An Econometric Analysis of the Canada-United States Automotive Agreement

The First Seven Years

David A. Wilton

ECONOMIC COUNCIL OF CANADA

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This study reflects the views of the author and not necessarily those of the Economic Council of Canada.

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Preface

This monograph was prepared as a background study for the Canadian Commercial Policy Review[1] undertaken by the Economic Council of Canada. The principal objective of this study is to analyse the macroeconomic effects of the 1965 Automotive Agreement on the Canadian economy as well as on the automotive industries. Econometric models of the Canadian automotive sector are developed and integrated into the large CANDIDE[2] model of the Canadian economy to provide estimates of the impact of the Agreement. I wish to thank Peter Cornell, Director of the Policy Group, and John Downs, staff member, for suggesting that this study be undertaken and for the co-operation extended to me in conducting the research. I am also grateful for advice, constructive criticism, and assistance from many individuals associated with the Economic Council of Canada and the Department of Economics at Queen's University. In particular I would like to thank Charles Beach, Ron Bodkin, Bobbi Cain, John Dawson, David Emerson, Roger Gagnon, Jim Gander, Nicholas Mathieu, Mike McCracken, André Raynauld, Tom Schweitzer, Philip Smith, Bert Waslander and three anonymous referees. None of the above individuals, nor the Economic Council of Canada, should be held responsible for any remaining errors nor should be associated with the views and conclusions of this study.

As is often the case with empirical studies, recent events may have overtaken some of the findings of this study. The basic econometric estimation required for this study was completed by early 1973, and established 1971 as the terminal date for the analysis. During the latter part of 1973 and early 1974, staff members of the Economic Council operationally integrated the estimated automotive satellite models into CANDIDE Model 1.1 (see Chapter 6 of this monograph authored by Nicholas Mathieu) and performed the necessary simulations. Consequently, this study was prepared and drafted during the 1972-74 period and provides an analysis of the 1965 Automotive Agreement only for the first seven years of its existence. A further analysis of the Agreement in the context of subsequent events, such as the energy crisis and the deep United States recession of the mid-1970s, must await another study.

1 Economic Council of Canada, *Looking Outward* (Ottawa: Information Canada, 1975).

2 CANDIDE is an acronym for CANadian Disaggregated InterDepartmental Econometric model.

An Econometric Analysis of the Canada-United States Automotive Agreement

1 Introduction, Summary and Conclusions

On January 16, 1965, the Canadian and United States governments signed an Automotive Products Agreement, permitting "controlled" free trade in automotive products between their respective countries. This Agreement represented "an effort by both countries to achieve mutual benefits through an arrangement designed to increase efficiency and lower costs in a basic industry joined by economic and financial ties but separated by tariffs and other barriers".[1] Since this bilateral commercial policy decision represents a substantially different approach to trade "liberalization" and the rationalization of industry, its success or failure may greatly affect the course of future government policy.

The basic objective of this study is to provide an econometric assessment of the impact of the Automotive Agreement on the Canadian automotive sector and the Canadian economy. While there have been a number of appraisals and analysis of certain aspects of the Agreement,[2] this study represents the first attempt to measure systematically the general equilibrium effects of the Agreement on the entire Canadian economy in terms of the following types of economic dimensions: growth rates, employment generation, investment expenditures, productivity, factor shares, inflation and the balance of payments. In addition, the effects of the Automotive Agreement will be contrasted to an alternative industrial strategy which the government might have chosen in lieu of the Automotive Pact. Thus, the Canadian economic costs and benefits of the Automotive Agreement will be analysed in the context of both a passive government role (i.e. no specific, alternative, compensatory policy) and an active alternative industrial policy designed to offset any potential shortfall in Canadian output and employment.

1 U.S. Senate Finance Committee, *First Annual Report of the President to the Congress, Canadian Automobile Agreement,* (Washington: 1967), p. 35.

2 See for example W. E. Alexander, *An Econometric Model of Canadian-U.S. Trade in Automotive Products, 1965-1971,* Technical Report 3, (Ottawa: Bank of Canada, 1974); C. E. Beigie, *The Canada-U.S. Automotive Agreement: An Evaluation,* Canadian-American Committee, Montreal, 1970; D. L. Emerson, *Production, Location and the Automotive Agreement,* Economic Council of Canada, (Ottawa: Information Canada, 1975); D. A. Wilton, "An Econometric Model of the Canadian Automotive Manufacturing Industry and the 1965 Automotive Agreement", *Canadian Journal of Economics,* May 1972; and P. Wonnacott and R. J. Wonnacott, *Free Trade Between United States and Canada, the Potential Economic Effects,* (Cambridge, Mass.: Harvard University Press, 1967).

Much of the empirical analysis in this study is an attempt to rewrite the economic history of Canada during the latter part of the nineteen sixties as it would have been had Canada not negotiated the Automotive Agreement with the United States. The research tool which makes possible such an exercise in counterfactual analysis is a set of computer simulation experiments performed on the CANDIDE model, an econometric model of the Canadian economy. While the CANDIDE model is an extremely large and highly disaggregative model, substantial additional econometric research into the behavioural relationships pertinent to the automotive industry is required to improve the power of the model to measure the impact of the Automotive Agreement. Given the distinctive industrial organizational features of the automotive manufacturing industry in contrast to the automotive parts and and accessories industry, two specific industry models are estimated and incorporated into the CANDIDE model. The direct effects of the Automotive Agreement are embodied in the individual structural relationships (equations) in the relevant sectors of the automotive satellite models through the frequent use of a specially designed parameter transitional shift function. This function allows the underlying structural parameters to shift in a gradual manner (over a transition phase) to significantly different levels in the post-Automotive Agreement era. Control simulations of the augmented CANDIDE model in which this parameter transitional shift function is operative (the Canadian economy with the Automotive Agreement) and nonoperative (the Canadian economy without the Automotive Agreement) are presented. Further counterfactual evidence is generated by a control simulation of the augmented CANDIDE model without the transitional shift function but with an alternative industrial policy introduced in 1965 and thereafter. These simulation results highlight the dramatic effects which the Automotive Agreement has had on the Canadian economy.

Invoking the traditional set of caveats concerning inherent errors in econometric models and the use of point estimates, the major conclusions of this econometric evaluation of the Automotive Agreement can be summarized. On the assumption of no specific alternative government policy, the signing of the Automotive Agreement had the following effects on the Canadian economy *for the year 1971:*

- (i) real Gross National Expenditure (GNE) was over 5% higher than it would have been without the Automotive Agreement;
- (ii) total employment within the Canadian economy increased by almost 4%;
- (iii) the general rate of inflation did not appreciably change although retail automobile prices declined by 12%;
- (iv) while large increases in corporate profits (8.8%) and in total wages, salaries and supplements (6.5%) occurred, real wages per employee only moderately increased (2.6%);

(v) real gross capital stock in the Canadian economy marginally increased (1.3%);

(vi) there was a strong favourable effect on the current account of the balance of payments.

To reiterate, these results are based on two simulations of an enlarged CANDIDE model in which the only difference is the presence (absence) of the shifts in the underlying structural parameters which can be directly attributed to the signing of the Automotive Agreement. In other words, if the Canadian government had not negotiated the Automotive Pact (and had not adopted other new policy initiatives which are not included in the present structure of CANDIDE), then the results from this study reveal that the 1971 level of real output in the Canadian economy would have been approximately 3.3 billion dollars lower, accompanied by almost 300,000 fewer jobs.

These favourable effects were the economy-wide manifestation of the stimulus given to the automotive sector by the Automotive Agreement. In the motor vehicle manufacturing industry, the Auto Pact generated a full 100% increase in the level of real output. Simulation results indicate even greater gains for the Canadian automotive parts and accessories industry under the Automotive Agreement. The automotive parts and accessories industry tripled the level of real output, added an additional 26,000 employees and experienced a substantial investment boom during the first seven years of the Auto Pact. In fact, almost all of the new jobs in the automotive sector which can be attributed to the Agreement were created in the automotive parts and accessories industry, not the motor vehicle industry. Finally, both industries reaped a considerable increase in corporate profits over the levels which would have been realized without the Automotive Agreement, largely the result of increases in output and (labour) productivity accompanying the rationalization of the automotive sector.

In the final chapter of this study, the impact of the Automotive Agreement is compared with an alternative industrial policy which stimulates investment in the manufacturing sector to achieve the same simulated level of output and employment as obtained under the Agreement. If the goal of an industrial strategy is to increase the manufacturing base in Canada, the Automotive Agreement generated an additional $300 million of real output and 80,000 jobs in the manufacturing sector over the levels achieved under this alternative manufacturing investment policy. More important than the differential effects of these two alternative industrial policies on the sectoral distribution of output and employment are the balance-of-payments effects. The Automotive Agreement transformed the large simulated deficit on current account into a surplus of $200 million for the year 1971. On the other hand, the alternative new investment policy simulation substantially increased the existing current account deficit to a level exceeding $2 billion for the same year. The tremendous surge in automotive exports (largely to the United States) under the Automotive Agreement structure more than offsets the increased flow of imports which typically accompany a higher rate of economic activity. The Automotive Agreement, born out of balance-of-payments concerns, generated a spectacular growth in automotive exports and a substantial improvement in the Canadian trade balance during the 1965-71 period.

The econometric research strategy adopted in this study to evaluate the general equilibrium effects of the Automotive Agreement on the Canadian economy necessarily imposes restrictions or constraints on the scope of this evaluation. In particular, any deficiencies of specification within the CANDIDE model will affect the results of this study. Perhaps even more worrisome than the CANDIDE sins of commission are its sins of omission. For example, the CANDIDE model is not (yet) on a regional basis and consequently the regional effects of the Automotive Agreement on Canadian economic development are not analysed. However, given the strong favourable effects from the Automotive Agreement and the location of the automotive industry primarily within Southern Ontario, one suspects that this single policy action may have had a greater impact on strengthening the Ontario economic base than the combined effects of all the DREE grants and subsidies to underdeveloped Canadian regions.

An even more important omission in this evaluation of the Automotive Agreement is the lack of a comparable study for its impact on the United States economy. It is clearly inappropriate to regard the Automotive Agreement as a "zero sum game" in which Canadian gains must of necessity be United States losses. The crucial issue is the distribution of the North American increases in output which are attributable to the Auto Pact, an issue beyond the scope of this study.

Finally, the results of this study provide an evaluation of the Automotive Agreement only through the first seven years of its existence. Without wishing to invoke any Biblical omens, these seven years were generally prosperous for both the United States and Canada, and thus the results of this study may be conditional on favourable economic conditions within the United States (and may not necessarily hold for "seven lean years").[3] While one can only speculate, a severe recession in the United States, such as that in 1973-75, may permeate the Canadian economy to a greater degree because of the Automotive Agreement's integration of the North American automotive industry. The fact that the automotive trade surpluses of 1970-71 have dissipated into substantial deficits in 1974-75 may signal a reversal of some of the positive effects of the earlier years. For better and for worse, the Canadian economy is now even more dependent upon economic activity within the United States. Whether the Automotive Agreement will continue

3 During this seven-year period, the United States economy grew at an annual rate of 4%, had an average inflation rate of approximately 4%, and experienced an average unemployment rate of 4.3%.

to have such favourable effects during the less prosperous years of the business cycle (and in the context of a new energy structure) is an open question which will require several more years of data before a comparable answer can be offered.

Despite these substantial qualifications, the basic conclusion of this study can be stated succintly. During the 1965-71 period, the Automotive Agreement was very good for Canada. Canadian citizens enjoyed lower automobile prices (although not at the free trade price) and increased employment prospects. The automotive industries, through rationalization made possible under the Agreement, experienced a tremendous growth in output accompanied by increased productivity and higher corporate profits. The Canadian government, by signing the Automotive Agreement, was simultaneously able to achieve substantial economic growth, a strengthening of the manufacturing base, a reduction in unemployment, and a dramatic improvement in the balance of payments. These simulation experiments, based on the first seven years of its existence, suggest that the Automotive Agreement was one of the most successful economic decisions undertaken by the Canadian government in the post-war era.

2 The Canadian Automotive Industry and the Canada-United States Automotive Agreement

In order to understand and model the structural impact of the Automotive Agreement on the Canadian economy and automotive sectors, it is useful to review the historical context of both the Canadian automobile industry and the Agreement. Besides providing a brief historical review of the evolution of the Canadian automobile industry, this chapter also describes a number of salient economic characteristics of the Canadian automotive industry and the 1965 Canada-United States Automotive Agreement.

The Canadian Automotive Industry

The origins of the Canadian automotive industry can be traced back to August 1904 when the Ford Motor Company of Canada was incorporated in Windsor, Ontario. The initial production process consisted of simply putting bodies and wheels on Ford chassis, ferried across the Detroit river from the "parent" Ford operation, for sale in Canada and the British Commonwealth. While there were only 117 Ford automobiles "assembled" in Canada in this initial year,[1] the basic subsidiary nature of the Canadian automobile industry (which persists to the present era seventy years later) was firmly established.

Three years later the McLaughlin Carriage Company was formed in Oshawa, producing a McLaughlin-Buick automobile, followed by the Chevrolet Motor Company of Canada in 1915 under a direct agreement with the parent United States Chevrolet organization.[2] These two McLaughlin companies were sold to General Motors in 1918, and formed the General Motors Company of Canada, Ltd. By this time, the assembly line technique had been established and the collective Canadian motor vehicle assembly industry had grown to almost 100,000 units per year.

1 This initial year of automobile assembly was carried out by 17 employees with a total payroll of $12,000.

2 Both of these firms were initiated by Robert McLaughlin whose endeavours in Canadian transportation equipment can be traced back to *1867* and the construction of his first *sleigh* in Tyrone, Ontario.

The final member of the "Big Three", Chrysler Corporation of Canada, was incorporated in 1925, assuming the Canadian assets of the Maxwell-Chalmers firm. A number of smaller firms (e.g. International Harvester [1910] and White Motor Company [1916]) also joined the Canadian industry in its formative years with the most interesting smaller firm being the Studebaker Company. Dating back to 1909, this latter firm remained active in Canada until the tariff revisions of the 1930s. However, in 1947 Studebaker resumed production in Hamilton, Ontario and in 1963 the entire United States operation was moved to the Canadian plant in a last-ditch effort to save the automobile line. Less than three years later, the fate of the Studebaker was completely sealed and all passenger car operations were discontinued. More recent additions to the automotive industry include American Motors (1956) and Volvo (1961).

In tracing the development and growth of the Canadian automotive assembly industry, the dominant feature is the pervasive role of Canadian tariffs. In fact it would be difficult to determine whether the tariff presents a history of the automotive industry or whether the industry provides a history of Canadian tariff laws. In the early stages a 35% tariff was in effect, designed primarily to protect the Canadian industry from United States imports.[3] Behind this high tariff wall domestic production flourished with production increasing to over 200,000 units by 1926. Even more important, preferential tariff laws with the British Commonwealth generated substantial exports (approximately one-third of domestic production) in spite of great inefficiencies in production compared to the larger United States industry. Thus, this early development of the automobile industry, which represented substantial industrial growth, was primarily a result of high tariffs enticing United States firms to begin domestic Canadian assembly rather than exporting finished vehicles into Canada.

These high tariff walls were not without a cost. Canadian consumers were increasingly becoming aware of the Canadian-United States price differential (up to 35%) and in 1926 the tariffs were reduced to 20 and 27½%. To offset the reductions in tariff protection, the Canadian government granted a number of special duty drawback and tariff provisions to the Canadian automotive industry, the first in a series of special government concessions to the automotive industry.[4] The combined effect of the lower tariff and special concessions to the industry was continued growth in the Canadian industry until the severe depression of the 1930s.[5]

3 The tariff on United Kingdom imports was only 22½% but sufficient to protect the Canadian industry from British production.

4 See *Report, Royal Commission on the Automotive Industry,* Vincent Wheeler Bladen, Commissioner (Ottawa: Queen's Printer, 1961) for further details.

5 By 1929 Canadian vehicle assembly had reached 263,000 units of which approximately 40% were exported (primarily under British Commonwealth Tariff Preferences).

While a number of minor tariff changes were made in the early 1930s, the major revision took place in 1936. The rate of duty on all motor vehicles was reduced to 17½% for Most-Favoured-Nations and zero under British Preferential Tariffs, coupled with a provision for duty-free entry of automotive parts providing certain "content" requirements were maintained.[6] Subsequent to this major tariff change and "content" provisions of 1936, there were few changes in commercial policy regarding the Canadian automobile industry until the Royal Commission into the automotive industry (1960-61) and the events which led up to the Automotive Agreement.

During this twenty-five year interlude, the Canadian automotive industry had a mixed record. The stimulus provided by World War II and the Korean War to (war) vehicle production boosted annual vehicle production to almost 500,000 units in 1953. In terms of automobile units, the peak annual production (assembly) was reached in 1955-56 with 375,000 units in each year. However, during the mid-1950s and early 1960s the position of the domestic Canadian automotive industry deteriorated substantially. From 1955 through 1961 the number of motor vehicle units produced per year decreased by 15% while unit sales of motor vehicles in Canada increased by 10%. During this six-year period, exports of all motor vehicles *fell* by 34% while imports *rose* by 31%. In terms of automobiles alone, the import-export imbalance widened by over 50% to 97,000 units in 1961.[7] Thus, by 1960 almost 40% of all automobiles marketed in Canada were manufactured outside of Canada (with the majority of these originating overseas).

Given the stagnation in the Canadian automotive industry and this rapid rise in European automotive imports, the Canadian government appointed a Royal Commission (also referred to as the Bladen Commission) to study the automotive industry. In the final report, Bladen recommended a series of measures including removal of the 7½% excise tax (the only proposal actually adopted by the Canadian government), the establishment of a 10% tariff on British automotive products, and an extended Canadian content requirement for duty-free entry of automotive products including motor vehicles.[8] In spirit, Bladen's recommendations of 1961 followed the logic of the 1936 major tariff revision by providing protection and relief from duties

6 Again, for further details see *Report, Royal Commission on the Automotive Industry*, pp. 8-11. As Bladen states, "It is difficult to assess the impact of the tariff changes and the new content provisions of 1936. The three-year period which preceded the war was marked by unsettled economic conditions and does not provide a fair basis on which to judge their effect. Production in the motor vehicle industry increased substantially in 1937 but declined until the outbreak of war . . . . A number of low-volume producers ceased manufacturing in Canada after 1936 . . . (the tariff changes) may well have been a contributing factor."

7 In fact, this imbalance reached a staggering total of 153,000 units in 1960. In the 1946-52 period the annual imbalance averaged only about 7,000 automobile units.

8 *Report, Royal Commission on the Automotive Industry*, Chapter 6.

for the local industry via a complex set of Canadian content provisions and export incentives. As Beigie points out, the Bladen plan would have entailed a closer integration of Canadian production with that in the United States.[9]

By the time the Bladen Report was released and digested, the level of European automotive imports was subsiding and the "extended content plan" was never implemented. However, during 1962-63 two duty-remission plans were implemented which were reminiscent of Bladen's proposals. In 1962, a year of foreign exchange rate and balance-of-payment difficulties for Canada, the Canadian government re-instated a 25% import duty on automatic transmissions but remitted the duty back to the manufacturer if exports of automotive parts were increased beyond a 1961-62 base-year level.[10] A year later this duty remission program was extended to all imports of automotive products conditional on an increase in exports of all automotive products beyond the 1961-62 base-year level.

The international ramifications of this extended duty remission program were readily apparent by early 1964. These unilateral Canadian policy actions could be interpreted as export bounties, and thus the United States government would be required under GATT to impose countervailing duties. In fact, a number of American parts manufacturers began pressing the United States Treasury Department for such an action. In the face of the unacceptability of the Canadian export provisions (to American manufacturers) and the fear of a mounting series of trade restrictions, the United States government reluctantly began bilateral discussions with the Canadian government. Thus, the January 1965 Canada-United States Automotive Agreement, the outcome of these discussions, emerged from beneath a threatening cloud of restrictive, unilateral Canadian actions and was subject to active political and economic criticism in the United States prior to ratification by the United States Senate in October 1965.[11]

The Canada-United States Agreement

The essence of the Agreement sought to rationalize the production of automotive products within the North American Market. Under the provisions of the Agreement, Canada could now specialize in the production of a few "makes and models" for domestic and (United States) *export* markets while a great variety of United States-produced automobiles could enter Canada duty-free from the larger parent industry.[12] The Agreement does not,

9 C.E. Beigie, *The Canada-U.S. Automotive Agreement: An Evaluation*, Chapter 3.

10 Also remitted were duties on engine block imports, again conditional on increased exports of automotive parts. For further details of these actions, see Beigie, *ibid.*

11 In contrast, the reactions to the Agreement within Canada and the multinational automobile industry might be best described as restrained enthusiasm.

12 In fact, the Agreement is multilateral from the Canadian side and permits Canada to make similar arrangements with any country. On the other hand, the Agreement is bilateral from the United States side and applies only to Canada.

however, provide for complete free trade in automotive products between Canada and the United States. While United States authorities permitted unconditional duty-free Canadian automotive imports (providing they were at least 50% North American content), the Canadian government feared that such a provision might totally submerge the small local industry. Consequently, Canada permitted duty-free imports of automotive products only when ordered or purchased by Canadian automobile manufacturers who met certain specific qualifications. Free trade is, therefore, accorded only to "qualified" manufacturers, not to Canadian consumers.

> To qualify as a motor vehicle manufacturer for purposes of the new tariff treatment, a producer must continue to manufacture vehicles in the same ratio to his vehicle sales in Canada as he achieved during the 1964 model year. He is also required to maintain Canadian value-added in his Canadian vehicle production in an amount not less than that attained during the same year.[13]

The first qualification was intended to assure a continued growth in the assembling operation of motor vehicles in Canada (relative to Canadian sales), while the latter requirement of maintaining value-added at the 1964 level provided a safeguard to independent Canadian automotive parts producers.

Since the Automotive Agreement provided no guarantees for absolute growth in Canadian automotive production beyond the 1964 level, the Canadian government received assurances ("letters of intent") from the Canadian automotive subsidiaries that they would not only maintain their existing share of the expanding market but also that they would expand domestic production. More specifically, assurances were given that the Canadian automotive subsidiaries would increase Canadian value-added in the production of vehicles and original equipment parts by 60% of the growth in Canadian automobile sales (50% of the growth in Canadian commercial vehicle sales), and would also increase Canadian value-added in similar production by a total of 260 million dollars (over the 1964 level) by 1968.[14] Thus, the Canadian automotive industry was given relief from import duties and tariffs provided that the Canadian automotive industry supply a larger share of the Canadian and United States markets.

The possibility of negotiating such an Agreement can, in large measure, be attributed to the general characteristics of the Canadian automotive industry. As already pointed out, the development of the Canadian automobile industry was primarily a result of substantial tariff barriers enticing United States firms to locate in Canada and supply the Canadian (and part of the Commonwealth) market with Canadian assembled vehicles. Thus, the two most obvious features of the structure of the Canadian motor vehicle industry

13 Canada, Department of Industry, *News Release*, January 1965, p. 7.

14 As Beigie points out, these assurances were essentially side conditions imposed on the automotive companies by the Canadian government and indispensable to Canada's signing the formal Agreement. Despite their questionable legality and contemporary relevance, they remain the most controversial part of the Automotive Pact. For further details of the Automotive Agreement, the interested reader is again referred to Beigie's excellent study (*op.cit.*).

are (i) the domination of the industry by a few producers[15] and (ii) the complete control of the Canadian industry by United States firms.[16] In the words of the Royal Commission, "The most important characteristic of the Canadian motor vehicle industry is its dominance by that industry in the United States.... (Canadian-made automobiles are)... designed in the United States, their techniques of production follow closely those developed by their parent companies, and many parts are manufactured in the United States.... (Canada)... must accept some features of the industry in the United States, such as the multiplicity of models and the frequency of model change, which are less desirable especially in a smaller market."[17]

A final characteristic of the motor vehicle manufacturing industry which made it conducive to the negotiating of such an agreement is the high degree of continuous, automatic production technology with a well-developed division of labour. Such technology places a heavy emphasis on lengthy assembly lines and the capturing of economics of scale. Prior to the Agreement the Canadian industry produced a wide variety of models in one plant, as opposed to the United States organization of one or two basic models within a given plant. Thus, while the Canadian industry was able to capture some of the economies of assembly line operation, there existed a substantial degree of inefficiency (vis-à-vis the United States industry) arising primarily from the variety of models within the individual plant.[18] Given the tight, "oligopolistic" nature of this United States controlled industry, the only major obstacles to a profitable economic rationalization of industry would appear to have been the respective governments; and in this case, the governments actually proposed such a treaty.[19]

While the Agreement assured that the interests of the oligopolistic motor vehicle producers would be well served (with the least possible inconvenience), the potential effects on the independent automotive parts and

15 Using data collected by the Royal Commission on the Automotive Industry the "Big Three" producers account for 98% of all automobiles produced in Canada and 85% of commercial vehicles. Including a fourth producer (American Motors for automobiles, and International Harvester for commercial vehicles) raises this percentage to almost 100% (*Report*, p. 102).

