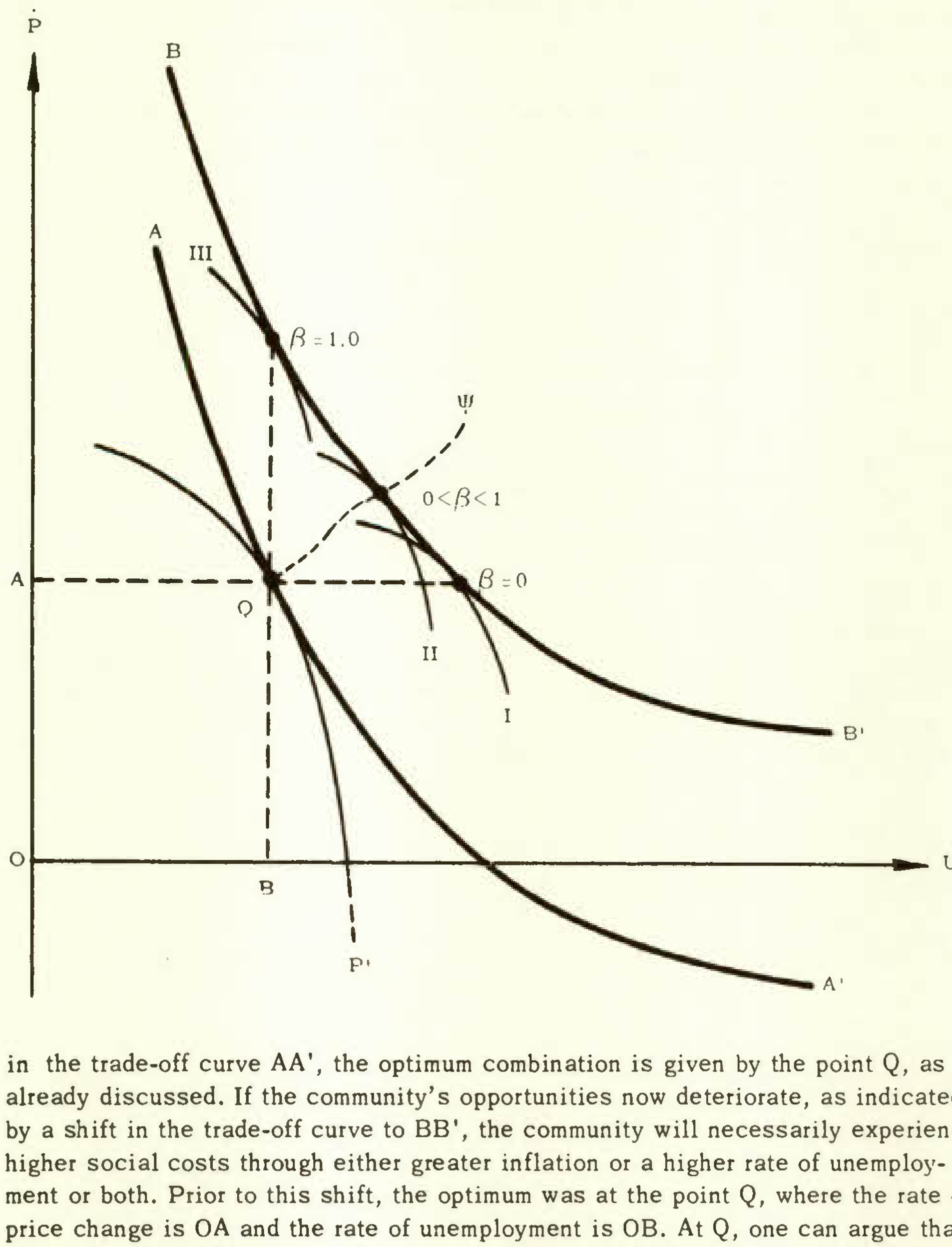
The discussion of this Appendix will focus on Figure 9.1; the basis of this discussion is the theory of the optimum policy combination, as developed in Section 6 of Chapter 2. The curves AA' and BB' correspond to the curves presented in Figure 2.1, and, as already pointed out, the point of tangency Q is reproduced from Figure 2.3. This point may be regarded as an optimum combination of the rate of change in consumer prices and the level of unemployment, for a given family of community indifference curves and at given values of the other explanatory variables of the trade-off relationship. When variations in other determinants of the rate of price changes, such as the rate of change in import prices and in U.S. wages, are taken into account, we have seen that such variations will shift the two-dimensional trade-off curve closer to, or further from, the axes. The curve BB' is the trade-off locus when variations in these other determinants have produced a more inflationary environment (for a given rate of unemployment). What will the optimum policy combination of a rate of inflation and an unemployment rate be in these changed circumstances?