16 All major Canadian automobile firms are owned totally by the parent company with the exception of the Ford Motor Company of Canada which has a *minority* distribution of shares available to the (Canadian) public.

17 *Report, Royal Commission on the Automotive Industry*, p. 21.

18 For a discussion of economies of scale at various volume levels within the automotive industry see, J.S. Bain, *Barriers to New Competition*, (Cambridge, Mass.: Harvard University Press, 1956); C.E. Edwards, *Dynamics of the United States Automobile Industry*, (Columbia, South Carolina: University of South Carolina Press, 1966); and G. Maxy, and A. Silbertson, *The Motor Industry*, (London: George Allen and Unwin Ltd., 1959).

19 Even though similar "agreements" in other industries are always possible, the probability of a series of such industrial agreements would appear to be very low. Many unique factors (both economic and political) were operative in this particular industry agreement, and it would be unwise to generalize from this specific bilateral government action to other sectoral applications of a similar type of policy.

accessories manufacturers are more ambiguous. Recall that the safeguards in the Automotive Pact pertaining to automotive parts and accessories are in absolute terms, not relative terms. As shown in Table 2-1, the automotive parts and accessories industry is characterized by many more firms of a small scale with a much greater labour intensity.[20] Adjustment and transitional costs would be much greater for these small, independent automotive parts and accessories producers; and, unlike the motor vehicle manufacturers, would largely have to be borne by the individual firm.[21]

Table 2–1

Vital Statistics for the Automotive Products Industries, 1963

	Motor vehicle manu-facturers	Automotive parts and accessories manu-facturers	Truck body and trailer manu-facturers	Total
Value of shipments (Millions)	1,516	545	65	2,126
Value-added (Millions)	540	254	26	820
Number of employees	31,727	25,441	4,129	61,297
Number of firms				
Total	18	136	131	285
Shipments less than $1,000,000	3	76	113	192

Source: Statistics Canada 42-209, 42-210 and 42-217.

In conclusion, the Automotive Agreement was expected to have a substantial impact on various aspects of the structure of the automotive industries in Canada, although the magnitude, and possibly even the direction, of these structural effects were not easy to predict.[22] The next chapter discusses the methodology for this study which attempts to quantify the macroeconomic effects of the Agreement on both the automotive industries and the entire Canadian economy during the first seven years of its existence.

20 The similarity in organizational features of the automotive parts industry, and the truck body and trailer industry (in contrast to the motor vehicle industry) has prompted their aggregation in the empirical analysis. This decision was not without a data preparation cost as the truck body and trailer industry prior to 1961 was included in the motor vehicle industry, and thus had to be subtracted from the motor vehicle manufacturing data using unpublished sources.

21 The oligopolistic motor vehicle industry was permitted to reduce the price of Canadian vehicles at their own discretion with the protection that Canadian citizens could not import vehicles at the zero tariff price. The automotive parts and accessories industry was forced to compete directly with United States firms with the only protection being in terms of absolute value-added levels in the motor vehicle industry.

22 See Beigie, *op.cit.*, Chapter 5 and Emerson, *op.cit.*

3 Methodology of the Study

As stated in Chapter 1, the principal objective of this study is to evaluate, through econometric analysis, the general equilibrium effects of the Automotive Agreement on the Canadian economy and the automotive sector. Such an analysis requires a model of the Canadian economy which highlights interindustry relationships as well as the more conventional demand-oriented features of a macroeconomic system. The CANDIDE model provides a *mélange* of traditional Keynesian macroeconomics along with an interindustry, input-output system, and is employed as the "backdrop" for this econometric study of the Automotive Agreement.

Since a general description of the CANDIDE model is readily available,[1] only a few comments on this model are appropriate. First, and most striking, is the size of the CANDIDE system. The original version of CANDIDE contained 1556 individual equations, of which 570 are stochastic. Much of the size of the model can be attributed to the interindustry input-output system which transforms 166 final expenditure categories into 51 industrial sectors. Despite this large input-output system, CANDIDE Model 1.0 is essentially a demand-driven system with little attention devoted to supply constraints. Parenthetically, CANDIDE Model 1.0 is underdeveloped in a number of its supply relationships (e.g. the wage-price links) and in its treatment of financial variables. CANDIDE's basic strength lies in the translation of real final demands into real industry outputs. One final point of interest is the "endogenity" of many government expenditure categories as the government is assumed (in CANDIDE) to react to changing economic conditions by increasing or decreasing various types of expenditures.

Despite the very large size of the CANDIDE model, substantial refinements and disaggregations are required to modify the CANDIDE system for an analysis of the Automotive Agreement. As M.C. McCracken points out, "the model is not, of course, all purpose, but rather a skeletal framework of the economy which we hope will provide a valuable input to policy studies".[2] It

1 See M.C. McCracken, *An Overview of CANDIDE MODEL 1.0*, CANDIDE Project Paper No. 1, Economic Council of Canada, February 1973.

2 *Ibid.*, p. 5.

is best viewed as a "general purpose" model onto which individual researchers (or government agencies) can graft satellite models for "specific" purposes. In the following three chapters, approximately 100 *additional* endogenous variables are provided as both the demand and supply sides of the CANDIDE systems are restructured for this specific policy-oriented "automotive" study. The two main features of this restructuring are (i) a substantial extension to the CANDIDE foreign trade block to incorporate automotive trade flows, and (ii) the construction of two *new* industrial submodels (with accompanying wage, price, profit, employment, investment, output relationships) for the motor vehicle assembly industry and the automotive parts and accessories industry.

One final comment concerning the CANDIDE model. Like most other large scale models, CANDIDE has evolved through a series of adjustments, refinements, elaborations and re-estimations. When this present study was undertaken, CANDIDE Model 1.0 (May, 1972) was operational and has been subsequently fully documented by a published series of seventeen CANDIDE Project Papers. However, when the simulations for this study were initiated in the latter part of 1973, CANDIDE Model 1.0 had given birth to Model 1.1. At the time of writing this manuscript, this new model had not as yet been accorded full ceremonial rites (such as published project papers), and consequently any references contained in this text will be to the earlier published version of CANDIDE Model 1.0 (1973). This offspring, CANDIDE Model 1.1, has incorporated many of the relationships presented in the next three chapters and is the operative model for the simulation experiments contained in Chapters 7 and 8.

As done in the CANDIDE model, all parameter estimates for this study are calculated by applying ordinary least-squares to annual data over the post-Korean era.[3] While it can be argued that a simultaneous equation estimation technique may be more desirable, such methods also entail questionable assumptions (e.g. asymptotic properties of a static model are *not* necessarily relevant for this particular study). On a more practical level, estimating annual reduced-form equations (for two-stage least-squares) when there are several hundred predetermined variables is infeasible.[4] Finally, since all parameter estimates of the CANDIDE model will influence the simulations of Chapters 7 and 8, one can make a small debating point for uniformity in estimating all structural parameters.[5]

3 Given data idiosyncracies for particular variables, the actual starting point for the regressions in this study vary over the 1950-56 time period.

4 The use of principal components or structurally ordered instrumental variables may render a feasible two-stage estimation procedure, although at a cost in terms of "efficiency" and "unbiasedness" properties (recall that the regression period contains only fifteen to twenty observations).

5 The author willingly confesses to substantial intrepidation at the thought of having to estimate the entire CANDIDE system with a two-stage procedure, or to defining a compact "efficient" set of instruments for the CANDIDE model to use in an automotive subsystem within CANDIDE (the choice of *which* small set of instruments may be just as arbitrary as the use of "no" instruments).

An Interstructural Parameter Transition Function

Before proceeding with the specification of an "automotive" subsystem within the CANDIDE model, one fundamental statistical problem must be overcome. Conventional econometric analysis of time-series data assumes that the underlying structural relationships are stable over time. However, the basic hypotheses of this study are that the Automotive Agreement has had a significant impact on the structure of the automotive industries (and the Canadian economy). If this is true, then obviously the underlying economic structure is not stable; and a method of detecting such fundamental structural change in the various underlying structural parameters must be incorporated into the analysis. The usual practice of economists in such cases is to employ *F*-tests, as outlined by Chow,[6] to test the equality of regression coefficients (all coefficients or a subset) in two or more regressions. There are two major problems with such a procedure: the identification of the exact point of structural shift and the assumption that the entire shift is accomplished in one interval of time. Both of these problems are present if the Chow technique is implemented in this study.

First, while the Automotive Agreement was signed in January 1965, it was not ratified by the U.S. Senate and House of Representatives until October 1965 (following a protracted debate). Thus considerable uncertainty as to the fate of the Agreement may have existed during this period of time which, in turn, may have delayed the start of part of the rationalization process until the next model changeover (i.e. the summer of 1966). Even if the start of the rationalization process was unambiguous, it is highly unlikely that the entire set of adjustments could be accomplished in one year. Evidence presented elsewhere indicates that much of the impact of the Agreement on the motor vehicle industry may not have occurred until 1967-68.[7] Consequently industry structural adjustments to the January 1965 Automotive Agreement are likely spread over four or five years with the precise structural forms of this shift unknown.

On the assumption that the structural shift arising from the signing of the Automotive Agreement was extended over several years, the econometric task is to test the null hypothesis that there has been no structural shift against the hypothesis that there are two distinctly different structures separated by a transition period. A misspecification which fails to allow for such a transition phase may bias the results in favour of the null hypothesis of no structural shift.[8]

6 G. C. Chow, "Tests of Equality Between Sets of Coefficients in Two Linear Regressions", *Econometrica*, July 1960, pp. 591-605.

7 D. A. Wilton, "An Econometric Model of the Canadian Automotive Manufacturing Industry and the 1965 Automotive Agreement", particularly Table II, p. 177.

8 To illustrate this point, consider the simple case where they intercept shifts to a higher value (slope coefficients are unaffected) over an interstructural transition phase of "*r*" intervals of time. Assuming that the observations for the explanatory variables have a secular time trend and the structural shift is monotonic, then the inclusion of these *r* observations in the new structure (or in the old structure, or dividing them between the two structures) will reduce the "observed" difference between the intercepts in the two structural periods.

The option of simply discarding these "troublesome" interstructural observations is not possible for two reasons. First, since there are only two or three available observations in the post-Agreement "stable" structure, a serious statistical problem exists in attempting to identify the new structural parameters. Second, the use of simulation techniques, a necessary tool for this study, is placed in jeopardy when structural relationships are undefined over certain intervals of time.

Alternatively, one could introduce a set of four to six interactive dummy variables to cover each interval of time in the transition period. This approach does not make particularly efficient use of the data (there are usually only twenty observations available for estimation purposes), and it fails to incorporate potentially useful *a priori* information about the transitional pattern of the Automotive Agreement-induced structural shift.

The approach taken in this study is to specify a parameter interstructural transition function for the period of time in which the new, post-Automotive Agreement structure is evolving (i.e. the transition phase prior to the new stable structure). This approach permits an analysis of the nature and characteristics of the interstructural transition phase, maintains the continuity of the underlying model, minimizes the loss in valuable degrees of freedom, and permits simulations over the interstructural periods.[9]

To define a parameter interstructural transition function assume that a relationship spanning two distinct structures can be represented in the following manner:

$$(3\text{-}1) \quad y_t = a + b_t x_t + u_t$$

or

$$(3\text{-}2) \quad y_t = \begin{cases} a + b_0 x_t + u_t & (t = 1, 2, \ldots, m) \\ a + b_i x_t + u_t & (t = m + i;\ i = 1, 2, \ldots, r) \\ a + b_r x_t + u_t & (t = m + r + 1, \ldots, T) \end{cases}$$

where u_t are independently and normally distributed errors with mean zero and constant variance, and where there are T independent pairs of observations $(y_1, x_1, \ldots y_T, x_T)$. For simplicity of exposition it is assumed that the hypothesized structural shift, commencing at time $m + 1$, occurs only for the b coefficient, taking on values of b_0 in the first structure and b_r in the second structure. Both m, the termination point of the old structure, and r, the transition interval in units of time, are assumed to be known (and defined below).

The behaviour of the b parameter over the transition phase (b_i) is assumed to be approximated by an nth order time polynomial (where $n<r$). In other

9 For a more complete account of this econometric technique, see D. A. Wilton, "Structural Shift with an Inter-Structural Transition Function", *Canadian Journal of Economics*, August 1975.

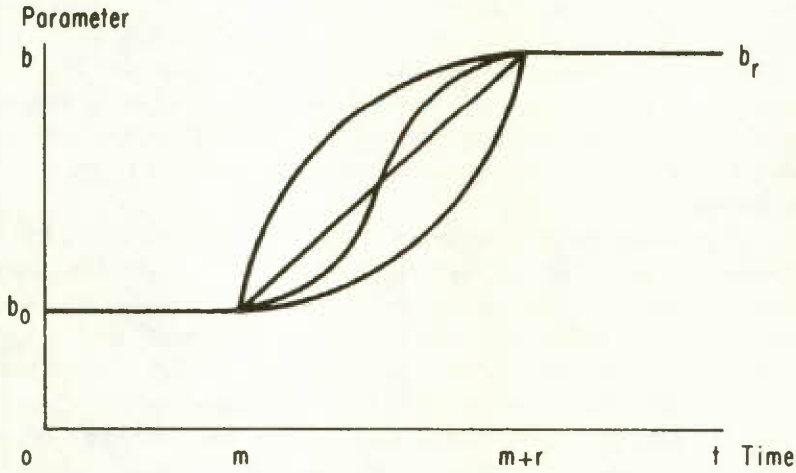
words, the b parameter is assumed to move from b_0 to b_r by following some time polynomial over the r period transition phase.

$$(3\text{-}3)\quad b_i = b_0 + c_1 i + c_2 i^2 + \ldots + c_n i^n \; (i = 1, 2, \ldots, r)$$

Several possible shapes for this parameter transition function are given in Chart 3-1.

Chart 3-1

Possible Shapes for the Parameter Interstructural Transition Function



The specification of the b parameter in (3-2) can be simplified by noting that when $i = 0$, then b_i is equal to b_0; and when $i = r$, then b_i is equal to a constant, say b_r. Define a vector Z of T elements which consist of m zeros followed by a time trend to r and then a series of $(T\text{-}m\text{-}r)$ values of the parameter r.

$$(3\text{-}4)\quad Z = \left\{ 0, 0, \ldots 0, 1, 2, \ldots, r, r, \ldots, r \right\}$$

Thus, the b_t in (3-1) can be represented simply as

$$(3\text{-}5)\quad b_t = b_0 + c_1 Z_t + c_2 Z_t^{\,2} + \ldots + c_n Z_t^{\,n} \quad (t = 1, 2, \ldots, T)$$

Substituting (3-5) into (3-1) produces the following results:

$$(3\text{-}6)\quad y_t = a + (b_0 + c_1 Z_t + c_2 Z_t^{\,2} + \ldots + c_n Z_t^{\,n}) X_t + u_t$$

which can be rearranged as

$$(3\text{-}7)\quad y_t = a + b_0 X_t + c_1 (Z_t X_t) + c_2 (Z_t^2 X_t) + \ldots + c_n (Z_t^n X_t) + u_t$$

The hypothesis that there has been a structural shift occurring over an *r* period transition phase can be verified by the calculation of an *F*-value to test whether the set of *c* parameters is significantly different from zero.

To employ this test, three parameters are assumed to be known; *m, r,* and *n.* In the application of this technique in Chapters 4 and 5, *m* is assumed to be the year of 1964, the last year of the pre-Agreement structure, and *r* is assumed to be 5, years of adjustment or transition. The specification of the degree of the polynomial is either done on economic grounds or by employing significance tests for the various *c* parameters.

To summarize, a simple model for the regression problem of a structural shift which consumes several intervals of time to complete the shift has been specified for use in the next three chapters. This model permits a smooth transition of underlying structural parameters from the pre-Agreement structure to the post-Agreement structure, and is easily tested by employing standard significance tests. The flexibility of this technique allows for testing the possibility of *no* parameter structural shift in a particular underlying relationship as well as permitting different structural shift patterns between industries and between different economic relationships (e.g. prices and investment).

Besides providing a simple estimation technique to overcome the statistical problems associated with noninstantaneous structural shift, another advantage of the parameter interstructural transition function approach is the ease with which Automotive Agreement simulation experiments can be performed.[10] When the *Z* vector, denoted as *WAFT* in the remaining chapters of this study, is present, various underlying structural parameters gradually shift to new post-Agreement levels. A simulation experiment in which the *Z* vector is suppressed (zeroed out) depicts the automotive industry and/or economy as it would have been if the pre-Agreement parameter structure had persisted through the years beyond 1964. As discussed further in Chapters 7 and 8, this one vector can be regarded as a simple "on-off" experimental switch to describe a "simulated" Canadian economy with or without the Automotive Agreement.

10 A brief introductory section of Chapter 7 is devoted to a discussion of simulation methodology.

4 Demand Relationships for Automotive Products

This chapter, along with the next two, develops and tests econometric models for the Canadian automotive industries. Given the large number of relationships required and presented in these three chapters, an analysis of individual equations for these relationships must, of necessity, be skeletal. Taken as a whole, this set of relationships is postulated to describe, with a certain degree of parsimony, the basic economic structure of the Canadian automotive industries. The most important design feature of the system is the deliberate, and frequent, use of the parameter transition function (developed in the preceding chapter) to permit a general equilibrium analysis of the structural impact of the Automotive Agreement on the entire Canadian economy.

The organization of these three core chapters which present the underlying econometric relationships for the study is as follows. The present chapter presents the "demand" side of the system and provides nineteen structural equations (and numerous identities) to summarize consumer purchases of automotive products, automotive export and imports flows, and interindustry purchases of relevant (intermediate) automotive products. The next chapter provides the "supply" side of the system including wage, price, profit, employment and investment relationships for both the automotive manufacturing industry and the automotive parts and accessories industry. The third chapter in this sequence (Chapter 6) integrates the newly developed automotive models into the CANDIDE system. This chapter has been prepared and written (in its entirety) by Nicholas Mathieu.

Consumer Expenditures on Automotive Products

CANDIDE Model 1.0 disaggregates personal expenditures into fifty-six components, one of which is transportation durables.[1] For purposes of this

1 The fifty-six consumption functions in CANDIDE are based on the Houthakker-Taylor model with the transportation durables equation specified in terms of one basic explanatory variable, total consumer expenditures. For further details see equation No. 37 in T. T. Schweitzer and T. Siedule, *CANDIDE Model 1.0: Savings and Consumption*, CANDIDE Project Paper No. 2, Economic Council of Canada, May, 1973.

study, a more disaggregative analysis is desirable with particular attention focused on sales of *new* automobiles, relative price effects, and domestic industry supply conditions. To replace this one transportation durables equation, three new equations are specified to determine consumer expenditures on new automobiles, on used automobiles, and on automotive parts and accessories.

The analysis of personal expenditures on new automobiles is based on the conventional stock adjustment model[2] in which new car sales are assumed to reflect a partial adjustment by consumers to the discrepancy (gap) between a "desired" stock of automobiles and the previous existing stock of automobiles.[3] The desired stock is assumed to be a linear function of total personal expenditures on all goods and services and the relative price of automobiles (compared to a price index for all consumer expenditures). To test for a domestic supply constraint, i.e. the "availability" of new cars, a variable measuring the number of man-days lost because of strike activity within the Canadian motor vehicle industry is included in this relationship. Finally, to allow for trends in population growth, all expenditure and stock data are expressed in per capita terms.

As shown in equation (S1), all hypothesized explanatory variables have coefficients which are significantly different from zero.[4] An annual depreciation-scrappage rate of 26%[5] results in a speed of adjustment from actual to desired stocks of approximately two-thirds in any given year. Short-run elasticities of new car sales with respect to total consumer expenditures, relative prices, and supply constraints are calculated to have the

2 See, for example, G. C. Chow, *Demand for Automobiles in the United States,* (Amsterdam: North-Holland Publishing Company, 1957.)

3 The actual stock of automobiles is determined by a fourteen-year moving average of new automobile expenditures with the weights constructed from available Canadian data on depreciation and scrappage rates (see 11 below). For further details on the construction of these weights, see D. A. Wilton. "An Econometric Model of the Canadian Automobile Manufacturing Industry", unpublished Ph.D. dissertation (Massachusetts Institute of Technology, 1969).

$$(11)\quad TGSTK_t = .725\,CDT11K_t + .583\,CDT11K_{t-1} + .437\,CDT11K_{t-2} + .349\,CDT11K_{t-3} + .255\,CDT11K_{t-4} + .190\,CDT11K_{t-5} + .148\,CDT11K_{t-6} + .086\,CDT11K_{t-7} + .062\,CDT11K_{t-8} + .050\,CDT11K_{t-9} + .038\,CDT11K_{t-10} + .028\,CDT11K_{t-11} + .020\,CDT11K_{t-12} + .015\,CDT11K_{t-13} + .010\,CDT11K_{t-14}$$

4 t-statistics are given in parentheses below each coefficient. Other statistics and abbreviations presented with each equation are as follows :

- $\bar{R}^2$ = coefficient of determination, corrected for degrees of freedom (for the dependent variable in "level" form)
- *S.E.E.* = standard error of estimate
- *D. W.* = Durbin-Watson statistic
- *OLS* = ordinary least-squares
- *HL* = Hildreth-Lu estimation technique for first order autocorrelation
- p^* = the value of p which minimizes the *S.E.E.* on the assumption that the error term e conforms to the following first-order autoregressive model : $e_t = pe_{t-1} + v_t$, where v is independently distributed.

A complete set of mnemonics is presented in the Appendix.

5 This annual estimate is obtained by "fitting" a time trend to the log of the complement of the depreciation-scrappage rates presented in (11), i.e. the estimated root of this geometric progression.

following values: 2.56, -1.84 and -.17 respectively. While the signing of the Automotive Agreement would not be expected to alter the coefficients of this consumption equation (and, therefore, no parameter transition shift function is required), any increase in Canadian income and/or decline in relative automobile prices will have a substantial impact on new car sales given the very elastic demand schedule with respect to both income and relative prices.

$$[S1] \quad [CDT11K/POP] = \underset{(1.15)}{.08941} + \underset{(3.21)}{.1190} [CATOTK/POP] - \underset{(2.94)}{.1399} [CDT10P/CATOTP] - \underset{(2.00)}{.004600}\, SDLMV - \underset{(2.93)}{.4092} [TGSTK/POP]_{t-1}$$

$\bar{R}^2 = .9627$ $\qquad D.W. = 1.53$

$S.E.E. = .004746$ $\qquad (HL, 1949\text{-}71); p^* = .5261$

The two remaining components of personal transportation durables (used car expenditures and automotive parts and accessories expenditures) are less important for an examination of the Automotive Agreement and are given rather simple explanations. In equation (S2) per capita personal expenditures on used automobiles are assumed to be related solely to total personal expenditures[6] with an estimated elasticity of 1.06. Personal expenditures on automotive parts and accessories are assumed to be determined by relative prices and the change in total personal expenditures. The negative sign on the latter variable in equation (S3) presumably reflects the substitutability of automotive parts for automobile purchases when income (personal expenditures) is rising at a below-normal rate. Given the substantial degree of first-order autocorrelation in the automotive parts and accessories equation, estimates are presented for the first-differenced (Δ) functional form.

$$[S2] \quad [CDT12K/POP] = \underset{(.36)}{-.00122} + \underset{(6.34)}{.01389} [CATOTK/POP]$$

$\bar{R}^2 = .9049$ $\qquad D.W. = 1.42$

$S.E.E. = .001558$ $\qquad (HL, 1949\text{-}71); p^* = .4922$

6 No adequate price index for used car purchases is available.

$$[S3] \quad \Delta\,[CDT20K/POP] = \underset{(7.41)}{.00104} - \underset{(1.61)}{.005428}\Delta^2\,[CATOTK/POP] - \underset{(3.35)}{.01940}\,\Delta[CDT20P/CATOTP]$$

$\bar{R}^2 = .9915$ $D.W. = 1.86$

$S.E.E. = .000539$ (OLS, 1950-71)

Exports of Automotive Products

Perhaps in no other area have the effects of the Automotive Agreement been more pervasive than in terms of automotive trade flows. As illustrated in Table 4-1, prior to the Agreement Canadian automotive export products were directed almost exclusively to two markets: (i) Australia and New Zealand (presumably a reflection of Commonwealth tariff preferences) and (ii) less developed countries in Latin America, Asia, and Africa. The United States market during this era was virtually closed to Canadian-made motor vehicles.[7] The Automotive Pact completely reversed the direction of exports as the United States receives 90% of Canadian automotive exports. Even more important than the switch in destination of exports is the dramatic increase in importance and level of automotive trade flows. Exports of motor vehicles have increased from 2-3% of total Canadian motor vehicle production prior to the Agreement to well over 50% of vehicle production in the late 1960s.

Table 4-1

Exports of Automotive Products by Destination

	1950	1955	1960	1965	1970
	(Millions of dollars)				
Automobiles					
Australia and New Zealand	10.5	4.9	5.7	9.5	1.3
Underdeveloped countries	7.7	7.6	15.9	57.3	70.1
Europe	1.1	.7	2.2	15.6	1.3
United States	0	0	.4	66.2	1,664.2
Commercial Vehicles					
Australia and New Zealand	4.5	1.6	.9	4.5	7.5
Underdeveloped countries	4.4	4.0	2.9	4.1	64.9
Europe	0	.4	0	.3	1.5
United States	0	.2	0	14.4	482.3
Automotive Parts and Accessories					
Australia and New Zealand	4.0	13.8	17.5	12.1	26.4
Underdeveloped countries	8.1	9.2	4.5	15.1	48.7
Europe	1.2	2.3	1.2	6.2	14.5
United States	1.3	13.8	4.8	151.8	1,044.0

7 For example, automobile exports to the United States in 1955 totalled five units ($9,136).

Total exports of automotive products have increased from $56 million in 1960 to $3,427 million in 1970, a sixty-one fold increase!

In the face of such phenomenal structural shifts, not to mention the difficulties associated with the specification of variables to measure foreign demand factors (particularly in the underdeveloped world), econometric analysis must be extremely rudimentary. As done in CANDIDE Model 1.0, exports are directionally split into two groups, United States and non-United States, but further disaggregated into three types of automotive products: automobiles, commercial vehicles, and automotive parts and accessories.[8] For the four "vehicle" export equations, economic behaviour prior to the signing of the Agreement is proxied by a constant term (i.e. no economic structural forces)[9] with the parameter transition function utilized in the post-Agreement era to capture this surge in export flows. For United States export flows, the structural shift variable (*WAFT*) is interacted with an appropriate United States domestic activity variable, while for non-United States export flows no appropriate activity variable is readily available and by default *WAFT* is interacted with the constant term. Finally, exports of automotive parts and accessories to non-United States markets are assumed to follow, with a distributed lag, the export of motor vehicles to these same markets.[10]

[S4] $$CARUXK = \underset{(.02)}{.1686}\ C63 + \underset{(.72)}{20.555}\ D64 + \underset{(23.84)}{3.9463}\ WAFT^2{*}APUSK - \underset{(12.36)}{.4216}\ WAFT^3{*}APUSK$$

$\bar{R}^2 = .9980$ $\quad D.W. = 2.38$

$S.E.E. = 28.64$ $\quad$ (*OLS*, 1949-71)

[S5] $$COMUXK = \underset{(.06)}{.1207}\ C64 + \underset{(24.97)}{.7372}\ WAFT^2{*}PDE - \underset{(12.39)}{.07563}\ WAFT^3{*}PDE$$

$\bar{R}^2 = .9981$ $\quad D.W. = 3.07$

$S.E.E. = 7.92$ $\quad$ (*OLS*, 1949-71)

[S6] $$PARUXK = \underset{(1.55)}{-31.006} + \underset{(2.58)}{2.6008}\ APUSK + \underset{(39.09)}{4.3117}\ WAFT6{*}APUSK$$

$\bar{R}^2 = .9973$ $\quad D.W. = 2.30$

$S.E.E. = 18.99$ $\quad$ (*OLS*, 1950-71)

8 For a description of all export and import relationships in CANDIDE, see J. R. Downs (with B. Cain), *CANDIDE MODEL 1.0: Foreign Trade*, CANDIDE Project Paper No. 7, Economic Council of Canada, November 1973.

9 Values for the constant term reflect the average level of vehicle exports prior to the Automotive Agreement. It should also be pointed out that all automotive exports to the United States are exogenous in CANDIDE (*ibid*., p. 7).

10 To the extent that the Automotive Agreement influences the export of such motor vehicles, future exports of automotive parts and accessories will also be affected.

[S7] $$CARRXK = \underset{(6.00)}{22.284} + \underset{(3.67)}{66.672}\ WAFT - \underset{(2.13)}{21.724}\ WAFT^2 + \underset{(1.53)}{2.114}\ WAFT^3$$

$\bar{R}^2$ = .8292 — D.W. = 1.82

S.E.E. = 12.34 — (OLS, 1954-70)

[S8] $$COMRXK = \underset{(2.42)}{4.539} + \underset{(11.46)}{9.915}\ WAFT$$

$\bar{R}^2$ = .8906 — D.W. = 2.49

S.E.E. = 6.50 — (OLS, 1954-70)

[S9] $$PARRXK = \underset{(.88)}{2.1817} + \underset{(3.60)}{.1286}\ TMVRXK_t + \underset{(11.29)}{.1346}\ TMVRXK_{t-1} + \underset{(12.18)}{.1296}\ TMVRXK_{t-2} + \underset{(6.01)}{.1137}\ TMVRXK_{t-3} + \underset{(4.26)}{.0868}\ TMVRXK_{t-4} + \underset{(3.47)}{.0489}\ TMVRXK_{t-5}$$

$\bar{R}^2$ = .9672 — D.W. = 2.44

S.E.E. = 4.69 — (OLS, 1959-71)

[I2] $$TMVRXK = CARRXK + COMRXK$$

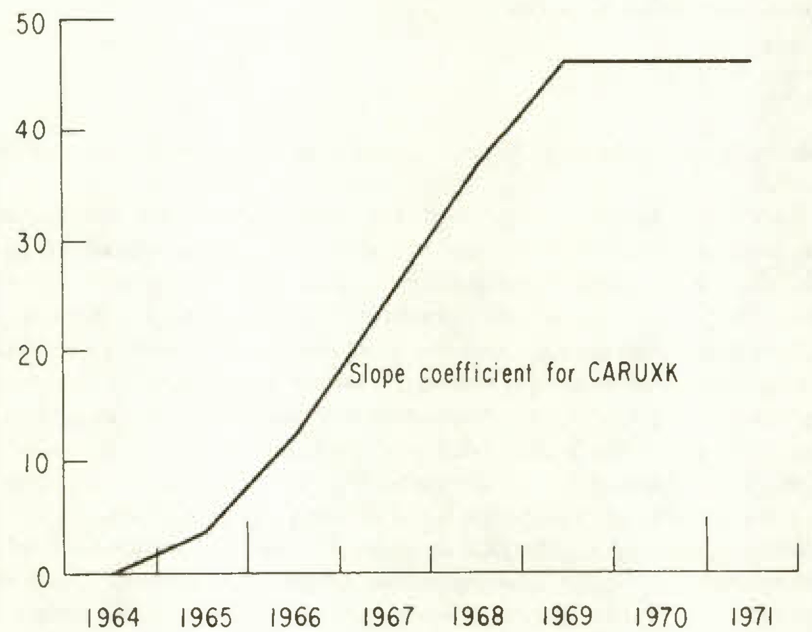
In reviewing these six stochastic equations, several remarks concerning the estimation and specification procedures should be made. First, the error term likely will have heteroscedastic properties in equations where the dependent variable increases by large proportions, and thus *t*-statistics will be unreliable. In particular, standard errors for many of the pre-Agreement explanatory variables (e.g. *C*63, *C*64, *D*64) are undoubtedly overstated with a corresponding understatement of *t*-statistics. Secondly, the transition function has been extended through the year 1970 for the exports of automotive parts and accessories to the United States since the full adjustment process for the independent automotive parts industry is likely to lag that of the oligopolistic motor vehicle industry. Given some instability in automotive exports to non-United States markets in the early 1950s, these equations have been estimated from 1954 on with an appropriate lag in starting point for the automotive parts and accessories equation (which incorporates the Almon distributed lag procedure).[11]

11 S. Almon, "The Distributed Lag Between Capital Appropriations and Expenditures", *Econometrica*, January 1965. For this particular equation, a quadratic polynomial is constrained to have a zero end point at a lag of six years.

In terms of the parameter estimates, most of the structural shift in automotive exports to the United States occurs in the 1967-69 period while a much more rapid structural shift in the level of automotive exports to the rest of the world is apparent. For illustrative purposes, the time-variant parameter for automobile exports to the United States, estimated using the parameter transition function approach, is presented in Chart 4-1.

Chart 4-1

Time-Variant Marginal Propensity to Export Automobiles to the United States[1]



1 Coefficient on *APUSK* Interacted Variables in *CARUXK* Equation [S4].

Imports of Automotive Products

Turning to Canadian automotive imports, the effects of the Agreement are sizable (but not as pronounced as for export trade flows) and, fortunately, more tractable from an economic structural point of view. While total automotive imports from the United States have grown seven-fold from 1960 to 1970, import flows before the signing of the Automotive Agreement were quite substantial (see Table 4-2) and permit the identification of economic structural relationships. As done for exports, imports are disaggregated by direction or point of origin, (United States versus non-United States –

Table 4-2

Imports of Automotive Products by Origin

	1955	1960	1965	1970
	(Millions of dollars)			
Automobiles				
United States	58.9	63.5	125.4	660.3
Rest of World	20.0	150.1	112.9	217.6
Commercial Vehicles				
United States	43.1	33.4	56.0	297.0
Rest of World	3.2	8.2	11.7	37.3
Automotive Parts and Accessories				
United States	266.5	312.0	797.9	1928.8
Rest of World	5.2	15.5	20.8	98.5

essentially European and Japanese origin), and by type of automotive product.

Prior to the Automotive Agreement the Canadian automotive manufacturing industry produced a wide range of conventional, medium-priced vehicles and the parent United States industry supplied most of the more limited-demand, specialty models such as convertibles and hard-tops. The Agreement rationalized Canadian production into a small number of models, resulting in a wide range of models being imported from the United States. In modelling the level of imported United States-produced automobiles, the two critical determinants are the level of total automobile demand in Canada and the Automotive Agreement-induced structural shift in the mix of automotive imports and domestic production (i.e. a shifting propensity to import United States-produced automobiles). Of secondary importance is the possibility of a substitution of United States-produced vehicles for identical Canadian production because of domestic shortages, such as a strike in the Canadian industry, or movements in relative prices. Since Canadian and United States list prices tend to move together in nominal "dollars",[12] a change in the foreign exchange rate may make it more profitable to relocate some production of standard vehicles between the two countries.

As shown in equation (S10), this model performs reasonably well for Canadian imports of United States-produced automobiles. The import structural shift parameter (for total expenditures on all automobiles) is hypothesized to lie on a third-order polynomial, and shifts from a value of .052 prior to the Agreement to a value of .360 in 1969 with most of the adjustment taking place in 1966 and 1967 (parameter values of .189 and .328 respectively). A stronger Canadian dollar (i.e. the value of *REXN* declines) significantly increases Canadian imports of "less expensive" United States-produced vehicles. As discussed at a later point, not all of a foreign exchange

12 See equation (S35) in Chapter 5.

rate movement appears to be reflected in Canadian wholesale automobile prices which raises the possibility that production of conventional motor vehicles could be profitably diverted to the parent United States firm if the Canadian dollar strengthens.

$$
\begin{aligned}
[S10] \quad CARUMK = {} & \underset{(3.16)}{468.37} + \underset{(2.41)}{.05194}\ CDT11K \\
& - \underset{(2.25)}{.05492}\ WAFT{*}CDT11K + \underset{(7.23)}{.08761}\ WAFT^2{*}CDT11K \\
& - \underset{(8.24)}{.01285}\ WAFT^3{*}CDT11K - \underset{(3.10)}{466.94}\ REXN \\
& + \underset{(.90)}{20.777}\ SDLMV{*}C66
\end{aligned}
$$

$\bar{R}^2 = .9913$ $\qquad$ $D.W. = 1.94$

$S.E.E. = 27.33$ $\qquad$ $(OLS,$ 1948-71)

A similar type of model is employed to explain Canadian imports of United States-produced commercial vehicles. The major change in specification is the use of an appropriate activity variable, investment in machinery and equipment which includes most purchases of commercial vehicles. The empirical results for imports of United States commercial vehicles (S11) conform to those obtained for United States automobile imports. The coefficient on the activity variable gradually shifts from a value of .020 (1950-64 period) to a value of .066 in 1969 with most of the shift again occurring in the 1967-69 period.

$$
\begin{aligned}
[S11] \quad COMUMK = {} & \underset{(2.78)}{236.32} + \underset{(2.10)}{.01961}\ IME + \underset{(2.47)}{.00301}\ WAFT^2{*}IME \\
& - \underset{(1.05)}{.0023}\ WAFT^3{*}IME - \underset{(2.91)}{249.75}\ REXN \\
& + \underset{(1.44)}{19.79}\ SDLMV{*}C66
\end{aligned}
$$

$\bar{R}^2 = .9678$ $\qquad$ $D.W. = 1.88$

$S.E.E. = 16.48$ $\qquad$ $(OLS,$ 1950-71)

As shown in Table 4-2, a substantial volume of automotive parts and accessories have always been imported from the United States. While a portion of these imports have gone directly to final demand, much of such imports have been used in the production process of Canadian-assembled motor vehicles. To test the proposition that the import component of automotive parts in the Canadian assembly operation has changed, the structural shift parameter model is again employed. The results of equation (S12) clearly reveal that the import component of automotive parts into the Canadian motor vehicle assembly process has significantly increased from a coefficient on gross motor vehicle production of .25 in 1950-64 to .46 in 1970. This large parameter increase has occurred despite the dramatic increase in motor vehicle production. Imports of United States-produced automotive parts and accessories receive a significant, but rather small, stimulus from increased consumer purchases of automotive parts and accessories (an elasticity of only .17).

$$[S12] \quad PARUMK = \underset{(.41)}{-6.219} + \underset{(4.38)}{.2126}\ CDT20K + \underset{(16.61)}{.2548}\ GOMVK + \underset{(20.37)}{.03574}\ WAFT6*GOMVK$$

$\bar{R}^2 = .9983$ $\qquad$ $D.W. = 3.09$

$S.E.E. = 17.72$ $\qquad$ $(OLS,$ 1950-70)

Imports of automotive products from countries other than the United States have exhibited considerable variation over the entire post-war era. Much of this variation can be attributed to changing consumer tastes for "foreign" and/or compact automobiles, coupled with a sluggish response by the North American industry to changing preferences. As done for imports of automobiles from the United States, the major determinant of imports of foreign-produced automobiles is the level of new car purchases in Canada. However, given changing taste patterns over the 1950s and 1960s for foreign automobiles, this marginal propensity to import is clearly time-variant. Employing a modification of the parameter structural shift function, the marginal propensity to import foreign-produced automobiles is assumed to lie on a fifth-order time polynomial over the 1954-70 sample period.[13] Since there is no reliable price deflator for foreign imports, the relationship is specified in "current" dollar form. Given the general structure of the CANDIDE model and the difficulties in computing an average foreign exchange rate variable for all countries, the Canada-United States exchange rate is employed to test for changes in automobile imports arising from movements in the Canadian dollar.

As revealed in equation (S13), the foreign exchange rate has a strong, significant effect on foreign automobile imports.[14] The initial interacted term for the time-variant marginal propensity to import foreign automobiles is insignificant and is consequently suppressed. The temporal pattern for this

13 Using the same terminology as employed in Chapter 3, the b_t parameter is assumed to lie in a fifth-order time polynomial where the time trend in the Z vector is defined over the *entire* sample period (i.e. there are no zeros in the Z vector).

14 The elasticity of imports of foreign-produced vehicles with respect to the foreign exchange rate exceeds six.

marginal propensity to import foreign-produced automobiles, as presented in Chart 4-2, clearly highlights the tremendous growth in small car imports in the late 1950s and early 1960s (the Volkswagen phenomenon), and the emerging Japanese import boom in the late 1960s.

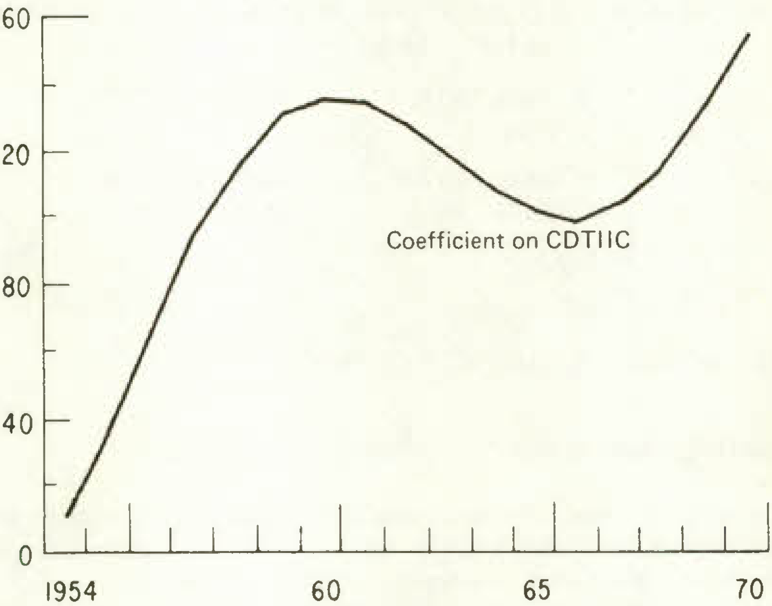
$$[S13]\quad CARRMC = \underset{(2.50)}{619.21} - \underset{(2.55)}{642.10}\,REXN + \underset{(4.60)}{.01305}\,TT^2{*}CDT11C$$
$$- \underset{(3.54)}{.002323}TT^3{*}CDT11C + \underset{(2.86)}{.0001425}\,TT^4{*}CDT11C$$
$$- \underset{(2.34)}{.000002891}\,TT^5\,{*}CDT11C$$

$\bar{R}^2 = .9227$ $\qquad$ $D.W. = 1.72$

$S.E.E. = 16.96$ $\qquad$ (OLS, 1954-70)

Chart 4-2

Time-Variant Marginal Propensity to Import Non-United States-Produced Automobiles [1]



1 Coefficient on *CDT11C* Interacted Variables in *CARRMC* Equation [S13].

Imports of commercial vehicles, and automotive parts and accessories from foreign producers are of less empirical consequence. The structural model for foreign commercial vehicle imports parallels that employed for United States commercial vehicle imports with two modifications. First, no significant Automotive Agreement structural shift in the basic relationship is expected. Second, an additional price effect (the wholesale price of Canadian-produced vehicles) is included in the relationship. Demand elasticities for foreign imports of commercial vehicles with respect to the four explanatory factors in equation (S14) are the following: (i) domestic investment: 1.8; (ii) man-days lost in strike activity: 0.2; (iii) domestic wholesale prices: 2.2; and (iv) foreign exchange rate: 6.7. Imports of automotive parts and accessories from foreign producers are simply assumed to be related to past vehicle imports. The distributed lag estimates in equation (S15) are again obtained using the Almon technique, with a third-order polynomial.

[S14] $$COMRMC = \underset{(1.50)}{36.225} + \underset{(5.77)}{.005846}\ IMEZ + \underset{(3.58)}{6.7016}\ SDLMV - \underset{(2.55)}{68.075}\ REXN + \underset{(1.66)}{23.81}\ WPMV$$

$\bar{R}^2 = .8650$ $\quad$ $D.W. = 1.34$

$S.E.E. = 3.59$ $\quad$ (OLS, 1952-70)

[S15] $$PARRMC = \underset{(3.11)}{-28.217} + \underset{(4.46)}{.3001}\ TMVRMC_t + \underset{(2.02)}{.0844}\ TMVRMC_{t-1} + \underset{(.10)}{.0049}\ TMVRMC_{t-2} + \underset{(.29)}{.0092}\ TMVRMC_{t-3} + \underset{(1.17)}{.0448}\ TMVRMC_{t-4} + \underset{(1.29)}{.00592}\ TMVRMC_{t-5}$$

$\bar{R}^2 = .7892$ $\quad$ $D.W. = .82$

$S.E.E. = 13.03$ $\quad$ (OLS. 1956-70)

[I3] $$TMVRMC = CARRMC + COMRMC$$

Input-Output Relationships

As pointed out above, industry output or production plays a pivotal role in the CANDIDE model. In CANDIDE Model 1.0, 166 final demand categories are converted into final commodity requirements by means of an expenditure matrix. These final demand commodity requirements are then transformed, by utilizing an input-output table, into total gross output and value-added for 43 industries, one of which is the total motor vehicle industry.[15] Within this

15 For further details, see L. Auer and D. Vallet, *CANDIDE MODEL 1.0: Industry Output Determination*, CANDIDE Project Paper No. 8, Economic Council of Canada, August 1974.

input-output conversion process are implicit two critical sets of "intermediate" demand relationships for this study. First, Canadian demand for commercial vehicles is aggregated with machinery and equipment *investment* equations in CANDIDE,[16] and thus the intermediate demand for such motor vehicles (and the apportioning of such "investment" demands to the motor vehicle industry) is determined within this input-output set of identities. Secondly, a large portion of domestically produced automotive parts and accessories are "intermediate" products for the motor vehicle industry, a demand relationship which is also an integral part of the input-output system. Both of these intermediate demands for automotive products are contained in the large CANDIDE system, and filter through the input-output tables to the automotive industries.

While this study retains the basic input-output structure of CANDIDE, the level of disaggregation is extended. For example, the earlier section of this chapter provides ten additional final demand categories to channel through the input-output framework. Perhaps the most important extension to this basic input-output structure is the disaggregation of the motor vehicle industry into two components: the motor vehicle assembly industry (Standard Industrial Classification 323) and the automotive parts and accessories industry including the manufacturing of truck bodies and trailers (SIC 324 and 325).

"Output" for these two automotive industries is generated from the 1961 Input-Output Table using similar techniques as employed in CANDIDE:

> Because technological improvements are adopted over time or the user industry substitutes one factor for another in response to the level of output or price changes, the inputs of one industry to another are not fixed. Since the input-output tables reflect interindustry relations for only one year (assuming them to be fixed), their use in determining industry outputs over time is frequently criticized as unrealistic. This criticism is applicable not only to the coefficients in the technology matrix but also to the coefficients reflecting the market shares, the commodity composition of final demand, and the proportion of value added in gross output.... The approach adopted is similar to that used by Ross Preston in the Wharton Long-Term Model. The basic idea is to "model" the residual or difference between the value-added estimate (obtained from the input-output framework) and the observed Real Domestic Product by industry. In CANDIDE Model 1.0 this involves only 41 equations instead of thousands of individual coefficient changes. The specification for this adjustment mechanism is:
>
> $$(RDP_i - Y_i) = a + b^*t + c^*\,(RDP_i - Y_i)_{t-1} + d^*(RDP_i - Y_i)_{t-2}$$
>
> where
>
> RDP_i = Real Domestic Product, ith industry
> Y_i = initial estimate of value added, ith industry
> t = time

16 There are thirty-eight machinery and equipment relationships in CANDIDE Model 1.0. For further details, see D. A. White. *CANDIDE Model 1.0: Business Fixed Investment*, CANDIDE Project Paper No. 5, Economic Council of Canada, February 1974.

The time trend reflects the longer-term changes in the residual, and the autoregressive terms are used to "pick up" cyclical effects.[17]

Three additional comments concerning the use of this identity adjustment technique are required. First, since both gross output and value-added are prominent in this industry study, two equations are provided for each subindustry (gross output and materials input). Second, the Automotive Agreement may very well have altered the fixed coefficients associated with the automotive industries in the 1961 Input-Output Table, and consequently the interacted structural shift variables may have a significant impact of the discrepancies between actual gross output (materials) and I/O calculated gross output (materials) in the 1960s. Finally, data source errors may arise as data for the two subindustries of this study are based on the Census of Manufactures, not Real Domestic Product as used in CANDIDE.

The first two equations (S16) and (S17) transform final demands into gross industry outputs.[18] In both cases, one autoregressive term and an explicit cyclical demand effect are present. In addition, the Automotive Agreement provides a moderate depressing effect on the gross output discrepancy in the motor vehicle industry (about 2 1/2% of gross output in 1969) and a substantial positive effect on the automotive parts and accessories industry (approximately 20% in 1969). With respect to material inputs, the Automotive Agreement has substantially decreased (by about 14%) the material input into the production of motor vehicles over that which prevailed in 1961 (i.e. an Automotive Agreement-induced shift to greater value-added component in the production of vehicles). The reverse effect, to a lesser extent, appears to be the case in the automotive parts and accessories industry. These four econometric equations, which attempt to overcome a fixed set of input-output coefficients, explain over 99% of the variation in gross output and material inputs (primarily in terms of final demands) and reveal significant structural shifts in the input-output system arising from the signing of the Automotive Pact.

$$[S16]\quad (GOMVK - MOTVYRG) = \underset{(.50)}{8.6699} + \underset{(2.09)}{.6092}\,(GOMVK - MOTVYRG)_{t-1} - \underset{(2.50)}{18.298}\,WAFT + \underset{(1.85)}{.1645}\,\Delta CDT11K$$

$$\bar{R}^2 = .9965 \qquad D.W. = 2.19$$

$$S.E.E. = 54.20 \qquad (OLS,\ 1951\text{-}70)$$

17 M. C. McCracken, *An Overview of CANDIDE Model 1.0*, pp. 62-64.

18 The CANDIDE identities for input-output calculated gross output contain 105 individual components for both the motor vehicle and the automotive parts and accessories industries.