As before, this will depend upon the preference function of the authorities, which is presumed to reflect the wishes of the community. Three possibilities are shown in Figure 9.1, corresponding to several possibilities. If the social preference function generates community indifference curve I, then the target value for the rate of price change remains unchanged and the resulting value of the parameter β, as defined in the text of this Chapter, is zero. If the appropriate community indifference curve is that labeled III, then the target value for the unemployment rate is unchanged and all of the external pressures on the rate of change in prices are absorbed into the price level target. In this case, β is equal to unity. If the appropriate community indifference curve is that labeled II, then the response to the deterioration in the objective environment will be both to incur an increased rate of unemployment (but not so much as would be permitted in the case of indifference curve I) and to incur an increased rate of inflation (but not as much of an increase as with indifference curve III). The implied value of the parameter β will be, therefore, some intermediate value lying between zero and unity. The series of derived values of β define an "expansion path", or locus of optimal combinations of the rate of inflation and the level of unemployment, as the influence of non-unemployment variables shifts the trade-off curve closer to and further from the axes. (In Figure 9.1, this locus of optimal combinations is denoted by the symbol Ψ.) Consequently, both β and the point Q (the value of k'') are simultaneously determined by the empirical trade-off relationship and the family of community indifference curves, which reflect the preferences of society for the policy objectives of high employment and price level stability.

Finally, it seems worth presenting the argument for the assertion that zero and unity are likely to be the limiting values of the parameter β. Prior to the shift

Figure 9.1

GRAPHICAL DERIVATION OF THE VALUE OF THE PARAMETER β, IN THE THEORY OF THE OPTIMUM POLICY COMBINATION



in the trade-off curve AA', the optimum combination is given by the point Q, as already discussed. If the community's opportunities now deteriorate, as indicated by a shift in the trade-off curve to BB', the community will necessarily experience higher social costs through either greater inflation or a higher rate of unemployment or both. Prior to this shift, the optimum was at the point Q, where the rate of price change is OA and the rate of unemployment is OB. At Q, one can argue that the marginal social cost of an incremental amount of further inflation will be just balanced by the marginal social cost of a further small increase in the rate of unemployment; this is a necessary condition for an optimum at an interior point. Now if the community is going to suffer (say) a greatly increased rate of unemployment, it seems highly unlikely that it would opt for a lower rate of inflation than previously. For the higher rate of unemployment should increase not only the total social costs of unemployment, but also the *marginal* social costs of this phenomenon, while a lower rate of inflation should, by similar reasoning, entail a lower *marginal* social cost of inflation. Consequently, if the point Q was a social optimum before the shift in the trade-off curve, a point on BB' below the point labeled $\beta = 0$ could not be a social optimum after this shift, because, at all such points, the marginal social costs of unemployement would then exceed the marginal social costs of inflation. A similar argument can be developed for the presumption that unity is the other extreme value of the parameter β. Furthermore, the argument suggests that the intermediate case (represented by community indifference curve II) is the one that we should regard as typical.

PUBLICATIONS OF ECONOMIC COUNCIL OF CANADA		PUBLICATIONS DU CONSEIL ÉCONOMIQUE DU CANADA
Annual Reviews	**Author — Auteur**	**Exposés annuels**
First Annual Review: Economic Goals for Canada to 1970 (EC21-1/1964, $3.50)	Council — Conseil	Premier exposé annuel: Objectifs économiques du Canada pour 1970 (EC21-1/1964F, $3.50)
Second Annual Review: Towards Sustained and Balanced Economic Growth (EC21-1/1965, $2.75)	Council — Conseil	Deuxième exposé annuel: Vers une croissance économique équilibrée et soutenue (EC21-1/1965F, $2.75)
Third Annual Review: Prices, Productivity and Employment (EC21-1/1966, $2.75)	Council — Conseil	Troisième exposé annuel: Les prix, la productivité et l'emploi (EC21-1/1966F, $2.75)
Fourth Annual Review: The Canadian Economy From the 1960's to the 1970's (EC21-1/1967, $2.75)	Council — Conseil	Quatrième exposé annuel: L'économie canadienne des années 1960 aux années 1970 (EC21-1/1967F, $2.75)
Staff Studies		**Études préparées par le personnel**
1. Population and Labour Force Projections to 1970 (EC22-1/1, $.75)	F. T. Denton, Y. Kasahara, S. Ostry	1. Projections de la population et de la main-d'œuvre jusqu'à 1970 (EC22-1/1F, $.75)
2. Potential Output, 1946 to 1970 (EC22-1/2, $1.00)	B. J. Drabble	2. Potentiel de production, 1946 à 1970 (EC22-1/2F, $1.00)
3. An Analysis of Post-War Unemployment (EC22-1/3, $.75)	F. T. Denton, S. Ostry	3. Une analyse du chômage depuis la fin de la guerre (EC22-1/3F, $.75)
4. Housing Demand to 1970 (EC22-1/4, $.75)	W. M. Illing	4. Demande d'habitations pour 1970 (EC22-1/4F, $.75)
5. Business Investment to 1970 (EC22-1/5, $1.00)	D. A. White	5. Investissements privés pour 1970 (EC22-1/5F, $1.00)
6. Special Survey of Longer Range Investment Outlook and Planning in Business (EC22-1/6, $.25)	B. A. Keys	6. Enquête spéciale sur les intentions et la programmation à moyen terme des entreprises privées (EC22-1/6F, $.25)
7. Canada and World Trade (EC22-1/7, $.50)	M. G. Clark	7. Le Canada et le commerce mondial (EC22-1/7F, $.50)