[S17] $(GOPAK - PATBYRG) = \underset{(.11)}{1.0390} + \underset{(4.15)}{.5830}\ (GOPAK -$

$PATBYRG)_{t-1} + \underset{(3.91)}{55.343}\ WAFT + \underset{(2.71)}{.09429}\ \Delta MOTVYRG$

$\bar{R}^2 = .9939$ $D.W. = 2.28$

$S.E.E. = 33.62$ $(OLS,$ 1951-70)

[S18] $(MATMVK - MOTVYRM) = \underset{(1.80)}{34.694} - \underset{(8.15)}{58.396}\ WAFT -$

$- \underset{(2.40)}{5.5272}\ TIME52$

$\bar{R}^2 = .9961$ $D.W. = 1.59$

$S.E.E. = 33.65$ $(OLS,$ 1952-70)

[S19] $(MATPAK - PATBYRM) = - \underset{(1.67)}{12.198} + \underset{(2.74)}{.7488}\ (MATPAK -$

$PATBYRM)_{t-1} - \underset{(1.90)}{.5637}\ (MATPAK - PATBYRM)_{t-2}$

$+ \underset{(3.99)}{31.437}\ WAFT$

$\bar{R}^2 = .9896$ $D.W. = 1.96$

$S.E.E. = 22.38$ $(OLS,$ 1952-70)

To summarize the final demand relationships in this study, fifteen new equations are specified to replace five old equations in the CANDIDE Model 1.0. While a structural shift arising from the signing of the Automotive Agreement does not explicitly enter the Canadian consumption functions for automotive products, implicit effects will be present to the extent that relative prices and/or domestic expenditures have been affected by the Agreement. On the other hand, the Agreement has had a dramatic structural effect on most automotive trade flow equations. All automotive trade flows to and from the United States are significantly altered by the Agreement, as are exports of automotive products to the rest of the world. Only imports of foreign-produced vehicles are structurally unaffected by the Automotive Pact, although the indirect effects of the Pact permeating throughout the Canadian economy will likely produce minor changes in such imports.

These fifteen final demand relationships, along with other CANDIDE final demands, are filtered through input-output tables to generate industry output for the two automotive industries. The four technical input-output relationships presented are intended to overcome (partially) the time invariant characteristics of an input-output table, and reveal that the Automotive Agreement has induced a higher degree of value-added in the motor vehicle industry (than would have existed without the Agreement) but a slightly lower degree of value-added in the automotive parts and accessories industry.

5 Automotive Industry Models and Supply Relationships

In the previous chapter, structural relationships were presented for fifteen automotive-related final demand categories which are channeled through a large input-output table to generate real gross output (an implicity value-added) for the two automotive industries. While automotive output is primarily demand determined in this system, there are a number of links in these demand relationships to the supply or industrial side of the model (e.g. prices, strike activity and related industry outputs). This chapter presents two sectoral submodels for the automotive assembly industry and the automotive parts and accessories industry. These two submodels portray the major structural features of the two automotive industries for analytical purposes and identify the direct effects on the Automotive Agreement on the structure of the automotive industries. In addition, these two industry models "close out" the system by providing structural relationships for the important "industrial" links from the supply side of the system to the demand side. The presentation of the industry submodels is organized by types of "industrial" decisions: employment, investment, wages, and prices. Given that all of these decisions are assumed to be profit maximizing, the actual level of profits is residually determined.

Industry Employment Decisions

To analyse the demand for labour within these two automotive industries, the work force is partitioned into production (hourly-rated) and nonproduction (salaried) employment components. This basic division of employment is undertaken for two analytical reasons. First, economic costs associated with hiring, training and firing decisions are likely to be more important for nonproduction workers giving rise to different adjustment processes (lags) for altering the number of employees for the two categories of labour.[1] Second,

1 The concept of labour as a "quasi-fixed" factor with adjustment costs and lags was first suggested by W. Oi, "Labour as a Quasi-Fixed Factor", *Journal of Political Economy*, December 1962, pp. 538-555.

the subsidiary nature of the automotive manufacturing industry has resulted in a smaller proportion of nonproduction employees in the Canadian industry than in the United States industry as many of the specialized staff functions are conducted by the parent firm. The Automotive Agreement may have accentuated this disparity with even more staff functions being centralized in the "head" office.

A second major analytical distinction to be made in the employment decision is the choice between the number of workers and number of hours which they work. Variations in hours worked will likely provide the principal shortrun adjustment to changes in the desired labour input while adjustments to the size of the work force will be distributed through time. Consequently, structural relationships for three industry employment variables are specified: production labour input (man-hours), nonproduction labour force, and average hours worked per year.

Production Man-Hours Input

The basic theoretical construct in the man-hours decision is the industry production function, i.e. the technological relationship between output and the various factors of production. The theoretical underpinnings, methodology, and statistical estimates for the two automotive industry production functions were jointly undertaken with David Emerson. In a companion study on the Automotive Agreement, Emerson presents a detailed examination of various theoretical and empirical issues concerning these production function estimates,[2] and only a brief summary is presented in this study.

A Cobb-Douglas value-added[3] production function is estimated for both industries which is inverted to obtain a structural relationship for the man-hour input of production labour. The precise labour input concept in the production function is "production-worker-equivalent man-hours", defined in identities [I4] and [I5].[4] Gross capital stock and a capacity variable, average hours worked per year,[5] are the two remaining economic production-function variables. Since a principal objective of the Automotive Agreement was to increase production efficiency within the automotive sector, an Auto Pact-induced structural shift in the efficiency scalar (λ) of the Cobb-Douglas production function is a crucial testable hypothesis.

$$Q = e^{\lambda} L^{a} H^{b} K^{c}$$

2 D. L. Emerson, *Production, Location and the Automotive Agreement*, Chapter 3.

3 This output specification has been advocated by Z. Griliches and V. Ringstad, *Economies of Scale and the Form of the Production Function: An Econometric Study of Norwegian Manufacturing Establishment Data*, (Amsterdam: North-Holland Publishing Company, 1971), pp. 108-109.

4 For details on the specification of this concept, see *ibid.*, pp. 23-24.

5 Also see M. S. Feldstein, "Specification of the Labour Input in the Aggregate Production Function", *Review of Economic Studies*, October 1967, pp. 375-386.

As shown in equations (S20) and (S21), the effects of the Automotive Agreement on the production process are significant and exceptionally large. For the automobile assembly industry e^{λ} shifts from a 1964 value of 2.88×10^{-16} to a 1969 value of 5.79×10^{-16} – an increase in efficiency of 101%! For the automotive parts and accessories industry the structural shift interaction is significant for both the efficiency scalar and the capacity effect,[6] although somewhat more modest. In this earlier cited companion study, Emerson has traced these automotive production efficiency gains to two sources: (i) increased specialization from a reduction in product/model lines and (ii) an industry expansion scale effect. For both industries, over 85% of this Automotive Agreement-induced efficiency gain can be attributed to an increase in specialization.[7]

[S20] $$\log VAMVK = \underset{(4.47)}{-35.784} + \underset{(2.30)}{.3375} \log GKSMVK + \underset{(5.69)}{1.6739} \log LEFMV + \underset{(2.61)}{2.6938} \log HMV + \underset{(4.43)}{.1399}\, WAFT$$

$\bar{R}^2 = .9396$ $D.W. = 1.11$

$S.E.E. = .1489$ (OLS, 1950-70)

[S21] $$\log VAPAK = \underset{(6.24)}{-13.487} + \underset{(6.97)}{.3338} \log GKSPAK + \underset{(17.76)}{1.0356} \log LEFPA + \underset{(2.35)}{.7272} \log HPA + \underset{(2.19)}{.7342}\, WAFT^2 - \underset{(2.17)}{.0947}\, WAFT^2 * \log HPA$$

$\bar{R}^2 = .9977$ $D.W. = 2.40$

$S.E.E. = .02741$ (OLS, 1950-70)

[I4] $$LEFMV = PMHMV\ [1.0 + (TEWBMV - PEWBMV)/PEWBMV]$$

[I5] $$LEFPA = PMHPA\ [1.0 + (TEWBPA - PEWBPA)/PEWBPA]$$

Average Hours Worked per Employee

As stated above, these two production functions can be inverted to obtain estimates for production man-hours. Additional structural relationships are

6 The latter effect diminishes the elasticity of output with respect to hours worked after the rationalization of the industry, presumably because there are less economies left to be exploited by longer production runs after rationalization takes place.

7 D. L. Emerson, *op.cit.*

required for average annual hours worked and nonproduction employment (with the number of production employees determined by identities [I6] and [I7]). The existence of long, integrated assembly lines and a basic complementarity between labour and existing capital places a heavy burden on the hours-worked variable for short-run labour adjustments occasioned by changes in output. While the annual nature of the model masks much of this short-run adjustment, average hours worked per year are assumed to vary primarily with changes in real output. Of secondary importance is the level of strike activity within the motor vehicle industry which will lower the level of annual hours worked per employee (i.e. it does not affect the number of employees).

[I6] $PEMV = PMHMV/HMV$

[I7] $PEPA = PMHPA/HPA$

As shown in equations (S22) and (S23), there is a strong positive effect on hours worked from changes in the level of real output, diminishing in magnitude after the Agreement. The lagged motor-vehicle-strike-activity variable in the automotive parts and accessories industry reflects a delayed repercussion effect on the automotive parts industry. Finally, the intercept in each equation can be interpreted as the normal level of hours worked (with no change in output or strike activity), and is calculated to be 42.7 hours per week in the motor vehicle industry and 40.4 in the automotive parts and accessories industry.

[S22]
$$\underset{(140.03)}{HMV = 2228.22} + \underset{(3.14)}{.5269\ \Delta VAMVK}$$
$$- \underset{(1.86)}{.0808\ WAFT * \Delta VAMVK} - \underset{(1.75)}{82.11\ SDLMV * C64}$$

$\bar{R}^2 = .3791$ $D.W. = 2.31$
$S.E.E. = 58.99$ (OLS, 1950-70)

[S23]
$$\underset{(231.13)}{HPA = 2105.80} + \underset{(6.22)}{1.1128\ \Delta VAPAK}$$
$$- \underset{(2.75)}{.1399\ WAFT * \Delta VAPAK} - \underset{(1.93)}{46.55\ (SDLMV * C64)_{t-1}}$$

$\bar{R}^2 = .7011$ $D.W. = 2.44$
$S.E.E. = 29.63$ (OLS, 1950-70)

Nonproduction Employment

Given the supervisory or administrative nature of nonproduction labour, the level of the nonproduction work force is specified in terms of gross real output and the existing capital stock. As shown in equations (S24) and (S25), both variables are significant for each industry and have relatively low elasticities.[8] These parameter estimates also reveal that the Automotive Agreement has structurally diminished the role of nonproduction employment in each industry. The coefficient on the capital stock variable has declined by 49% in the motor vehicle industry and by 60% in the automotive parts and accessories industry, a clear indication of the declining relative importance of nonproduction (salaried) workers in the Canadian motor vehicle industries after the signing of the Automotive Agreement.

$$[S24] \quad NPEMV = \underset{(.19)}{118.59} + \underset{(4.29)}{2.527}\, GOMVK$$

$$+ \underset{(6.07)}{12.615}\, GKSMVK - \underset{(4.10)}{1.225}\, WAFT * GKSMVK$$

$\bar{R}^2 = .9512$ $\qquad$ $D.W. = 1.59$

$S.E.E. = 604.5$ $\qquad$ (OLS, 1950-70)

$$[S25] \quad NPEPA = \underset{(1.03)}{338.29} + \underset{(5.72)}{4.823}\, GOPAK$$

$$+ \underset{(4.75)}{8.7763}\, GKSPAK - \underset{(6.11)}{1.045}\, WAFT * GKSPAK$$

$\bar{R}^2 = .9825$ $\qquad$ $D.W. = .89$

$S.E.E. = 308.1$ $\qquad$ (OLS, 1950-70)

Investment Decisions

The flexible accelerator mechanism is selected as the basic theoretical model underlying investment decisions in the automotive industry. In this model, investment decisions (I) are assumed to narrow the gap (by the factor γ) between desired and actual capital stock with desired capital stock (K^*) specified in terms of expected levels of output (Q^e)

$$I_t = \gamma\,(K_t^* - K_{t-1})$$

$$K_t^* = \theta\, Q_t^e$$

Since there is no clear road to take in formulating expectations from *ex post* data, a five-year, "Almon" distributed lag, with weights constrained to lie on a first-order polynomial, is employed to proxy expected real output (see [18] and [19]). It is assumed that any structural shift arising from the

8 The elasticity of nonproduction employment in the motor vehicle industry is .65 with respect to the capital stock and .41 with respect to gross output. Similar elasticities for the automotive parts and accessories industries are .55 and .50 respectively.

Automotive Agreement will primarily affect the desired capital-output ratio (θ)[9]. While θ may initially increase as new investment required for rationalization takes place, a substantial decline in θ will likely occur as the "rationalized" industry moves toward increased productive efficiency. A cubic parameter transition function defined over six years is employed to permit sufficient flexibility to capture both the short-run and long-run structural impact on θ. Denoting the "hypothesized" structural shift in the capital-output ratio by the time-variant θ_t, the estimated model can be represented by the following notational equation.

$$I_t = \gamma(\theta_t Q_t^e - K_{t-1})$$

Estimates for this model applied to investment in machinery and equipment and investment in structures (for both industries) are presented in equations (S26) to (S29). Since gross capital stock data are available only at the industry level, the speed of adjustment (γ) will be understated for each investment component.[10] As expected, a more rapid adjustment is found for the machinery and equipment component than for structures in both industries. With respect to the time-variant, Automotive Agreement-dependent coefficients on expected output, there is a monotonic decline for both investment components in the motor vehicle industry with the greatest reduction in the 1967-69 period and the smallest reductions in 1965-66.[11] Unlike the motor vehicle assembly industry, the automotive parts and accessories industry experienced an increase in the coefficients on expected output for 1965-66,[12] followed by a moderate decline back to 1969-70 values very close to the pre-Agreement structural parameters. Thus, the Automotive Agreement had a direct positive short-run effect and a rather neutral long-run effect on investment in the automotive parts and accessories industry, but a substantial depressant effect (*ceteris paribus*) on investment in the motor vehicle assembly industry. As discussed in Chapter 7, the "indirect" effects from additional output generated by the Automotive Agreement have largely offset these latter negative effects in the motor vehicle industry and reinforced increases in real investment in the automotive parts and accessories industry.

9 Obviously, there could also be a structural shift in the speed of adjustment (γ) or in the weights associated with expected output. As done in most other investment studies, "simple" assumptions must be made to permit econometric estimation and identification of complicated, interactive distributed lags.

10 The scrappage rate for capital stock (1.64% per annum in [110] and [111]), is based on an earlier study by the author (D. A. Wilton, 1969, *op.cit.*). In this study, the annual speed of adjustment in the motor vehicle manufacturing industry was found to be approximately one-third.

11 For machinery and equipment, the coefficient on expected output declines from a pre-Agreement value of .045 to .028 in 1970, while for structures the decline is slightly greater (from .046 to .025 over the same period).

12 For machinery and equipment, the coefficient peaked at .237, while for structures it peaked at .109 (both in 1966).

[S26] $$VMEMVK = \underset{(3.45)}{31.730} + \underset{(4.79)}{.04464}\, GOMVKE - \underset{(1.71)}{.001074}\, WAFT6^2 * GOMVKE + \underset{(1.11)}{.000102}\, WAFT6^3 * GOMVKE - \underset{(4.40)}{.1418}\, (GKSMVK)_{t-1}$$

$\bar{R}^2$ = .5878 $D.W.$ = 2.74
$S.E.E.$ = 5.64 (OLS, 1953-70)

[S27] $$VSMVK = \underset{(.60)}{5.98} + \underset{(4.62)}{.04638}\, GOMVKE - \underset{(2.51)}{.001700}\, WAFT6^2 * GOMVKE + \underset{(1.85)}{.000183}\, WAFT6^3 * GOMVKE - \underset{(2.88)}{.1000}(GKSMVK)_{t-1}$$

$\bar{R}^2$ = .5725 $D.W.$ = 1.44
$S.E.E.$ = 6.07 (OLS, 1953-70)

[S28] $$VMEPAK = \underset{(1.29)}{17.70} + \underset{(7.79)}{.1855}\, GOPAKE + \underset{(6.51)}{.08396}\, WAFT6 * GOPAKE - \underset{(9.51)}{.03703}\, WAFT6^2 * GOPAKE + \underset{(10.46)}{.004021}\, WAFT6^3 * GOPAKE - \underset{(4.45)}{.2774}(GKSPAK)_{t-1}$$

$\bar{R}^2$ = .9743 $D.W.$ = 3.08
$S.E.E.$ = 5.17 (OLS, 1953-70)

[S29] $$VSPAK = \underset{(.94)}{13.31} + \underset{(3.20)}{.07873}\, GOPAKE + \underset{(3.12)}{.04150}\, WAFT6 * GOPAKE - \underset{(4.09)}{.01641}\, WAFT6^2 * GOPAKE + \underset{(4.06)}{.001609}\, WAFT6^3 * GOPAKE - \underset{(3.20)}{.07873}\, (GKSPAK)_{t-1}$$

$\bar{R}^2$ = .7629 $D.W.$ = 3.28
$S.E.E.$ = 5.34 (OLS, 1953-70)

[I8] $$GOMVKE = .333\,GOMVK + .267(GOMVK)_{t-1} + .200\,(GOMVK)_{t-2} + .133(GOMVK)_{t-3} + .067(GOMVK)_{t-4}$$

[I9] $$GOPAKE = .333\,GOPAK + .267\,(GOPAK)_{t-1} + .200\,(GOPAK)_{t-2} + .133\,(GOPAK)_{t-3} + .067\,(GOPAK)_{t-4}$$

[I10] $$GKSMVK = .9836\,(GKSMVK)_{t-1} + VMEMVK + VSMVK$$

[I11] $$GKSPAK = .9836\,(GKSPAK)_{t-1} + VMEPAK + VSPAK$$

Wage Determination

The central feature of wage determination within the automotive industry is collective bargaining between the major firms and the United Automobile Workers (UAW). Such collective bargaining has generally resulted in pattern-setting,[13] multi-year wage contracts[14] with front-end loading and escalator clauses. As discussed below, these institutional features and rigidities have important econometric implications for wage analysis as one can not assume that wage rates adjust smoothly through time, the standard assumption of most wage research.

To model these institutional features, the following structural format has been adopted. The central decision variable in the wage block of the model is the negotiated wage rate for the motor vehicle industry. Econometric analysis of this critical negotiated wage-rate series incorporates the aforementioned institutional features into an estimated structural relationship. This "explained" negotiated wage-rate series is an important determinant in the level of average hourly earnings in the motor vehicle industry as well as the average wage level for nonproduction workers (two additional structural relationships). Since the automotive parts and accessories industry is characterized by many small firms, the role of unions is less pronounced and average wage levels are explained directly.

Negotiated Wage Rate in the Motor Vehicle Industry

Since the early 1950s the UAW has bargained for an escalator clause in all their contracts. This escalator, which forms an important part of the basic wage rate, is tied directly to the Canadian Consumer Price Index (CPI), and provides automatic cost-of-living increases as the CPI changes. To focus the

13 The fact that major firms bargain on a single company basis has resulted in the UAW attempting to secure major concessions from one firm, and then pressing for similar settlements with other firms.

14 Over the past twenty years, all UAW contracts have exceeded one year in duration with most having a three-year span.

analysis on the "negotiated" portion of the wage rate, the basic wage rate is partitioned into two components: the accumulated escalator and the "negotiated" component (see [112]). The accumulated escalator is specified by the identity [113] in which an escalator scalar (*ESCAL*) is calculated from the actual industry escalator clauses and applied to changes in the CPI.[15]

$$[112] \quad BEWMV \equiv BASEMV + EMV$$

$$[113] \quad EMV_t \equiv EMV_{t-1} + ESCAL_t{}^{*} \, [\, CPI_t - CPI_{t-1} \,]$$

Turning to the negotiated component of the basic wage rate, econometric analysis traditionally focuses on two major factors: price movements and the state of the labour market (e.g. the unemployment rate). Neither factor would appear to be relevant in determining negotiated wage rates in the motor vehicle industry. Price movements are already explicitly recognized in the escalator clause and labour market tightness is unlikely to affect wage movements in an oligopolistic industry dominated by one powerful union.

The critical wage determinant is likely to be the "demonstration" or spillover effect from other wage settlements, particularly the influence of "parent" United States industry-UAW settlements. Wage parity with the United States industry became an explicit union objective in the latter part of the 1950s and by the 1960s wage parity demands were an overriding concern of the UAW, both in Canada and the United States. To test the "wage parity" hypothesis, the relative United States-Canada basic wage rate is included as the principal explanatory factor. An increase in this ratio would prompt the Canadian union to increase its wage demands. Since the Automotive Pact may have intensified wage parity demands, three additive dummy variables (covering the 1964-71 contract period) are interacted with this United States automotive "spillover" variable.

In earlier papers the author has postulated an institutional econometric wage-change model which integrates "awkward" institutional labour market features such as multi-year contracts, bargaining patterns and locked-in increments into a set of weights for the distributed lag effects of all explanatory variables.[16] As shown in Table 5-1, these institutional weights for the motor vehicle manufacturing industry are temporally nonstationary and are dramatically different from equal weights, the standard assumption of conventional wage analysis. The distinctive diagonal patterns are clearly

15 This escalator scalar ranges from a value of 1.6 in 1952 to 2.5 in 1971, and simply refers to the number of cents given for each percentage point movement in the 1961-based CPI. For purposes of analysis the *ESCAL* vector is considered as exogenous to the model.

16 For further details of this institutional econometric wage change model, see J. C. R. Rowley and D. A. Wilton, "Empirical Foundations for the Canadian Phillips Curve". *Canadian Journal of Economics*, May 1974, pp. 240-250 and the references contained therein.

attributed to the coincidental signing of three-year contracts (with lock-in increments) in the motor vehicle industry. This table of highly variable weights, reflecting the bargaining pattern in the industry, is applied to all explanatory variables in the negotiated wage-rate equation.

Table 5-1

Weights for the Distributed Lagged Effect of Explanatory Variables in the Negotiated Wage-Rate Equation

	Lags			
	0	1	2	3
1956	0	2.000	0	0
1957	0	0	1.000	0
1958	1.000	0	0	0
1959	0	1.000	0	0
1960	0	0	1.000	0
1961	.750	0	0	0
1962	0	1.125	0	0
1963	0	0	1.125	0
1964	1.375	0	0	0
1965	0	.750	0	0
1966	0	0	.875	0
1967	0	0	0	0
1968	0	1.290	0	0
1969	0	0	1.400	0
1970	0	0	0	.310
1971	0	2.450	0	0

As shown in equation (S30), all wage-parity variables are significant.[17] Each successive wage settlement in the Automotive Agreement period is marked by a significant increase in the strength of the wage-parity demand. Thus, the critical wage-rate concept in the model is shown to be almost totally determined by movements in the relative United States-Canada automobile wage rate (intensified by the Automotive Agreement), and the Canadian CPI, in the context of an institutional econometric model.

$$[S30] \quad \frac{BASEMV - (BASEMV)_{t-1}}{(BEWMV)_{t-1}} = \underset{(3.67)}{-.1256} + [\underset{(4.63)}{.1354}$$

$$+ \underset{(3.84)}{.01385}\, WR1 + \underset{(7.15)}{.02103}\, WR2 + \underset{(11.50)}{.02750}\, WR3] * (WMVUS/BEWMV)_{t-1}$$

$\bar{R}^2 = .9909$ $D.W. = 2.00$

$S.E.E. = .0037$ (OLS, 1956-71)

17 The t-statistics are, however, overstated as the error term has the same moving-average properties as the explanatory variables. Also, it should be noted that the constant term has been subject to the same set of weights as the wage-parity variables.

Average Hourly Earnings in the Motor Vehicle Industry

The preceding analysis focuses directly upon the explanation of basic wage rates, the key concept in the collective bargaining process. However, in the day-to-day operations of the firm, average hourly earnings represent an important cost variable to the firm. Furthermore, such average wage concepts are typically employed in econometric wage research and model building (e.g. CANDIDE), and thus it is desirable to link the previously generated basic wage rate to the conventional average hourly earnings data. The principal and overwhelming determinant of average hourly earnings is obviously the level of negotiated wages; and, in an attempt to isolate other important explanatory variables, attention will be directed to the spread or differential between average hourly earnings and basic wage rates.[18]

An important determinant of this differential is overtime hours and premiums. If one assumes that this factor alone accounts for the differential, average hourly earnings can be represented in the following manner:

$$AHE = \frac{(W*H_{st}) + a\,(W*H_{ot})}{H}$$

where W = basic negotiated wage rate
H_{st} = straight-time hours
H_{ot} = overtime hours
a = overtime premium factor
H = total hours worked per week

Rearranging terms produces the following result:

$$(AHE - W) = W * \left[\frac{(a-1)*H_{ot}}{H}\right]$$

Thus a critical explanatory variable for this particular structural relationship is the proportion of overtime hours (to total hours worked) multiplied by the basic wage rate.

A second factor which may increase the differential between average hourly earnings and the basic wage rate is a changing labour skill mix in the work force. The negotiated basic wage rate consists solely of the minimum base rate with no allowance for higher skilled labour classes. To the extent that this labour mix varies through time, average hourly earnings will vary due to a changing set of aggregation weights.

To test these two hypotheses, proxies for overtime hours and labour skill mix must be constructed. Since the motor vehicle industry has been on a standard 40-hour-work week during this period of time, it is assumed that

18 This type of analysis was suggested some time ago by L. R. Klein, and R. J. Ball, "Some Econometrics of the Determinants of Absolute Prices and Wages", *Economic Journal*, September 1959, pp. 463-482, but has received little subsequent attention.

annual hours worked in excess of 2080 are overtime hours. This is, of course, an understatement of overtime hours since a work week of less than 40 hours at any point during the year will cancel out overtime at another point in the year. However, it is assumed that this proxy will move with the actual (unobserved) level of overtime hours, and capture movements in the differential which are attributable to overtime premiums. Given the lack of any continuous time-series data on the labour skill mix for production workers, the only option is to utilize the ratio of nonproduction workers to production workers as a rough indicator of a changing labour skill mix on the assumption that employment levels for higher skilled production workers and nonproduction workers move together.[19] Both of these proxies are significant with the expected positive signs (see equation [S31]). The coefficient on overtime hours produces an estimated (average) overtime premium rate of 1.9,[20] well within the time-and-a-half and double-time rates paid for overtime work in the motor vehicle industry.

$$[S31]\quad AHEMV - BEWMV = \underset{(.16)}{-.0081} + \underset{(3.20)}{.9135}\left[\left(\frac{HMV\text{-}2080}{HMV}\right) * BEWMV\right] + \underset{(2.22)}{.1094}\left[\left(\frac{NPEMV}{PEMV}\right) * BEWMV\right]$$

$\bar{R}^2 = .9903$ $\quad D.W. = 2.15$

$S.E.E. = .0940$ $\quad$ (*OLS*, 1951-71)

Average Hourly Earnings in the Automotive Parts and Accessories Industry

As pointed out above, the automotive parts and accessories industry is composed of many smaller firms with unionization a less important feature of wage determination; and, consequently, a more traditional analysis is employed for wage changes in this industry. Profitability within the industry and negotiated wage spillovers from the motor vehicle assembly industry are found to be two significant determinants for movements in the level of average hourly earnings in the automotive parts and accessories industry. No significant structural shift arising from the signing of the Automotive Agreement could be detected for the parameters in the automotive parts and accessories wage equation.

19 Over the business cycle this relationship will likely persist as firms will be most hesitant to release highly trained (and paid) employees in a recession for fear that they will incur substantial retraining costs to replace them at a later (more prosperous) time.

20 Given the inherent understatement of overtime hours in the proxy variable, this coefficient will be biased upward.

[S32] $\left[\frac{AHEPA - (AHEPA)_{t-1}}{(AHEPA)_{t-1}}\right] = \underset{(.47)}{-.6236} + \underset{(2.43)}{25.52}\ PRFPA/GKSPAK$

$+ \underset{(2.54)}{.3516} \left[\frac{BEWMV - (BEWMV)_{t-1}}{(BEWMV)_{t-1}}\right]$

$\bar{R}^2 = .9862$ $D.W. = 2.67$

$S.E.E. = 1.754$ (OLS, 1953-70)

Average Annual Wage for Nonproduction Employees

To complete the wage block in the model, wage equations are required for nonproduction workers. The annual wage for such workers can be thought of as a wage rate multiplied by the number of hours (weeks) worked during the year. Unfortunately, neither of these concepts are observable, and only the annual wage is known. It is assumed that the nonproduction worker wage rate is based on the wage rate paid to the production worker, and that nonproduction hours follow those of production workers. Logarithmic estimates for the two industries are presented in equations (S33) and (S34). Wage elasticities for nonproduction worker salaries with respect to production worker wage rates are significantly less than unity for the motor vehicle industry and significantly greater than unity for the automotive parts and accessories industry (although these "significant" differences are not overwhelming). As expected the elasticity with respect to production employment hours is quite low reflecting the greater stability in hours worked by salaried workers than by production-line workers.

[S33] $\log AWNPMV = \underset{(42.39)}{.9448} \log BEWMV + \underset{(64.68)}{.1491} \log HMV$

$\bar{R}^2 = .9891$ $D.W. = 1.43$

$S.E.E. = .0306$ (OLS, 1950-70)

[S34] $\log AWNPPA = \underset{(56.07)}{1.0443} \log AHEPA + \underset{(71.17)}{.1320} \log HPA$

$\bar{R}^2 = .9937$ $D.W. = 1.61$

$S.E.E. = .0229$ (OLS, 1950-70)

Price Decisions in the Motor Vehicle Industry

The inherent problems of a tightly oligopolistic industry structure, not to mention foreign ownership considerations, impose limitations on econometric analysis of wholesale motor vehicle industry prices.[21] The central price hypothesis of this study is that Canadian wholesale motor vehicle prices are primarily determined by movements in United States wholesale motor vehicle prices. It can be argued that the appropriate "marketing" concept is the total North American market with the small Canadian market (and domestic production) being an appendage to the large (and dominant) United States market. Since underlying costs and demand patterns tend to move together in the two countries, the pricing decision of the United States industry should broadly reflect price considerations in Canada. Given the geographic and economic proximity to the United States, the similarity in product lines and the subsidiary nature of the Canadian automotive industry, the wholesale Canadian motor vehicle price index is assumed to be determined by a "mark-up" of United States wholesale vehicle prices. The "mark-up" would reflect the inefficiencies of a smaller-scale Canadian production process (within the bands of the protective tariff).

This mark-up model is generalized to include two additional economic determinants of Canadian wholesale motor vehicle prices: movements in the foreign exchange rate and domestic industry labour costs. With respect to the role of the foreign exchange rate, in an earlier study the Wonnacotts found that Canadian prices were fairly insensitive to exchange rate variations, and that any automatic formula was inappropriate.[22] The strategy adopted in this study follows that employed previously by the author[23] in which the United States wholesale price index is *not* directly adjusted for foreign exchange rate movements, but rather the foreign exchange rate is included as a separate determinant (with a "different" elasticity). Since exchange rate movements associated with a fluctuating Canadian exchange rate may be regarded as only temporary (or transitory), the direct effects of such exchange rate movements on Canadian wholesale motor vehicle prices is expected to be much less pronounced than a similar change in the level of United States wholesale motor vehicle prices *per se.*[24]

The Automotive Agreement-induced rationalization of the industry, increased relative efficiency in domestic production and presumably permitted lower wholesale prices in Canada. To test this hypothesis, the (mark-up) coefficient on United States wholesale prices is subjected to the parameter transition function technique. As shown in equation (S35) the quadratic[25] structural shift function significantly lowers the coefficient on

21 For example, the appropriate unit of analysis may be the individual firm with industry prices being determined by the resolution of interfirm pricing strategies.

22 P. Wonnacott, and R. J. Wonnacott, *op. cit.*, Chapter 13.

23 D. A. Wilton "An Econometric Model of the Canadian Automotive Manufacturing Industry and the 1965 Automotive Agreement", pp. 157-181.

24 Both changes have the same direct effect on the protective tariff margin, but differ in the "possibility" of a subsequent reversal.

25 While the linear functional form was likewise significant, the quadratic form was chosen on the basis of a lower *S.E.E.* for the equation.

the United States price variable by .09 (or 9.3%) in 1969. The two other economic explanatory variables have significant but smaller effects on Canadian motor vehicle prices. As found in the earlier cited study, the .34 elasticity of Canadian wholesale prices with respect to changes in the Canadian United States exchange rate is very moderate.[26] Labour costs, as measured by the negotiated base wage rate, have a significant positive effect, but a rather small price elasticity (.15).[27]

$$[S35] \quad WPMV = \underset{(2.06)}{-.4016} + \underset{(8.35)}{.9573}\, WPUSMV - \underset{(2.46)}{.003544}\, WAFT^2 * WPUSMV + \underset{(2.00)}{.3152}\, REXN + \underset{(2.05)}{.06098}\, BEWMV$$

$\bar{R}^2 = .9808$ $\qquad$ $D.W. = 1.74$

$S.E.E. = .0119$ $\qquad$ $(OLS$, 1952-70)

In summary, the principal factor in determining the wholesale price index of Canadian motor vehicles is movements in the comparable United States price index. Domestic labour costs and foreign exchange rate movements are of secondary importance. The signing of the Automotive Agreement has significantly lowered the mark-up coefficient (on comparable United States prices) by approximately 9% (in 1969). However, since Canadian wholesale motor vehicle prices ranged from 10-17½% higher than comparable United States prices prior to the Agreement, the econometric analysis of this study confirms a widely accepted (and controversial) fact: not all of the inter-country wholesale price differential has been closed.[28]

For the automotive parts and accessories industry, wholesale prices are assumed to be determined by a mark-up on normal unit labour costs. Given the cyclical pattern in actual unit labour costs, primarily a result of cyclical movements in labour productivity, it is necessary to "purge" the unit labour cost series of short-run cyclical aberrations. This is accomplished by regressing actual unit labour costs on a time trend, and employing the calculated values as a proxy for normal unit labour costs (S36). Utilizing this constructed proxy for normal unit labour costs as the principal factor in explaining

26 In the earlier study (Wilton, 1972) this elasticity was found to be 41.

27 Attempts to convert the basic wage rate to a unit-labour-cost variable produced insignificant statistical results. Thus, part of this low elasticity can be attributed to offsetting gains in productivity (a missing variable) which reduce the necessity of passing along all wage increases in the form of higher prices. In the earlier cited study (Wilton, 1972), the elasticity of wholesale motor vehicle prices with respect to unit labour costs was found to be .72, considerably higher than that presented above (based on a sample period of 1948-64 and a two-stage estimation technique).

28 An analysis of the reasons for the persistence of a post-Agreement "mark-up" of United States vehicle prices is beyond the scope of this econometric study. Interested readers are referred to Chapter 5 in the Emerson study (*op.cit.*).

the automotive parts and accessories wholesale price index, the parameter estimates of equation (S37) reveal that the elasticity of wholesale prices with respect to normal unit labour costs is approximately .9. While the Automotive Agreement has inexplicably increased the mark-up coefficient on unit labour costs, the Agreement-induced decrease in unit labour costs (in equation [S36]) more than offsets the increase of the mark-up coefficient. Solving equations (S36) and (S37) simultaneously suggests that wholesale prices for automotive parts and accessories are approximately 3 % lower as a result of the Automotive Agreement.

[S36] $ULCPAT = \underset{(41.65)}{.3539} + \underset{(6.74)}{.006702}\, TIME52 - \underset{(6.49)}{.001121}\, WAFT{*}TIME52$

$\bar{R}^2 = .7247$ $\quad D.W. = 2.12$
$S.E.E. = .0150$ $\quad$ (*OLS*, 1952-70)

[S37] $WPPA = \underset{(.69)}{.03520} + \underset{(18.15)}{2.2984}\, ULCPAT + \underset{(23.75)}{.02355}\, WAFT^2 * ULCPAT$

$\bar{R}^2 = .9741$ $\quad D.W. = 1.31$
$S.E.E. = .0126$ $\quad$ (*OLS*, 1952-70)

Finally, retail prices for motor vehicles and automotive parts and accessories are assumed to be determined by a mark-up on the respective wholesale prices adjusted for various government taxes which apply to motor vehicle products.[29] Based on the estimates of equation (S38), the elasticity of retail motor vehicle prices with respect to wholesale prices is 1.15 and the signing of the Automotive Agreement has significantly *decreased* this retail mark-up by approximately 5%. As shown in Chapter 7, retail prices for motor vehicles have declined, *in total*, by 13-14% over the levels which would have prevailed without the Automotive Agreement. In equation [S39] a similar type of analysis is carried out for retail prices of automotive parts and accessories. The less satisfactory results for this latter retail price equation can, perhaps, be attributed to the fact that the largest market for automotive parts and accessories exists at the wholesale level, i.e. the intermediate demand by the motor vehicle manufacturing industry.

[S38] $CDT10P/[1.0 + .01\, TDT10R] = \underset{(1.47)}{-.1313} + \underset{(12.20)}{.9619}\, WPMVAJ$

$\qquad - \underset{(4.23)}{.02183}\, WAFT{*}WPMVAJ + \underset{(2.35)}{.002606}\, WAFT^2 * WPMVAJ$

$\bar{R}^2 = .9384$ $\quad D.W. = 1.30$
$S.E.E. = .0098$ $\quad$ (*OLS*, 1956-60)

29 Retail motor vehicle sales are subjected to varying provincial sales taxes while wholesale vehicle prices are subjected to federal sales and excise taxes.

[S39] $CDT20P/[1.0 + .01\ TDT20R] = -.6854 + 1.4929\ WPPAAJ$
(5.56) (13.29)

$+ .02120\ WAFT*WPPAAJ + .003328\ WAFT^2*WPPAAJ$
(2.97) (2.58)

$\bar{R}^2 = .9954$ $D.W. = 2.66$
$S.E.E. = .0124$ (OLS, 1956-70)

[I14] $WPMVAJ = [1.0 + .01\ ESCIS] * [1.0 + RSC] * WPMV$

[I15] $WPPAAJ = [1.0 + RSC] * WPPA$

Profit Relationship in the Motor Vehicle Industry

Given price, employment, wage and output decisions for each industry, profits should be residually determined. Unfortunately, the principal data source for this study, the Census of Manufactures, provides neither a time series for actual profits nor a complete breakdown of all expenses in the industry. The only available data for profits in the automotive industries are to be found in Department of National Revenue (DNR) publications, and are utilized (with some reservations) in this study. To overcome data discrepancies between these two distinctly different data sources, a Census of Manufactures "profit" proxy is constructed from available output, wage and material cost data (endogenous variables in the model). This profit proxy is used to explain the DNR concept of profits plus capital cost allowances in the automotive industries. Thus, equations (S40) and (S41), can best be regarded as "stochastic" identities necessitated by the lack of one consistent set of data for the automotive industries.[30]

[S40] $(PRFMV + CCAMV) = 14.998 + .6324\ PPRFMV$
(1.83) (11.51)

$- .2766\ WAFT*PPRFMV + .07880\ WAFT^2*PPRFMV$
(3.62) (2.11)

$- .006713\ WAFT^3*PPRFMV$
(1.42)

$\bar{R}^2 = .9265$ $D.W. = 2.42$
$S.E.E. = 14.92$ (OLS, 1953-70)

30 Since these equations are essentially relationships between two data sources, the decline in the coefficient on the profit proxy variable with the signing of the Automotive Agreement should be interpreted as a "data phenomenon" and not a structural Automotive Agreement effect on the industries.

[S41] $(PRFPA+CCAPA) = -4.910 + .6669\ PPRFPA$
$\qquad\qquad\qquad\qquad (.35) \qquad (3.82)$

$- .2631\ WAFT{*}PPRFPA + .12931\ WAFT^2{*}PPRFPA$
$\quad (1.77) \qquad\qquad\qquad (2.00)$

$- .01647\ WAFT^3{*}PPRFPA$
$\quad (2.08)$

$\bar{R}^2 = .9386$ $\qquad$ $D.W. = 2.70$
$S.E.E. = 13.36$ $\qquad$ (OLS, 1953-70)

[I16] $PPRFMV = GOMVC - MATMVC - TEWBMV$

[I17] $PPRFPA = GOPAC - MATPAC - TEWBPA$

To isolate profits without capital cost allowances (data for which are also not available in the Census of Manufactures but available from DNR), it is necessary to specify a structural relationship for capital cost allowances. Such capital cost allowances are assumed to be generated by the application of legal depreciation rates to past investment flows. Identities (I18) and (I19) create proxy variables for legal depreciation charges allowable on the most recent eight years of investment[31] and these two proxies, along with a dummy variable for the year 1964 (an outlying data observation) are employed to specify capital cost allowances in the two automotive industries.

[S42] $CCAMV = 16.10 + .5860\ PCCAMV + 23.66\ D64$
$\qquad\qquad\qquad (3.30) \qquad (2.50) \qquad\qquad (3.73)$

$\bar{R}^2 = .5030$ $\qquad$ $D.W. = .79$
$S.E.E. = 6.02$ $\qquad$ (OLS, 1955-70)

[S43] $CCAPA = 5.19 + .7642\ PCCAPA + 9.682\ D64$
$\qquad\qquad\qquad (3.16) \qquad (15.57) \qquad\qquad (2.18)$

$\bar{R}^2 = .9413$ $\qquad$ $D.W. = 1.57$
$S.E.E. = 4.28$ $\qquad$ (OLS, 1955-70)

[I18] $PCCAMV = \sum_{i=0}^{7} W_i\ VMEMVC_{t-i} + \sum_{i=0}^{7} V_i\ VSMVC_{t-i}$

[I19] $PCCAPA = \sum_{i=0}^{7} W_i\ VMEPAC_{t-i} + \sum_{i=0}^{7} V_i\ VSPAC_{t-i}$

$$W_i = \{.10000,\ .18000,\ .14400,\ .11520,\ .09216,\ .07373,\ .05898,\ .04719\}$$
$$V_i = \{.02500,\ .04875,\ .04631,\ .04400,\ .04180,\ .03971,\ .03772,\ .03584\}$$

31 It is assumed that one-half of the current year's investment is depreciated in the first year. Lack of earlier data and the degrees of freedom problem necessitated terminating the weights at some point. While the cut-off after eight years arbitrarily undervalues this proxy, the weights attached to investment flows of age nine years (and greater) are 3 % or less for each missing year.

Summary

This chapter has provided structural equations for the major economic relationships within the motor vehicle assembly and automotive parts and accessories industries. Of the twenty-four employment, investment, wage, price, and profit structural relationships presented, a significant Automotive Agreement-induced structural shift is detected in all but six of these equations. These two industrial subsystems can be viewed both as component industrial models which describe the economic structure of the automotive sector as well as the automotive "supply" links to the economy-wide CANDIDE model.

The next chapter, written by N. Mathieu, formally integrates these two industrial submodels into the CANDIDE system. Since this study represents the first attempt to integrate satellite industrial econometric models into the CANDIDE system, the next chapter is also intended to serve as a useful guide to future CANDIDE model users who may likewise wish to incorporate additional sectors into the CANDIDE system. The results of this automotive-CANDIDE integrated system will form the basis of simulation experiments (in Chapters 7 and 8) designed to quantify the effect of the Automotive Agreement on the Canadian economy and automotive sector.

6 Linkage of Automotive Sectoral Models to CANDIDE

by N. Mathieu

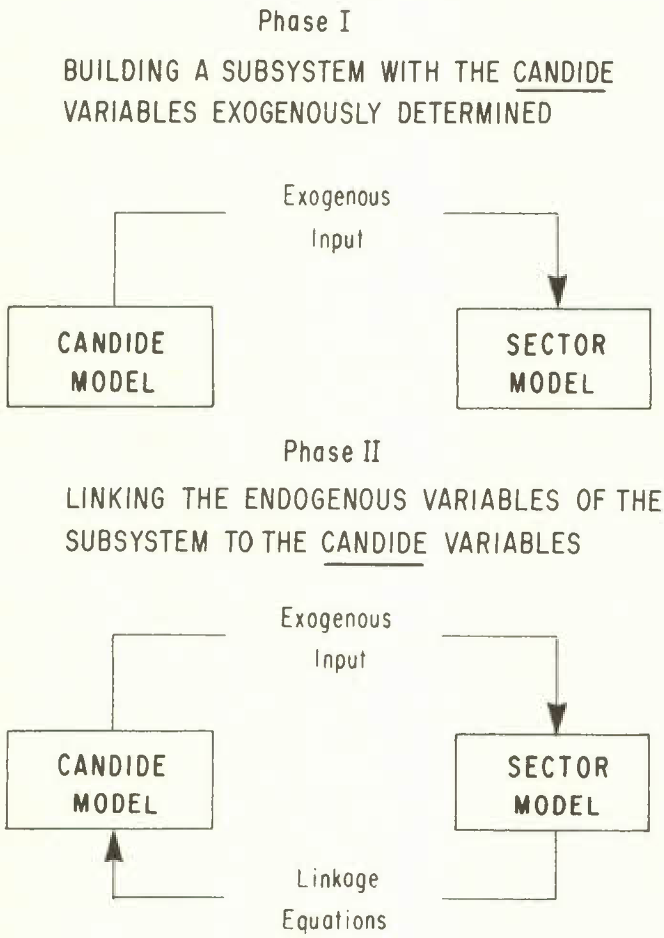
When the structural relationships of an industry model have been estimated, they can be used to simulate different sectoral policies. Such simulations show the variations at the sectoral level due to changes in specific policy variables. In this study of the effects of the Automotive Agreement, the policy elements related to the Agreement are mainly represented by the structural-shift variable (*WAFT*). The simulation results would be computed for a given set of economic conditions which are external to the sectoral model. These external hypotheses concern the surrounding domestic economy and the international environment as well. Therefore, the dynamic interrelations between the sector and the rest of the economy have not yet been considered. Only partial sectoral effects are investigated.

However, the sectoral model can be integrated into a larger econometric framework which contains behavioural equations regarding production, consumption and factor requirements of goods other than motor vehicles and/or automotive parts and accessories. In this case the variables of the domestic economy, which enter as explanatory variables in the sectoral model, are not exogenously determined any more. Also, if the integration is complete, the sectoral variables go into the identities of the main aggregates of the large model. When policy changes are then made in the sectoral model, they involve the large model as well. During the simulation of the entire model, an iterative adjustment process is working between the particular sectoral model and the rest of the economy. This second approach is, of course, more meaningful than the previous one as it bears results which are computed from a system of relations between the sector and the national economy. By contrast with the first approach, total sectoral effects are considered here.

In order to obtain a relevant adjustment procedure between the submodel and the model of the domestic economy, two categories of linkages must be analysed: the relations which go from the large model to the industry model and the feedback relations between the industry sector and the rest of the economy (see Chart 6-1). In this section we present first a development of the automotive subsystem with the variables of the national economy considered as exogenous. Then follows a description of the feedback relations, and

Chart 6-1

How to Integrate
a Sector Model into CANDIDE



finally we explain how the subsystem augmented by the linkage equations becomes part of CANDIDE Model 1.1.

The Subsystem with the CANDIDE Variables Exogenously Determined

The set of the estimated structural equations presented in Chapters 4 and 5 compose most of the subsystem. Some identities are added to ensure an accounting consistency between the variables during the simulation exercise.

In terms of model building the role of the identities is to close the subsystem.[1]

Current dollar identities for gross output, material inputs, and the total wage bill equations for motor vehicles, and automotive parts and accessories are components of the subsystem. In this way the explanatory variables of the profit equations are endogenized. As regards the input-output relations, the value-added variables of the sectoral model are connected to the CANDIDE Real Domestic Product variables.[2] This allows for the use of the CANDIDE input-output relations when the submodel is integrated. The sectoral submodel can not be simulated independently of CANDIDE unless these input-output relations linking the final demand variables with the sectoral input requirements are included.

In Chart 6-2 we can perceive how the CANDIDE variables impact the main components of the subsystem. The total consumption item from CANDIDE enters into the explanation of the different consumption functions of the sector model. Because of the relations between the consumption block and the production block in the subsystem, the total consumption item has an indirect effect upon the sectoral production requirements and the employment demands. The foreign trade equations, which have been integrated into CANDIDE Model 1.1 when the large model was set up, also influence the variables of the sectoral production block through the input-output relations.

Another important variable of CANDIDE, the Consumer Price Index, is inserted in the wage escalator effect of the subsystem. As the total basic wage rate is an explanatory variable of the average hourly earnings and the wholesale price equations in the motor vehicle industry, the CPI indirectly affects all the current value identities and the income distribution equations of the subsystem.

It has been mentioned how the CANDIDE items have an impact on the main variables of the subsystem. The next step is to analyse how the sectoral variables feed into the CANDIDE model. This second category of relations between the two models is complementary. It allows a direct feedback from the submodel to the large one as well as permitting an indirect feedback from CANDIDE to the sector model (and then an iterative adjustment between the sector model and CANDIDE).