Staff Studies (*continued*)		Études préparées par le personnel (*suite*)
8. Export Projections to 1970 (EC22-1/8, $.75)	J. R. Downs	8. Projections des exportations jusqu'à 1970 (EC22-1/8F, $.75)
9. Federal Tax Revenues at Potential Output, 1960 and 1970 (EC22-1/9, $.50)	D. J. Daly	9. Rendement des impôts fédéraux dans l'hypothèse de la réalisation du potentiel de production 1960 et 1970 (EC22-1/9F, $.50)
10. National Saving at Potential Output to 1970 (EC22-1/10, $.50)	F. Wildgen	10. L'épargne nationale dans l'hypothèse de la réalisation du potentiel de production pour 1970 (EC22-1/10F, $.50)
11. Changes in Agriculture to 1970 (EC22-1/11, $.50)	J. Dawson	11. Changements dans le secteur agricole jusqu'à 1970 (EC22-1/11F, $.50)
12. The Contribution of Education to Economic Growth (EC22-1/12, $1.90)	Gordon W. Bertram	12. Apport de l'éducation à la croissance économique (EC22-1/12F, $1.90)
13. Internal Migration in Canada, 1921-1961 (EC22-1/13, $1.60)	Isabel B. Anderson	13. Migration à l'intérieur du Canada, 1921-1961 (EC22-1/13F, $1.60)
14. Interregional Disparities in Income (EC22-1/14, $1.75)	S. E. Chernick	14. Disparités interrégionales du revenu (EC22-1/14F, $1.75)
15. An Analysis of Interregional Differences in Manpower Utilization and Earnings (EC22-1/15, $1.00)	F. T. Denton	15. Analyse des différences interrégionales dans l'utilisation de la main-d'œuvre et le revenu gagné (EC22-1/15F, $1.00)
*17. Business Cycles in Canada (EC22-1/17)	D. A. White	†17. Les cycles économiques au Canada (EC22-1/17F)
18. Manpower Planning in Industry: A Case Study (EC22-1/18, $1.00)	B. A. Keys H. H. Wright	18. La planification de la main-d'œuvre dans l'industrie (Étude de cas) (EC22-1/18F, $1.00)
19. Population, Family, Household and Labour Force Growth to 1980 (EC22-1/19, $1.00)	W. M. Illing Y. Kasahara M. V. George F. T. Denton	†19. La croissance de la population, du nombre de familles et de la main-d'œuvre, jusqu'en 1980 (EC22-1/19F)
*20. Enrolment in Schools and Universities, 1951-52 to 1975-76 (EC22-1/20)	Z. Zsigmond W. M. Illing	†20. Instructions aux écoles et aux universités, 1951-1952 à 1975-1976 (EC22-1/20F)
*21. Scale and Specialization in Canadian Manufacturing (EC22-1/21)	D. J. Daly B. A. Keys	†21. L'échelle et la spécialisation dans l'industrie manufacturière canadienne (EC22-1/21F)

Special Studies		Études spéciales
1. Immigration and Emigration of Professional and Skilled Manpower During the Post-War Period (EC22-2/1, $1.50)	L. Parai	1. Immigration et émigration de spécialistes et de travailleurs qualifiés depuis la fin de la guerre (EC22-2/1F, $1.50)
2. A Survey of Labour Market Conditions, Windsor, Ontario, 1964: A Case Study (EC22-2/2, $.50)	G. R. Horne W. J. Gillen R. A. Helling	2. Relevé des conditions du marché du travail à Windsor (Ontario), 1964 (Étude de cas) (EC22-2/2F, $.50)
3. Perspective on Canada's International Payments (EC22-2/3, $1.60)	David W. Slater	3. Perspectives quant aux paiements internationaux du Canada (EC22-2/3F, $1.60)
4. Incomes Policies—Some Foreign Experiences and their Relevance for Canada (EC22-2/4, $1.75)	David C. Smith	4. Politiques des revenus—certaines expériences à l'étranger et les conclusions à en tirer pour le Canada (EC22-2/4F, $1.75)
5. Price Stability and High Employment: The Options for Canadian Economic Policy: An Econometric Study (EC22-2/5, $3.25)	R. G. Bodkin E. P. Bond G. L. Reuber T. R. Robinson	
6. Canadian Labour Relations in an Era of Technological Change (EC22-2/6, $1.25)	J. R. Cardin	6. Les relations du travail au Canada face aux changements technologiques (EC22-2/6F, $1.25)