The type of linkages which have been made in order to ensure consistency between the CANDIDE aggregates and the automotive sectoral components are now explained.

The Linkage from the Submodel to CANDIDE Model 1.1

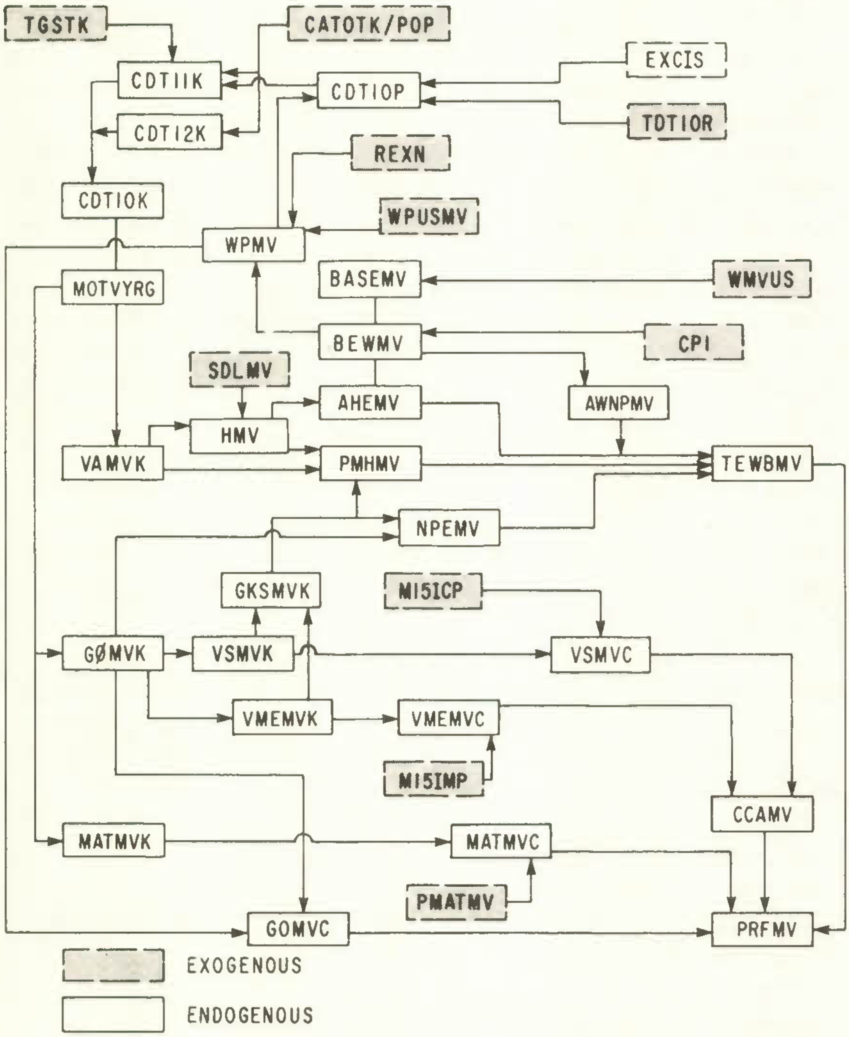
The main questions related to this second phase of the integration operation are: which CANDIDE variables have to be linked and how to define the linkage in econometric terms?

1 These additional identities are included in the Appendix, along with a complete mnemonic table.

2 See Chapter 4, equations [S16] to [S19].

Chart 6-2

Closed System for Motor Vehicles*
(Imports and Exports Excluded)



*The mnemonics are listed in the Appendix.

A careful examination of the CANDIDE structure shows that it is not necessary to enter all the endogenous sectoral variables into the CANDIDE aggregates through explicit linkage equations. There are in the large model chains of causal relations which constitute channels by which a variable can impact sequentially a set of other variables. Therefore, it is enough to link one element of the chain at the proper place in order to get the sectoral effects on the other variables which are situated along the sequence of causal relations. For example, the aggregated value for capital consumption allowances in CANDIDE is related to total investment by means of the undepreciated balance equation. And among the investment components we have endogenous variables for the transportation equipment capital expenditures, which depend mainly upon the output of automobiles and the cost of capital services. It is possible to make a link at one of the three stages: output, investment, or capital consumption allowances. We choose the output stage for mainly two reasons. One is that we keep the capital costs effects by maintaining the CANDIDE investment equation unchanged. In this way the monetary sector of CANDIDE is still related to the investment component concerning the automotive industry. The other reason is that the effects of the Automotive Agreement are transmitted by the linkage from output to investment, and then from investment to capital consumption allowances, without needing any other linkage in this specific chain of causal relations.

The output link for the investment function is made by relating the CANDIDE Real Domestic Product to the sectoral value-added variables:

[S44]
$$MA150Y = \underset{(6.59)}{139.38} + \underset{(9.48)}{0.5091}\,(VAMVK + 0.12287\ VAPAK) + \underset{(5.55)}{0.0513}\ WAFT^{*}(VAMVK + 0.12287\ VAPAK)$$

$\bar{R}^2 = 0.9868$ $\quad$ $D.W. = 2.45$

$S.E.E. = 33.032$ $\quad$ (OLS, 1950-70)

[S45]
$$MA153Y = \underset{(11.18)}{70.320} + \underset{(24.45)}{0.5054}\,(0.87713\ VAPAK)$$

$\bar{R}^2 = 0.9676$ $\quad$ $D.W. = 0.89$

$S.E.E. = 15.917$ $\quad$ (OLS, 1950-70)

Similarily, CANDIDE industry prices are linked to the sectoral price variables.

[S46]
$$MA15P = \underset{(12.22)}{0.5946} + \underset{(7.01)}{0.00646}\ TIME^{*}PRMA15P - \underset{(1.26)}{0.0107}\ WAFT^{*}PRMA15P$$

$\bar{R}^2 = 0.7527$ $\quad$ $D.W. = 1.0$

$S.E.E. = 0.0592$ $\quad$ (OLS, 1949-70)

[S47] $MA152P = \underset{(11.40)}{0.5951} + \underset{(6.51)}{0.00637}\ TIME*PRMA152P$

$- \underset{(1.12)}{0.00999}\ WAFT*PRMA152P$

$\bar{R}^2 = 0.7255$ $D.W. = 0.85$

$S.E.E. = 0.0623$ $(OLS,\ 1949\text{-}70)$

[I20] $MA153P = MA152P$

[I21] $PRMA15P = (VAMVK/GOMVK) *WPMV + (MATMVK/GOMVK) *PMATMV$

[I22] $PRMA152P = (VAPAK/GOPAK) *WPPA + (MATPAK/GOPAK) *PMATPA$

The other question is how to define the linkage in econometric terms when the levels of aggregation of the categories to be related are different. In the previous examples, the aggregation level for Real Domestic Products (and prices) in CANDIDE and in the sector models were close to each other. As a consequence the CANDIDE variables were regressed on a weighted sum, or a proportion, of the corresponding sectoral variables. When the levels of aggregation of the categories to be linked are more distant from each other, another method is used. The CANDIDE endogenous variable is replaced by the sum of the corresponding automotive sectoral components plus a term equal to the difference between the CANDIDE aggregate and this sum of automotive sectoral variables. This nonautomotive residual term is endogenized by regressing it on explanatory variables constructed from the CANDIDE aggregate less the corresponding sectoral activity variables. This approach is applied to the employment demand and the labour income equations:

[I23] $MAETH = MAETHR + PMHMV + PMHPA$

[I24] $MAET = MAETR + (TEMV/1000.) + (TEPA/1000.)$

[I25] $MAWA = MAWAR + (TEWBMV/1000.) + (TEWBPA/1000.)$

The estimated equations for the nonautomotive residual employment and labour income are the following:

[S48] $\log MAETHR + 0.5081 \log MACKR = \underset{(23.34)}{9.006} + \underset{(9.66)}{1.528}\ DPSIXT$

$$- \underset{(9.57)}{0.02543}{*}\ TIME{*}DPSIXT + \underset{(1.49)}{0.01632}\ D64$$

$$+ \underset{(8.57)}{0.600} \log MAYR$$

$$+ \underset{(14.6)}{0.4034} \log MAYR_{t-1} + \underset{(4.39)}{0.2035} \log MAYR_{t-2}$$

$\bar{R}^2 = 0.9982$ $D.W. = 2.31$

$S.E.E. = 0.0010$ (OLS, 1954-71)

[S49] $\log MAETR + 0.5081 \log MACKR = \underset{(3.82)}{1.698} + \underset{(6.68)}{1.2156}\ DPSIXT$

$$- \underset{(6.64)}{0.0203}{*}\ TIME{*}DPSIXT + \underset{(1.26)}{0.01579}\ D64$$

$$+ \underset{(5.44)}{0.4388} \log MAYR$$

$$+ \underset{(13.89)}{0.4419} \log MAYR_{t-1} + \underset{(5.55)}{0.2957} \log MAYR_{t-2}$$

$\bar{R}^2 = 0.9977$ $D.W. = 2.07$

$S.E.E. = 0.0114$ (OLS, 1954-71)

[S50] $MAWAR = \underset{(3.32)}{284.64} + \underset{(79.95)}{0.9626}\ (MAETHR{*}MAWH/1000.)$

$\bar{R}^2 = 0.9966$ $D.W. = 2.342$

$S.E.E. = 165.5$ (OLS, 1949-71)

[I26] $MACKR = MACK - GKSMVK - GKSPAK$

[I27] $MAYR = MAY - MA150Y - MA153Y$

These equations mirror the structural relationships for *MAETH, MAETR* and *MAWA* contained in CANDIDE.

In the case of the consumption function, there is no discrepancy item since the CANDIDE aggregate is exactly equal to the sum of the sector components:

[I28] $CDT10K = CDT11K + CDT12K$

Rebuilding CANDIDE Model 1.1

At this stage the linkage has been defined both ways, from the CANDIDE model to the sectoral model and reciprocally. The linkage equations become part of the subsystem. The final step is to integrate each equation of this subsystem into the structure of the large model.

The submodel is divided into blocks so that it is possible to transfer a number of them directly into CANDIDE Model 1.1. This is the case of the production block, the current values block, and the income distribution block of the subsystem. They are net additions to the large model. The components of the other blocks of the submodel are dispatched into CANDIDE, since they replace some of the CANDIDE equations. Thus, a new CANDIDE model has been built with the automotive sector included, and the system is ready for simulation experiments in the next two chapters.

7 An Analysis of the Effects of the Automotive Agreement

Having completed the specification of a system of behavioural, technological and definitional equations designed to quantify the economic structure of the Canadian automotive industries within the context of a large scale model of the Canadian economy, the general equilibrium effects of the Automotive Agreement can be determined. Given the many nonlinear features in the automotive sectoral models, simulation experiments are the obvious choice for this general equilibrium analysis and this chapter presents the results of two sets of simulations for the "augmented" CANDIDE model. The first simulation, designated the "control solution", explores the dynamic performance of the estimated model over the full sample period. By comparing this control solution to actual sample period data, one is able to judge how well the model functions as a complete, simultaneous system. The second simulation suppresses all underlying parameter shifts associated with the Automotive Agreement (i.e. suppresses the parameter transition function *WAFT*) and thus provides a model solution without the presence of the Automotive Agreement. Differences between this solution and the control solution provide an econometric measure of the total impact (or general equilibrium effects) of the Automotive Agreement on the automotive sectors and on the Canadian economy.

The Control Solution

The generation of a control solution path for any model is accomplished by providing values for the initial conditions (i.e. values for lagged variables) and exogenous variables, and then solving the model year by year for all endogenous variables.[1] A comparison of the control solution track with actual data provides a convenient and useful approach to assess the strengths and weaknesses of a model, particularly with respect to the systems features

1 Values of endogenous variables generated in one period are fed back into the model in subsequent periods as lagged endogenous variables.

of the model. However, as Howrey and Kelejian have pointed out,[2] there are two theoretical problems associated with the validation of a model through a comparison of a control solution with actual data. Since these two problems affect all simulation experiments, a brief discussion is devoted to each.

First, in a nonlinear model, such as that presented above, the application of nonstochastic or deterministic simulation procedures[3] will yield results that are inconsistent with the analytical-reduced form equation set. In other words, nonstochastic simulation results may diverge systematically from the historical values. As Howrey and Kelejian demonstrate, the mean path of a set of stochastic simulations will not be subject to this theoretical problem. Since the computational burden of calculating a large set (e.g. 100-200) of stochastic simulations is nontrivial, the crucial issue is the relative magnitude of the bias which will occur when deterministic simulation procedures are applied to nonlinear models. Fortunately, a number of recent studies have found that this bias or inconsistency is very slight and is perhaps a theoretical problem with only marginal empirical relevance.[4]

On the other hand, the second theoretical problem would appear to be of a greater consequence. Even if the underlying econometric model is well specified, the differences between the control solution and the actual data will be autocorrelated and heteroscedastic. To illustrate this proposition, consider a one-equation model, estimated in first difference form with a *well-behaved* error (u_t):

$$y_t - y_{t-1} = \hat{\alpha} + \hat{\beta}X_t + u_t$$

Given exogenous values for X_t and an initial value for y, simulated values for y_t are given by the following equation:

$$y_t^s = 1.0y_{t-1}^s + \hat{\alpha} + \hat{\beta}X_t$$

2 E.P. Howrey and H.H. Kelejian, "Simulation versus Analytical Solutions: The Case of Econometric Models" in T.H. Naylor, *The Design of Computer Simulation Experiments*, (Durham, North Carolina: Duke University Press, 1969).

3 In a deterministic simulation, all structural errors are set equal to zero. In a stochastic simulation, random variables (reflecting the error structure of each equation) are incorporated into each stochastic equation, and the model is repeatedly solved for different sets of random errors.

4 For example, FitzGerald finds that "One encouraging feature of the results is that the differences between forecasts made using deterministic simulation and average time-paths obtained from stochastic simulation appear to be negligible in the results obtained so far .... Such results suggest that one is justified in using the computationally cheaper deterministic simulation procedures for the production of short-term forecasts . . . ." ("Dynamic Properties of a Non-Linear Econometric Model" in A.A. Powell and R.A. Williams (eds.), *Econometric Studies of Macro and Monetary Relations*, (Amsterdam: North-Holland Publishing Company, 1973) pp. 191-192.) Also see, C.I. Higgins and V.W. FitzGerald, "An Econometric Model of the Australian Economy", *Journal of Econometrics*, Volume 1, No. 3, October 1973, and A.L. Nagar, "Stochastic Simulation of the Brookings Econometric Model" in *The Brookings Model: Some Further Results*, edited by J.S. Duesenberry *et al.*, (Chicago: Rand McNally and Company, 1969).

The simulation error $(y^s - y)$ at time t is given by the addition of the well-behaved error (u_t) to the simulation error in t-1. In short, the underlying, well-behaved errors cumulate in the y^s_{t-1} term, and at any point in time the simulation error (e^s_t) can be represented as the sum of all the previous underlying (well-behaved) errors

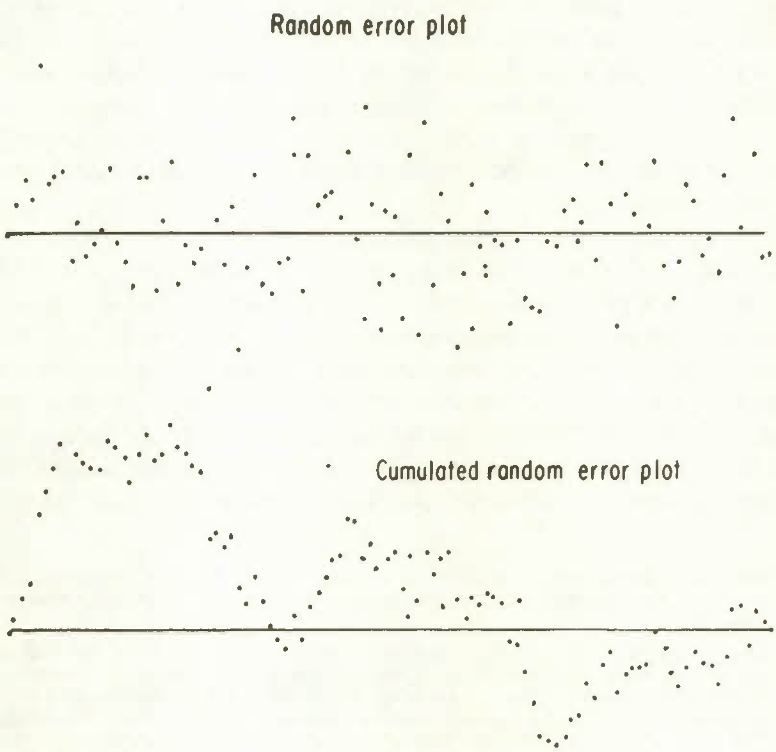
$$e^s_t = \sum_{i=1}^{t} u_i$$

Clearly there is a correlation between e^s_t and e^s_{t-i} and this series $(e^s_1, e^s_2, \ldots, e^s_t)$ exhibits *substantial* autocorrelation.

To demonstrate this point in a simple, intuitive fashion, the upper portion of Chart 7-1 displays a sequence of normal errors taken from a random number table. The lower portion presents a plot of the cumulative sum of these errors at each point in time and is unmistakenly autocorrelated. Thus, even if the underlying structural relationship has a well-behaved error structure, the presence of a first-differenced dependent variable will generate simulation errors which are autocorrelated.

Chart 7-1

Illustration of Random and Cumulated Random Errors



This proposition can obviously be extended to the conventional set of models with a lagged dependent variable having any estimated coefficient (say λ). In this case, the simulation error would be represented by the following expression:

$$e_t^s = \sum_{i=1}^{t} \lambda^{t-i} u_i$$

and is again autocorrelated. Finally, the presence of a lagged dependent variable anywhere in the model will cause this form of autocorrelation to permeate throughout the system of equations.

In summary, simulation values theoretically can diverge from actual values (in a nonlinear model), and the errors between simulation values and actual data will be autocorrelated in a dynamic model. While empirical evidence from previous studies tends to alleviate concerns over the first problem, the inherent autocorrelation in simulation errors is somewhat more worrisome. With this caveat made explicit, a review of the simulation errors in the new industry satellite models is now undertaken.

In Chart 7-2, actual data for gross real output[5] in the two automotive industries are contrasted to two different control simulations. The sectoral control simulation provides a solution to the automotive models on the assumption that all nonsectoral variables (such as GNE) are exogenous. In other words, a partial (sectoral) equilibrium analysis is depicted with no feed-backs from the automotive sector to the rest of the economy and back to the automotive sector. The second simulation, designated as an augmented CANDIDE-control simulation, provides a solution to the integrated automotive CANDIDE models. In this general equilibrium solution, underlying errors in the structure of the CANDIDE model are permitted to feed through to the automotive sectors.

In general, the control solutions provide a reasonably good representation of the actual data for nearly all endogenous variables in the automotive sectors. For most structural equations the sectoral simulation and the augmented CANDIDE simulation are quite similar suggesting that structural errors in the basic CANDIDE model are not particularly troublesome in analysing the dynamic performance of the two sectoral models.[6] Most of the cyclical movements in actual industry output are captured in the simulations, with the largest discrepancies occurring in 1961 (for motor vehicles) and 1964 (for automotive parts and accessories). Actual employment, investment and profit

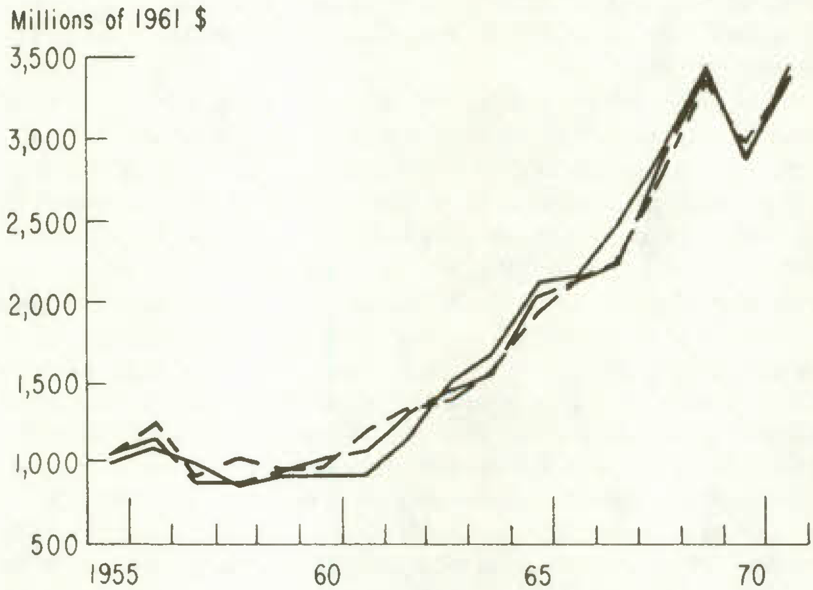
5 Space does not permit a display of all endogenous variables, and consequently real sectoral output (perhaps the major variable in the model) was chosen for illustrative purposes.

6 The most noticeable exceptions to this general statement would be the consumer automobile expenditures equation, in which it appears that CANDIDE model errors in personal disposable income cause much larger errors in the augmented CANDIDE simulation than in the sectoral control simulation, and in the input-output "adjustment" equations (which affect real output within the automotive sectors).

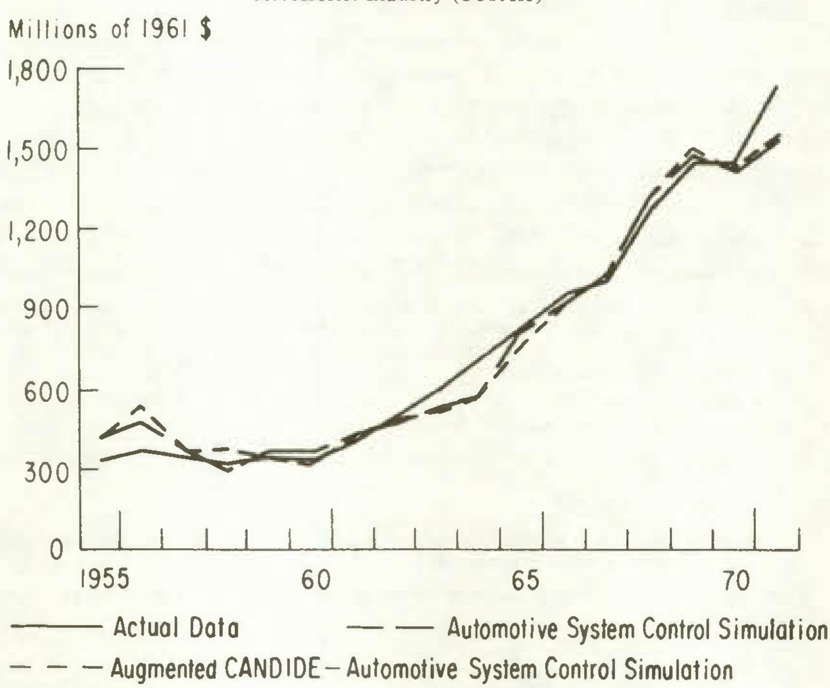
Chart 7-2

Comparison of Actual and Control Simulation Data

(i) Gross Output in the Motor Vehicle Industry (*GOMVK*)



(ii) Gross Output in the Automotive Parts and Accessories Industry (*GOPAK*)



patterns are closely tracked in the automotive parts and accessories industry, although somewhat larger simulated errors are found in the more cyclical motor vehicle industry. Finally, industry wage and price variables are simulated with very small errors and the parameter transition function maintains a close approximation of simulated trade flow data to the rapidly changing actual data.

In addition to the graphical analysis of model errors, Table 7-1 provides supplementary statistics on the simulation performance of the model. In most cases, the root mean square error (*RMSE*) for the 1955-70 control simulation is in line with the standard error of estimate (*S.E.E.*) from the underlying structural equation.[7] With very few exceptions (such as the "displayed" *GOMVK*), the *RMSE* for the full-model simulation does not increase appreciably over the sectoral model simulation. Calculated values for Theil Inequality Coefficients (TIC)[8] and the coefficient of determination (R^2)[9] provide further support for the propositions that the control solutions provide a reasonably good prediction of the actual data for nearly all endogenous variables and that error magnification in either the automotive sectoral models or in CANDIDE (filtering through to the automotive sector) is not a major problem. Systems errors reflect the error structure of the underlying equation(s) with the qualification of a predicted increase in the prevalence of autocorrelation. In most cases, the Durbin-Watson statistic for the simulated errors is lower than that obtained from the underlying regression error structure, particularly in equations with high coefficients on the lagged dependent variables (e.g. *MATPAK* and *AHEPA*).