Conference Papers and Reports	Documents et rapports de colloques
National Conference on Labour-Management Relations (1964) (EC22-364, $2.00)	Colloque national sur les relations patronales-ouvrières (1964) (EC22-364F, $2.00)
Conference on Stabilization Policies, Report of the Conference at University of Western Ontario, August 1965 (EC22-665, $3.00)	Colloque sur les politiques de stabilisation, Rapport du colloque tenu à l'Université Western Ontario, août 1965 (EC22-665F, $3.00)
Conference on International Trade and Canadian Agriculture, Banff, Alberta, January 1966 (EC22-766,$3.00)	Colloque sur le commerce international et l'agriculture canadienne, Rapport du colloque tenu à Banff (Alberta), janvier 1966 (EC22-766F, $3.00)

Papers presented at Conferences on Productivity through New Technology		Documents présentés aux Colloques sur la productivité par la nouvelle technologie
Modern Management (EC22-4/1, $.50)	G. G. Fisch	La gestion moderne (EC22-4/1F, $.50)
Practical Application of Data Processing in Small and Medium Manufacturing Companies (EC22-4/2, $.75)	H. S. Gellman R. C. Carroll	Application pratique du traitement de l'information dans les petites et les moyennes entreprises industrielles (EC22-4/2F, $.75)
A Practical Approach to Automatic Production (EC22-4/3, $.50)	D. J. Clough J. W. Abrams R. W. P. Anderson	Manière pratique d'envisager la production automatique (EC22-4/3F, $.50)
Advances in Metal Working (EC22-4/4, $.75)	J. Vande Vegte	Les progrès dans le travail des métaux (EC22-4/4F, $.75)
Improving Material Movement Through the Manufacturing Cycle (EC22-4/5, $.50)	J. A. Brown B. D. Beamish	L'amélioration du mouvement du matériel à travers le cycle manufacturier (EC22-4/5F, $.50)
The Economic Justification of New Equipment (EC22-4/6, $.75)	C. G. Edge	Justification économique du renouvellement de l'équipement (EC22-4/6F, $.75)
New Technology in Materials and Processes (EC22-4/7, $.70)	J. Vande Vegte	Nouvelle technologie visant les matières premières et les procédés (EC22-4/7, $.70)

Other Studies and Reports		Autres études et rapports
Annual Report (1964) (EC1-1964, $.50)	John J. Deutsch	Rapport annuel (1964) (EC1-1964F, $.50)
Annual Report (1965) (Fo 1/1965, $.50)	John J. Deutsch	Rapport annuel (1965) (Fo 1/1965F, $.50)
Annual Report (1966) (EC1-1966, $.50)	John J. Deutsch	Rapport annuel (1966) (EC1-1966F, $.50)
Annual Report (1967) (EC1-1967, $.50)	John J. Deutsch	Rapport annuel (1967) (EC1-1967F, $.50)

Other Studies and Reports (*continued*)		Autres études et rapports (*suite*)
A General Incentive Programme to Encourage Research and Development in Canadian Industry, A Report to the Economic Council of Canada (EC22-565, $.60)	Advisory Committee on Industrial Research and Technology — Comité consultatif sur la recherche industrielle et la technologie	Programme général de stimulation des travaux de recherche et de développement dans l'industrie canadienne, Rapport présenté au Conseil économique du Canada (EC22-565F, $.60)
A Declaration on Manpower Adjustments to Technological and Other Change (EC22-866, $.75)	Council — Conseil	Une déclaration au sujet de l'adaptation de la main-d'œuvre aux changements technologiques et autres (EC22-866F, $.75)
Towards Better Communications Between Labour and Management (EC22-967, $.25)	Council — Conseil	Vers une amélioration de la communication entre patrons et travailleurs (EC22-967F, $.25)
Interim Report—Consumer Affairs and the Department of the Registrar General (EC22-1067, $.25)	Council — Conseil	Rapport provisoire sur les affaires du consommateur et le ministère du Registraire général (EC22-1067F, $.25)

*forthcoming

†en préparation

Copies of the above publications may be obtained in English and French from the Queen's Printer, Ottawa. Payment should accompany orders to avoid possible delay in shipment.

On peut se procurer des exemplaires de ces publications, en anglais et en français, chez l'Imprimeur de la Reine, à Ottawa. Afin d'éviter les retards d'expédition, prière d'envoyer les chèques en même temps que les commandes.

Date Due

~~Jan 9/69~~
~~OCT 4 '78~~
~~NOV 14 '78~~