In summary, the control simulations suggest that the dynamic and structural characteristics of the automotive models, as well as CANDIDE Model 1.1, tend to keep the endogenous variables relatively closely on track over the fifteen-year sample period. Even though there are individual discrepancies and a predictable increase in autocorrelation of the errors, *RMS* errors are quite similar to the underlying *S.E.E.* from the basic regressions, Theil Inequality Coefficients are close to zero, and most coefficients of determination are well in excess of .90. Systems errors are not explosive, and

7 It must be remembered that the sample period for the regression equations usually differs from the 1955-70 simulation period, and that the *RMSE* is expected to exceed the *S.E.E.* given the underlying autocorrelation and heteroscedastic properties of the simulated errors.

8 Denoting simulated values by S_i and actual values of A_i, the Thiel Inequality Coefficient can be represented by the following expression:

$$TIC = [1/n \Sigma (S_i - A_i)^2]^{1/2} / [1/n \Sigma S_i^2 + 1/n \Sigma A_i^2]^{1/2}$$

where $0 < TIC < 1$

A value of zero would represent a perfect prediction and a value approaching unity would represent a very poor prediction.

9 This R^2 provides a simple measure of the goodness of fit between simulated and actual values.

can largely be attributed to the underlying error pattern in the particular structural equation.

Table7-1

Control Simulation Statistics

	Sectoral simulation			Augmented CANDIDE simulation			
	RMSE	*TIC*	R^2	*RMSE*	*TIC*	R^2	*D.W.*
CDT11K	106.4	.036	.954	121.8	.040	.940	1.33
CDT12K	39.7	.049	.873	41.4	.051	.861	.48
CDT20K	34.2	.033	.906	35.1	.035	.900	.10
CARUXK	30.02	.021	.998	29.98	.021	.998	2.56
COMUXK	8.12	.020	.998	8.12	.020	.998	2.52
PARUXK	17.85	.023	.996	17.74	.023	.997	2.27
CARRXK	10.60	.102	.866	10.60	.102	.866	2.11
COMRXK	6.30	.124	.895	6.30	.124	.895	2.48
PARRXK	5.18	.064	.941	5.18	.064	.941	1.69
CARUMK	32.05	.043	.987	33.19	.045	.986	1.43
COMUMK	10.81	.045	.980	11.14	.047	.979	1.47
PARUMK	36.59	.023	.993	47.63	.030	.988	1.19
CARRMC	18.40	.073	.895	20.98	.084	.864	1.87
COMRMC	3.20	.106	.892	2.94	.097	.909	1.12
PARRMC	10.94	.144	.838	12.07	.158	.803	.85
GOMVK	112.93	.030	.982	151.63	.041	.968	1.28
GOPAK	55.31	.034	.981	62.41	.039	.976	.76
MATMVK	68.59	.028	.981	87.69	.036	.969	1.42
MATPAK	31.41	.037	.974	34.81	.042	.969	.68
VAMVK	60.31	.046	.969	75.50	.057	.952	1.38
VAPAK	29.13	.037	.979	31.29	.040	.976	1.06
HMV	50.51	.011	.460	54.12	.012	.380	1.49
HPA	29.98	.007	.585	45.76	.011	.032	2.46
PEMV	3308	.067	.409	3282	.066	.418	.96
PEPA	2303	.043	.938	2480	.046	.928	1.13
NPEMV	693	.034	.909	764	.037	.889	.87
NPEPA	422	.031	.962	443	.032	.958	.63
VMEMVK	5.99	.154	.448	6.33	.164	.382	2.28
VSMVK	5.80	.196	.568	6.44	.220	.467	1.43
VMEPAK	7.37	.078	.950	8.34	.089	.936	1.13
VSPAK	5.78	.203	.731	5.99	.211	.712	2.66
BEWMV	.0001	.002	.999	.0004	.004	.999	.80
AHEMV	.080	.014	.988	.079	.014	.988	2.14
AHEPA	.049	.010	.990	.053	.011	.988	.63
AWNPMV	.032	.012	.990	.042	.014	.987	1.91
AWNPPA	.170	.012	.986	.179	.013	.985	1.03
WPMV	.039	.020	.540	.011	.006	.964	2.01
WPPA	.012	.006	.960	.012	.006	.960	1.30
CDT10P	.015	.008	.884	.015	.008	.881	1.48
CDT20P	.024	.011	.983	.024	.011	.983	1.51
PRFMV	27.9	.132	.640	34.1	.161	.462	1.49
PRFPA	10.7	.077	.925	12.1	.087	.903	2.09
CCAMV	5.50	.093	.556	5.53	.093	.552	.66
CCAPA	5.54	.095	.895	6.18	.107	.869	.73

The Effects of the Automotive Agreement on the Automotive Subsectors

As discussed above, the general equilibrium effects of the Automotive Agreement can be readily obtained from the constructed models by performing one additional simulation. Since the structural impact of the Agreement has been directly incorporated into the model through shifting the relevant underlying parameters in individual sectoral equations, a counterfactual description of the post-Agreement era can be obtained by freezing all parameters at their pre-Agreement levels. Such an econometric attempt to rewrite the economic history of 1965-71 without the 1965 Automotive Agreement is accomplished simply by suppressing the parameter shift variable (*WAFT*) and contrasting the new simulation results[10] to the control simulation presented above. To minimize the autocorrelation inherent in dynamic simulation experiments, both simulations commence in the year 1965. Values for lagged endogenous variables prior to 1965 are set at their actual levels, thus preventing error build-up (autocorrelation) from the 1950-64 period to filter through to the 1965-71 period. This, of course, does not prevent autocorrelation in the 1965-71 period arising from underlying structural errors within the post-Agreement sample years.

Chart 7-3 presents simulated data depicting the 1965-71 period for twenty-four of the major automotive sectoral variables under the two different structural assumptions, i.e. a control solution which includes the structural effects (through the parameter transition function) of the Automotive Agreement and a simulation which suppresses these new structural effects. For many of the endogenous variables in the automotive sectors there are dramatic changes arising from the Automotive Agreement during this seven-year period.[11] To analyse these results, the graphs have been arranged in the following sequence: wages, prices, final demand, industry output, investment, employment and profits. Where possible, the impact on the two separate automotive industries has been displayed in parallel fashion to highlight differential effects in the two industries.

Wage Effects

As discussed in Chapter 5, the critical endogenous variable in the wage block of the automotive sector is the union negotiated wage rate for the motor vehicle industry. Given that a three-year wage contract was signed just prior to the Automotive Agreement (including a wage-parity-demand variable represented by *WR*1), the "no-Agreement" simulation retains the effect of this initial wage parity variable (*WR*1) but suppresses subsequent (intensified)

10 All simulations from here on are in terms of the augmented CANDIDE Model 1.1, and not just an automotive sectoral solution.

11 The reader is again cautioned that the following analysis applies only to the first seven years after the Agreement, and should not be extrapolated to subsequent years.

Chart 7-3

Simulated Effects of the Automotive Agreement
on the Automotive Industries

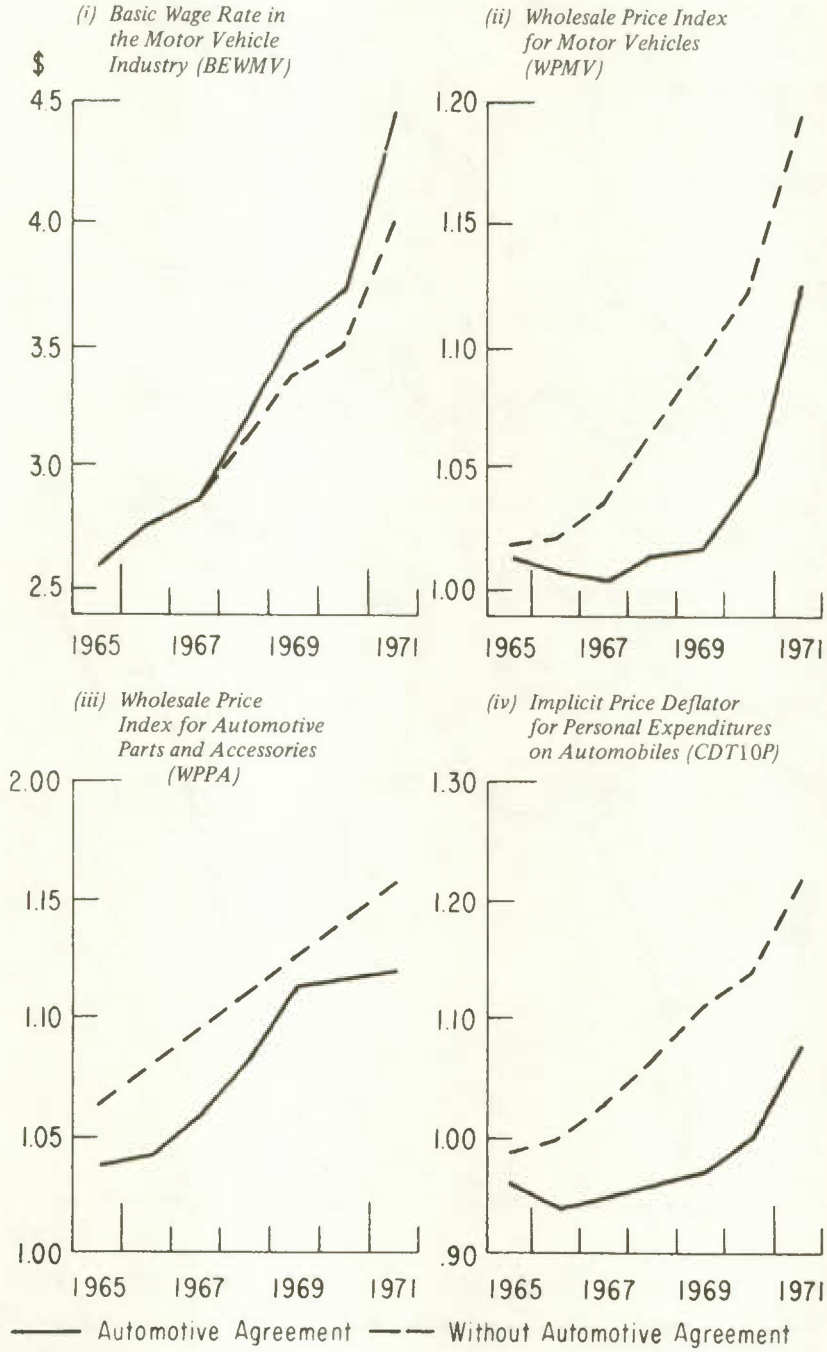


Chart 7-3 (continued)

Simulated Effects of the Automotive Agreement
on the Automotive Industries

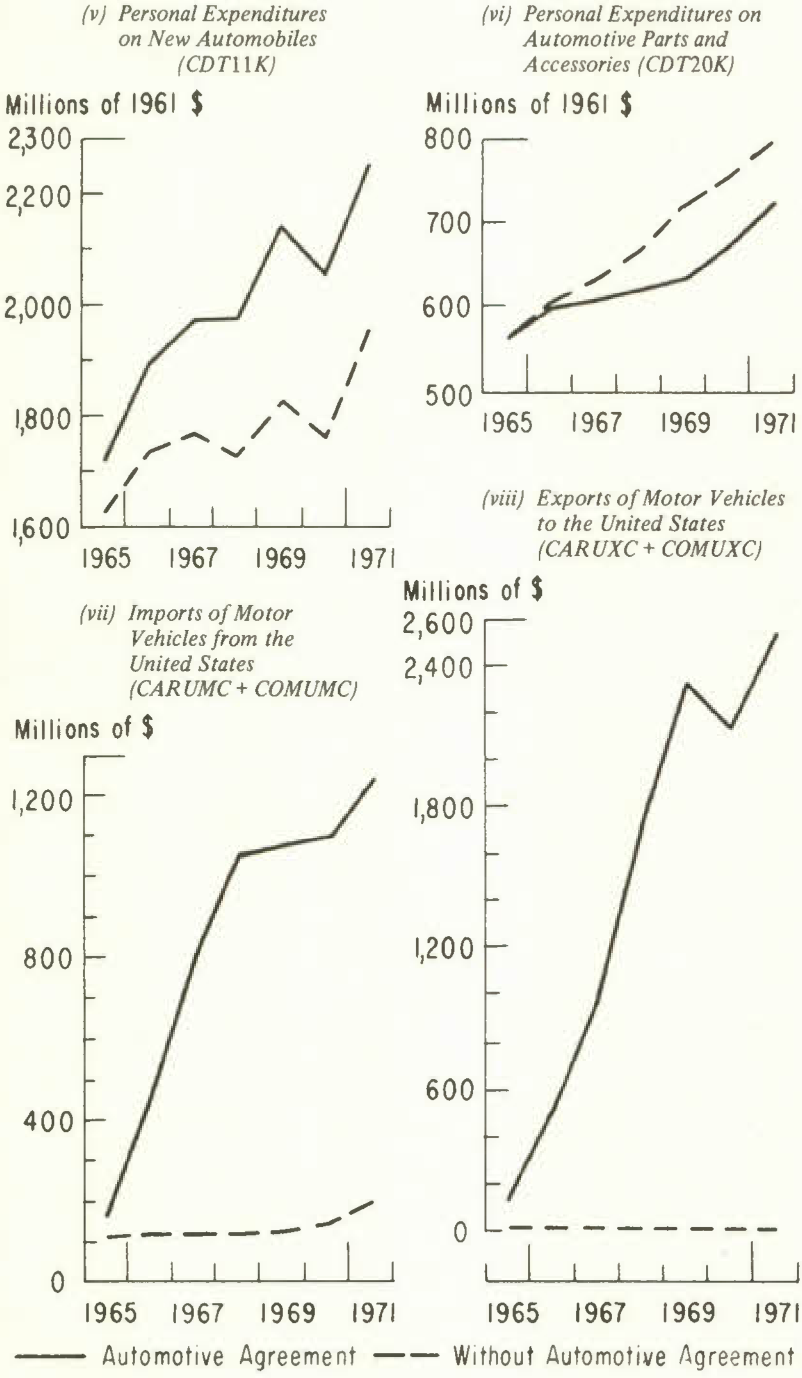


Chart 7-3 (continued)

Simulated Effects of the Automotive Agreement on the Automotive Industries

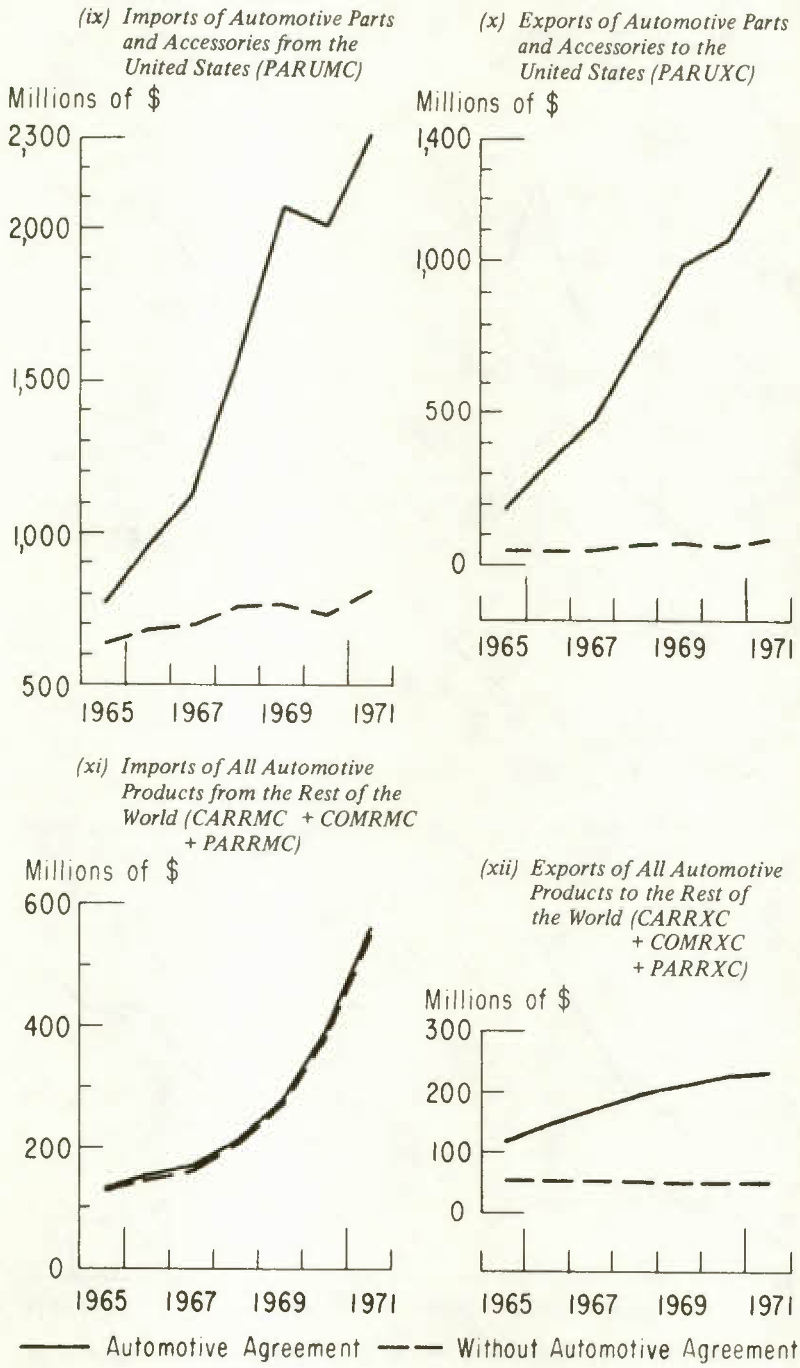
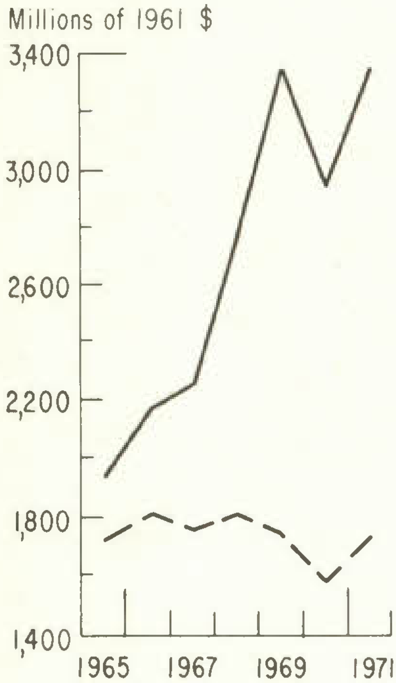


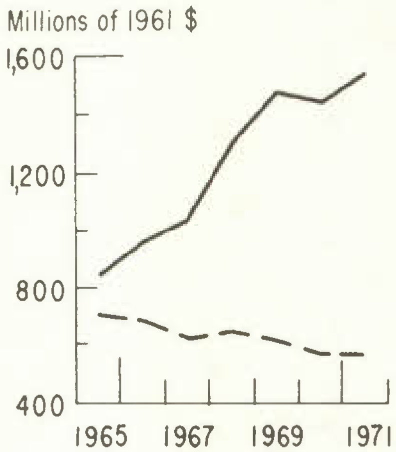
Chart 7-3 (continued)

Simulated Effects of the Automotive Agreement on the Automotive Industries

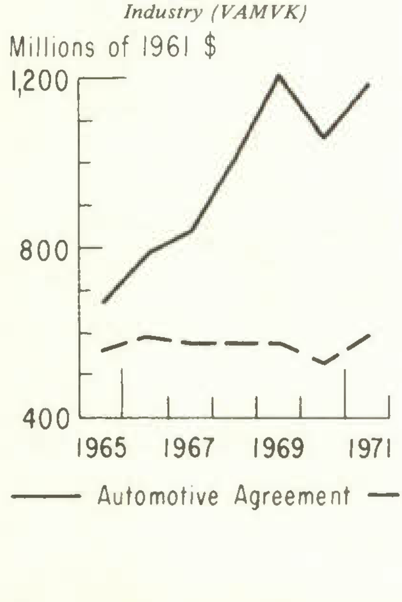
(xiii) Gross Output in the Motor Vehicle Industry (GOMVK)



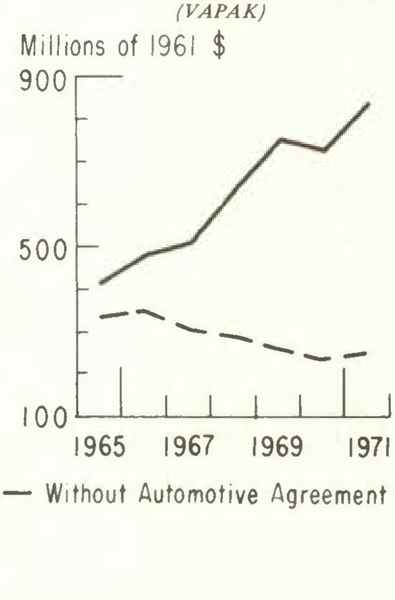
(xiv) Gross Output in the Automotive Parts and Accessories Industry (GOPAK)



(xv) Value-Added in the Motor Vehicle Industry (VAMVK)



(xvi) Value-Added in the Automotive Parts and Accessories Industry (VAPAK)



—— Automotive Agreement —— Without Automotive Agreement

Chart 7-3 (continued)

Simulated Effects of the Automotive Agreement on the Automotive Industries

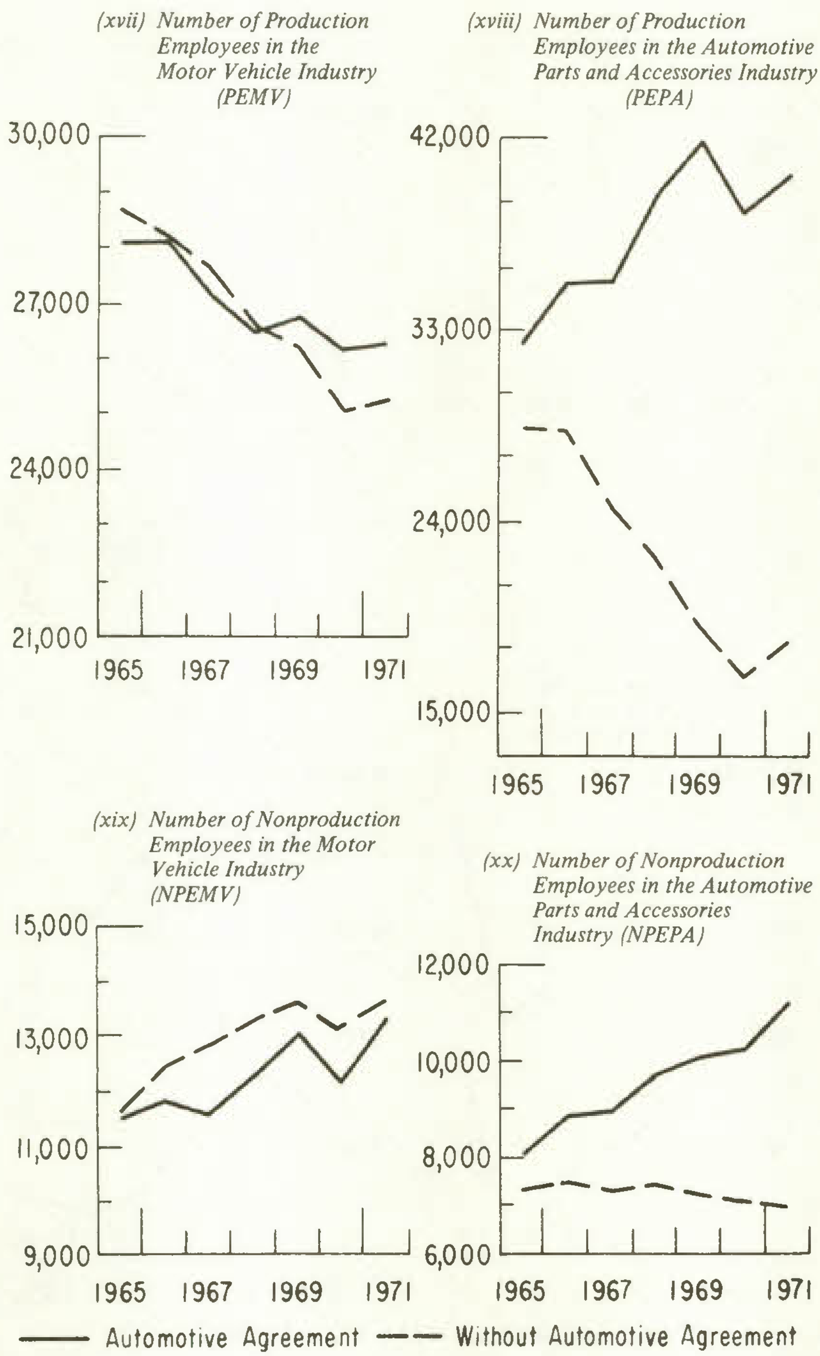
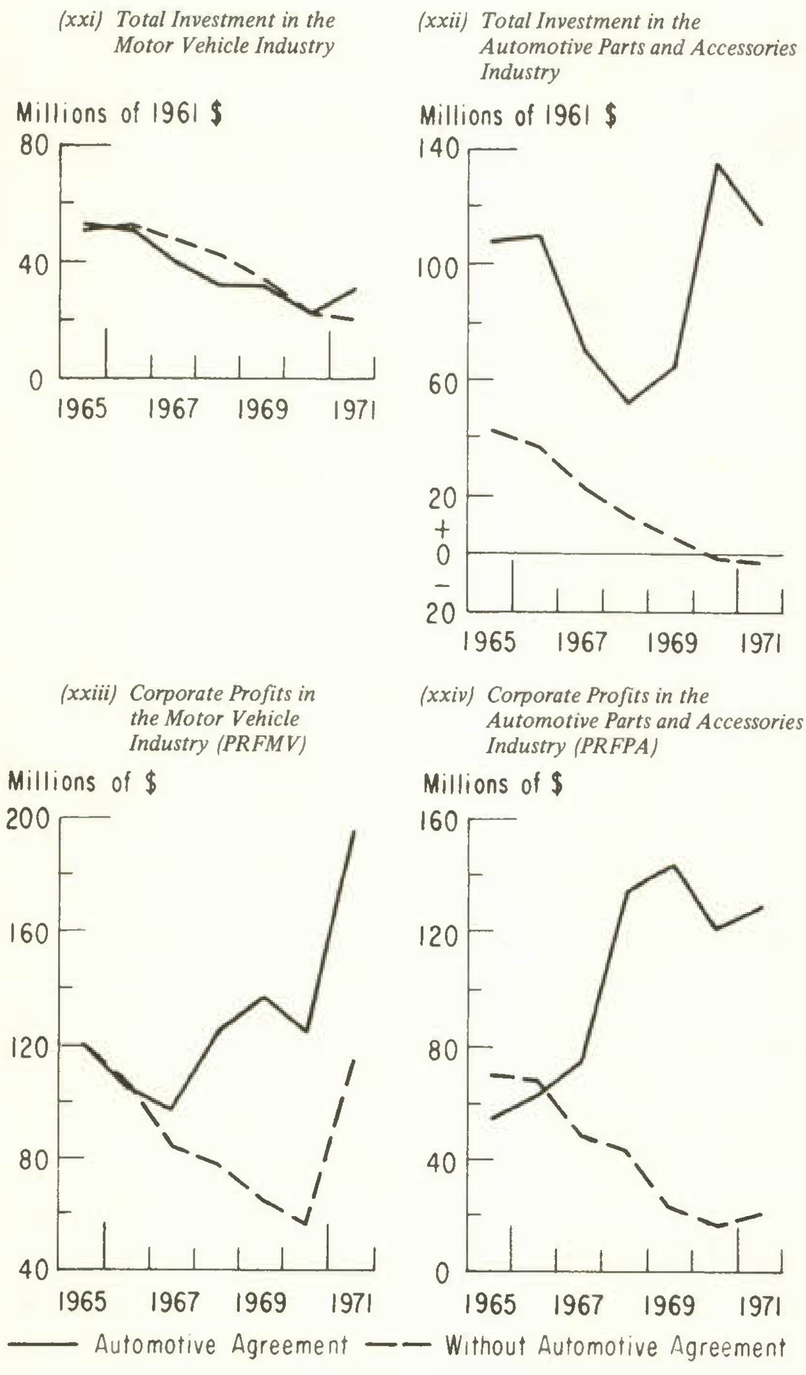


Chart 7-3 (concluded)

Simulated Effects of the Automotive Agreement on the Automotive Industries



wage parity demands which are structurally represented by the additive shift variables *WR*2 and *WR*3.[12] Consequently, for the first three years (1965-67) there was no appreciable change in the basic wage rate, followed by a more rapid increase in basic wage rates under the Automotive Agreement simulation as complete wage parity was achieved more rapidly (see Chart 7-3). Average hourly earnings effects in both industries tended to reflect these base wage rate movements as did changes in wages for nonproduction employees (not shown). In summary, the signing of the Automotive Agreement increased existing wage parity demands which accelerated the rate of wage inflation in both motor vehicle industries, particularly over the 1969-71 period. Given that nominal wage parity has been achieved in the motor vehicle industry, one would expect that subsequent wage rate increases would likely decelerate over the rates achieved in this transition period (*ceteris paribus*).

Price Effects

To quantify the impact of the Automotive Agreement on simulated motor vehicle prices, the combined effects of the following three Agreement-induced structural forces must be considered: (i) increased labour costs, (ii) substantially increased labour productivity (to be discussed later), and (iii) removal of the tariff and consequent reduction in the "mark-up" coefficient on the United States price variable. The net effects of those three structural forces produced a 6-7% reduction in simulated wholesale motor vehicle prices (over the "no-agreement" scenario) with a much more moderate 2-3% reduction in simulated wholesale prices for automotive parts and accessories. Retail prices for automobiles declined by an even larger amount (approximately 12%) in the control simulation over the level which would have persisted in a "no-Agreement" structure. These results are very similar to those obtained by the author in an earlier (partial equilibrium) analysis which found that 1968 retail prices were 10.2% lower (10% in 1968 for this full equilibrium study) than would have occurred without the Automotive Agreement.[13] Thus, the signing of the Automotive Agreement substantially lowered motor vehicle prices, particularly at the retail level by an apparent reduction in dealer

12 Recall that these two dummy variables are set up in a way which tests the proposition that there is a significant increase (decrease) in the wage parity variable from the *WR*1 level (not from zero).

13 D.A. Wilton, "An Econometric Model of the Canadian Automotive Manufacturing Industry and the 1965 Automotive Agreement", pp. 157-181. It should be noted that the methodology in these two studies is quite different as this present study (unlike the earlier one) (i) incorporates the effects of the Automotive Agreement directly into the structural equations; (ii) introduces a full set of feedbacks; (iii) extends the data set through 1971; (iv) provides an analysis of the automotive parts and accessories industry, and (v) contrasts control simulated data to alternate simulations (not actual data) to measure the effects of the Automotive Agreement.

mark-up.[14] For the automotive parts and accessories industry, a modest wholesale price reduction was detected with an inexplicable increase in retail prices for that portion of automotive parts and accessories which are purchased directly by consumers (not shown in Chart 7-3).

Final Demand

Given this lower level of retail automotive prices and the stimulus to national income (to be discussed later) under the Automotive Agreement structure, personal expenditures on new automobiles substantially increased. As shown in Chart 7-3, the Automotive Agreement generated a simulated increase exceeding 15% for new car expenditures during the 1968-71 period. This is in direct contrast to the much more modest effects of the author's previously cited study which ignored the feedbacks of an increase in Canadian income which can be attributed to the signing of the Automotive Agreement. Personal expenditures on automotive parts and accessories moderately declined in the Automotive Agreement era over the levels which would have been obtained in the absence of the Agreement.

As expected, the most dramatic effects of the Automotive Agreement are found in the export-import block of the model. Simulated 1971 exports of automobiles and commercial vehicles to the United States increased by factors of 11,257 and 3,970 (see Table 7-2) under the Automotive Agreement structure. The simulated total automotive trade balance with the United States in 1971 improved by 1.2 billion dollars over that level which would have occurred without the Automotive Agreement. Including the modest swing in the simulated automotive trade balance with the rest of the world, the signing of the Automotive Agreement reduced the total automotive products simulated 1971 balance from -1414 million dollars to -22 million dollars,[15] a level which was approximately .5% of the simulated level of automotive exports or imports. In short, the Automotive Agreement completely altered traditional trade patterns in automotive products, and provided a substantial stimulus to the Canadian economy as the gains in automotive exports greatly outstripped the increase in automotive import flows.[16]

14 As discussed in Chapter 5, these simulation results measure the differences between the Agreement structure and what would have been (i.e. "no-Agreement"), and do not directly indicate how much of the actual gap between Canadian and United States vehicle prices remained in existence.

15 The modest improvement in the automotive trade balance with the rest of the world was offset by a deterioration in the automotive parts and accessories trade balance with the United States, and thus the simulated reduction in the automotive trade deficit can be accounted for by the change in the motor vehicle trade balance with the United States.

16 As noted in Chapter 1, much of this favourable 1971 balance-of-payments effect appears to have dissipated by 1974-75.

Table 7-2

Change in Simulated Trade Flows
Attributable to the Automotive Agreement, 1971

	Trade with United States		Trade with Rest of World	
	Exports	Imports	Exports	Imports
Automobiles				
Millions of dollars	2026	777	58	9
Per cent	1,125,694	722	244	2
Commercial Vehicles				
Millions of dollars	516	268	53	0
Per cent	396,992	312	1,093	1
Automotive Parts and Accessories				
Millions of dollars	1,223	1,498	73	4
Per cent	1,397	185	328	3

Industry Output

This tremendous surge in automotive exports, coupled with increased personal expenditures on automobiles, greatly stimulated the growth of output in the motor vehicle industries. In terms of 1971 simulated gross real output, the Automotive Agreement generated 1.6 billion dollars of additional output in the motor vehicle industry[17] (a 94% increase over the level which would have occurred without the Agreement) and 1.0 billion dollars of additional output in the automotive parts and accessories industry (a 170% increase). In 1971 simulated real value-added terms, there was an Automotive Agreement-induced increase of $593 million (99%) in the motor vehicle industry and an increase of $589 million (234%) in the automotive parts and accessories industry. Using real output as a yardstick, in seven years the Automotive Agreement doubled the size of the motor vehicle industry and tripled the size of the automotive parts and accessories industry.

Without the Automotive Agreement, the automotive industries would have continued to exhibit the no-growth trends of the late 1950s and early 1960s. Despite a simulated annual growth rate in real expenditures on automobiles exceeding 5%, simulated real gross output in the Canadian motor vehicle industry increases by only 1½% per year in the no-Automotive Agreement solution. This compares to a 3% growth rate over the 1956-64 period. Simulated growth in real gross output for the automotive parts and accessories industry within a no-Agreement structure is virtually

17 The 1968 increase is .98 billion dollars, almost identical to that found by the author in the earlier cited study (D.A. Wilton, 1972, *op. cit.*).

zero during the 1965-71 period compared to a 1.5% growth rate for the 1956-64 period. The no-Automotive Agreement solution clearly depicts a stagnant automotive sector during the 1965-71, not unlike the sector's performance in the preceding eight years.

Investment in the Motor Vehicle Industries

While the Automotive Agreement resulted in a very pronounced increase in output for both automotive industries, a clear dichotomy exists between the two automotive industries in terms of how this increased output was achieved. The motor vehicle industry had a slightly lower simulated level of real investment expenditures during the 1965-71 period than it would have had if no Agreement had been signed.[18] On the other hand, the automotive parts and accessories industry experienced a substantial investment boom which can be directly attributed to the Automotive Agreement. Over these seven years, an additional 534 million dollars worth of Automotive Agreement-induced investment took place in the automotive parts and accessories industry and the 1971 simulated level of real gross capital stock increased by 118 % over that level which would have been in existence without the Automotive Agreement. Thus, the Automotive Agreement had virtually no effect on total investment in the motor vehicle industry, but had a substantial impact on investment in the automotive parts and accessories industry.

Industry Employment

Turning from capital to labour input, a very similar result is found. While production employment increased rapidly in the motor vehicle manufacturing industry in the early 1960s, from 1965 through 1971 a moderate decline in employment is present in both simulations (see Chart 7-3). The simulated number of new production jobs in the motor vehicle industry which can be attributed to the Automotive Agreement would appear to be only about 1,000 in 1970-71 with a small (and sometimes negative) effect in earlier years.[19] As found in the earlier cited study, nonproduction employment

18 Gross capital stock (1971) in the motor vehicle industry was .4% lower in the Auto Pact solution. These results are somewhat similar to those found by the author in the earlier study where only 1965 revealed a positive investment effect (1966-68 had negative effects).

19 This is the one result of this study which differs substantially from the author's earlier paper. The major reasons would appear to be (i) a switch to Census of Manufacturers data which has substantially lower estimates for production employment in the mid-to-late sixties and (ii) a different methodology which compares simulation output to simulation output (not actual data) and incorporates the Automotive Agreement directly into the structural parameters.

actually decreased because of the Automotive Agreement. In total, the number of employees in the motor vehicle manufacturing industry was virtually unaffected by the Automotive Agreement, although their productivity doubled given the rationalization within the industry.

In contrast, large gains in employment in the automotive parts and accessories industry can be attributed to the signing of the Automotive Agreement. Comparing the Automotive Agreement control solution with the "no-Agreement" solution for the year 1971 reveals that the Automotive Agreement produced 22,344 new production jobs and 4,273 new non-production jobs in the automotive parts and accessories industry. This represents a simulated increase of 106% in the total work force, slightly less than the 118% increase in the capital stock. In summary, the simulations indicate that the Automotive Agreement produced approximately 27,000 new jobs in the automotive sector (for the year 1971) with almost all of these jobs being located in the automotive parts and accessories industry.

Industry Profits

As shown in Chart 7-3, both industries experienced considerably higher corporate profits (before taxes) under the Automotive Agreement structure, particularly after the full effects of the Agreement were in place (1969-71). In the motor vehicle industry the signing of the Agreement generated an additional 70-80 million dollars worth of corporate profits while in the automotive parts and accessories industry the increase exceeded $100 million. However, the impact of the Automotive Agreement on motor vehicle industry profits is less clear cut when corporate profits are normalized by the growth in the industry (see Table 7-3). Motor vehicle profits per unit of output (either in gross or value-added terms) was relatively unaffected by the Automotive Agreement and continued to exhibit a modest secular decline. On the other hand, corporate profits relative to invested capital[20] was considerably higher in the motor vehicle industry under the Automotive Agreement structure, not surprising given the neutral Automotive Agreement effects on new investment expenditures within the industry. In the automotive parts and accessories industry all measures of relative profitability were higher under the influence of the Automotive Agreement during the 1965-71 period. Summarizing the simulated effects of the Automotive Agreement on automotive corporate profits, nominal dollar profits and the return on capital clearly increased in the motor vehicle industry under the influence of the Auto Pact, although corporate profits per vehicle were

20 It should be noted that this ratio compares nominal dollar profits to real capital stock.

unaffected. By any yardstick, the automotive parts and accessories industry was more "profitable" with the signing of the Automotive Agreement.[21]

Table 7-3

Relative Profitability within the Automotive Industries

	1955-1964 Average	1965	1967	1969	1971
Motor Vehicle Industry					
PRFMV/GOMVC					
with Automotive Agreement	.081	.061	.044	.040	.052
without Automotive Agreement		.068	.046	.033	.056
PRFMV/VAMVC					
with Automotive Agreement	.268	.206	.154	.175	.191
without Automotive Agreement		.249	.182	.132	.184
PRFMV/GKSMVK					
with Automotive Agreement	.193	.210	.153	.200	.272
without Automotive Agreement		.211	.129	.091	.160
Automotive Parts and Accessories Industry					
PRFPA/GOPAC					
with Automotive Agreement	.088	.064	.069	.088	.074
without Automotive Agreement		.094	.072	.032	.030
PRFPA/VAPAC					
with Automotive Agreement	.191	.141	.158	.191	.156
without Automotive Agreement		.202	.154	.085	.079
PRFPA/GKSPAK					
with Automotive Agreement	.124	.120	.120	.198	.136
without Automotive Agreement		.174	.109	.047	.046

The Effects of the Automotive Agreement on the Canadian Economy

To measure the extent to which this growth in the automotive sector, attributable to the signing of the Automotive Agreement, permeated the entire Canadian economy, the same simulation procedures as employed in the previous section are utilized for the full CANDIDE model (including the new automotive subsectors). The control solution depicts the Canadian economy with the Automotive Agreement in force while the "no-Agreement" solution again suppresses all Automotive Agreement structural shift variables. A

21 A major determinant of this increased profitability under the Automotive Agreement was the tremendous increase in productivity within both industries. Simulated real value-added per man-hour in the motor vehicle industry doubled under the Automotive Agreement. (In fact, virtually all of the increase in output within the motor vehicles industry can be attributed to productivity gains, and not increased factor inputs.) Productivity gains attributable to the Automotive Agreement in the automotive parts and accessories industry were less spectacular, but still represented a 50% simulated increase in value-added per man-hour in 1971.

comparison of the two simulations provides an econometric estimate of the general equilibrium effects of the Automotive Agreement on the entire Canadian economy.

These results are clearly conditional on the degree to which the CANDIDE system provides an adequate representation of the structure of the Canadian economy. While an evaluation of the structure of the 1600-equation CANDIDE model can not be undertaken in this study, misspecification within this large system may affect the conclusions of this study. For example, even though government expenditures are endogenous within the CANDIDE system, the medium-term nature of CANDIDE may not permit a complete specification of government reaction functions and/or counter-cyclical policy initiatives. Such a misspecification would lead to an overstatement of the effects of the Automotive Agreement in the sense that a "benevolent" government would intercede to prevent a serious recession through some form of active discretionary or compensatory policy.

As depicted in Chart 7-4, the signing of the Automotive Agreement had a substantial impact on real output in the Canadian economy during the 1965-71 period. Notwithstanding the above caveat, the 1971 simulated level of real Gross National Expenditures was 5.3 % higher (or 3.3 billion dollars) than it would have been without the signing of the Agreement. While almost one-half of this gain in simulated real output was in the manufacturing sector,[22] large Auto Pact-induced output increases permeated the transportation, trade, and service sectors of the Canadian economy. (Table 7-4 presents the sectoral distribution of the additional Real Domestic Product which can be attributed to the Automotive Agreement for the years 1968 and 1971.) In terms of conventional multiplier analysis, the increase in real value-added within the automotive sector translated into a 2.7 multiplier increase in real Gross National Expenditures (averaged over the 1965-71 period).[23]

This increase in Real Domestic Product which can be attributed to the signing of the Automotive Agreement generated substantial increases in employment. As depicted in Chart 7-4, CANDIDE simulations reveal that almost 300,000 more jobs (in 1971) resulted from signing the Automotive Agreement. The aggregate effect of the Automotive Agreement was to reduce the simulated level of unemployment by approximately 185,000 and lower the unemployment rate to approximately 6% in the 1969-71 period (in contrast to an unemployment rate in excess of 8% in the "no-Agreement"

22 Approximately 85% of this gain in the manufacturing sector was directly accounted for by the motor vehicle industries themselves.

23 This multiplier would appear to be in line with other CANDIDE Model 1.1 simulations. For example, a continuous 200-million-dollar change in government fixed-capital investment was found to have a fifth-year multiplier of 2.6 during the expansionary mid-1960s (R.G. Bodkin, T.T. Schweitzer and S.M. Tanny, "The Model as a System", *CANDIDE Model 1.1*, Chapter 24, mimeo.).

Table 7-4

Impact of the Automotive Agreement on Sectoral Real Domestic Product

	1968		1971	
	(Millions of 1961 dollars)	(Percentage change)	(Millions of 1961 dollars)	(Percentage change)
Agriculture (*AGY*)	.09	.01	26.03	1.14
Forestry (*FOY*)	2.10	.37	4.42	.73
Fishing (*FSY*)	− .22	− .25	.23	.25
Mining (*MIY*)	29.71	1.24	50.74	1.78
Manufacturing (*MAY*)	832.01	6.19	1359.90	9.20
Construction (*COY*)	−4.34	− .14	24.70	.74
Utilities (*UTY*)	28.00	1.68	61.61	3.06
Transportation (*TSY*)	162.40	3.13	308.43	5.23
Trade (*TRY*)	218.71	3.34	406.96	5.62
Finance (*FIY*)	63.45	1.69	116.19	2.81
Services (*CSY*)	160.16	2.04	345.29	3.89
Public Administration (*ADY*)	42.31	1.42	91.68	2.87

simulation).[24] In terms of the sectoral distribution of these new jobs, almost 90% were located in the manufacturing, service, and trade sectors (see Table 7-5). In total, these simulations reveal that the Automotive Agreement increased employment by almost 4% with only a small proportion of the new jobs (approximately 10%) being located in the automotive sector.

While the Automotive Agreement had a substantial impact on real output and employment, the effects on investment and the level of gross capital stock were much more moderate. Even though real investment expenditures on both machinery and equipment, and nonresidential construction were higher under the Automotive Agreement structure, their combined proportion of real Gross National Expenditures was less under the Automotive Pact. In terms of real gross capital stock for the Canadian economy, the Automotive Agreement produced only 1.25% additional capital stock by 1971. Comparing these two simulations for the manufacturing sector, real gross capital stock increased by 2.1% contrasted to real output and employment gains of 9.2% and 4.7%.

While the wage-price block of CANDIDE has been subject to some criticism,[25] simulation results presented in Chart 7-4 generally reveal that the Automotive Agreement had virtually no effect on the rate of inflation in Canada. The level of the Consumer Price Index in 1971 was only .4% higher under the Automotive Agreement than it would have been. Since the

24 The stimulus given to the economy by the Automotive Agreement "encouraged" an additional 114,000 workers to join the labour force, thus dulling the full impact of the job-generation effects of the Agreement on the unemployment rate.

25 See for example the comments in the *Tenth Annual Review* of the Economic Council of Canada, (Ottawa: Information Canada, 1973) particularly pp. 15-16.

Chart 7-4

Simulated Effects of the Automotive Agreement on the Canadian Economy

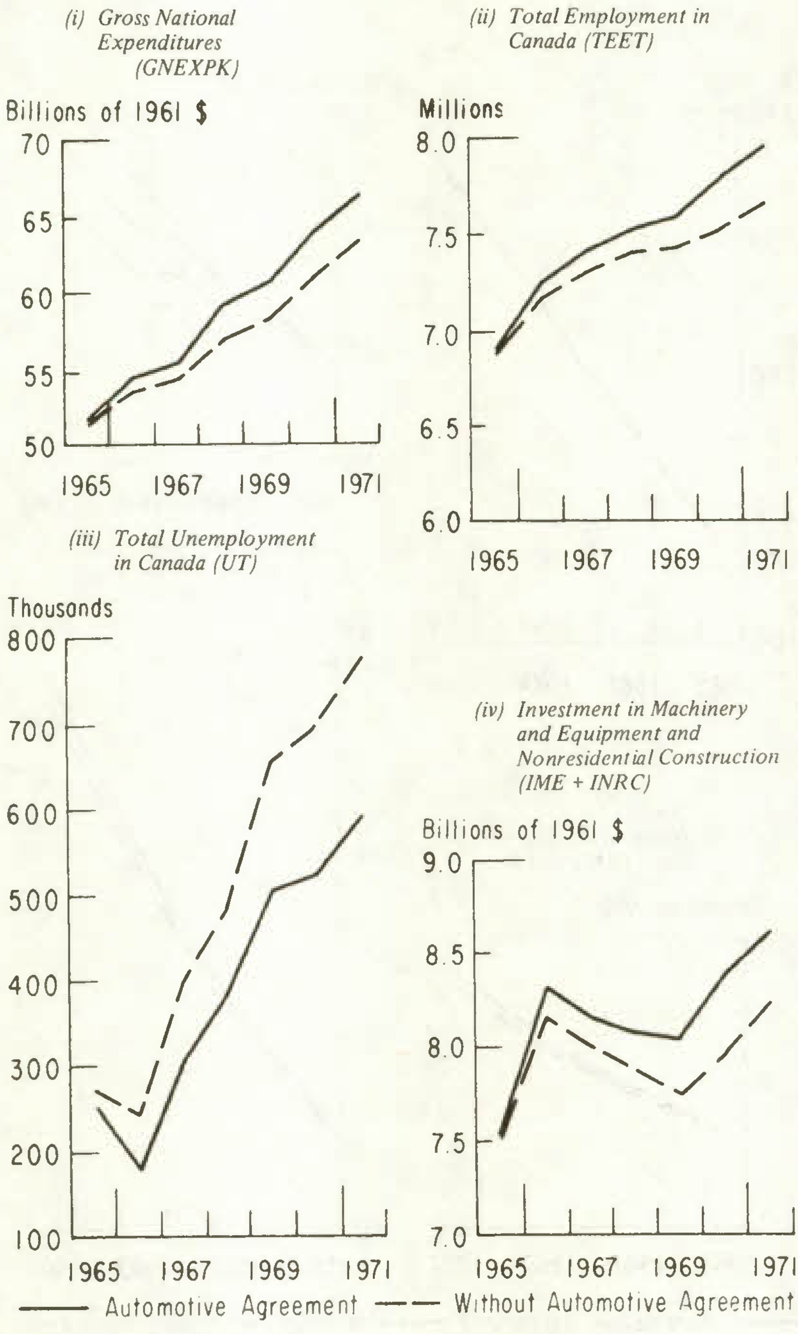


Chart 7-4 (continued)

Simulated Effects of the Automotive Agreement on the Canadian Economy

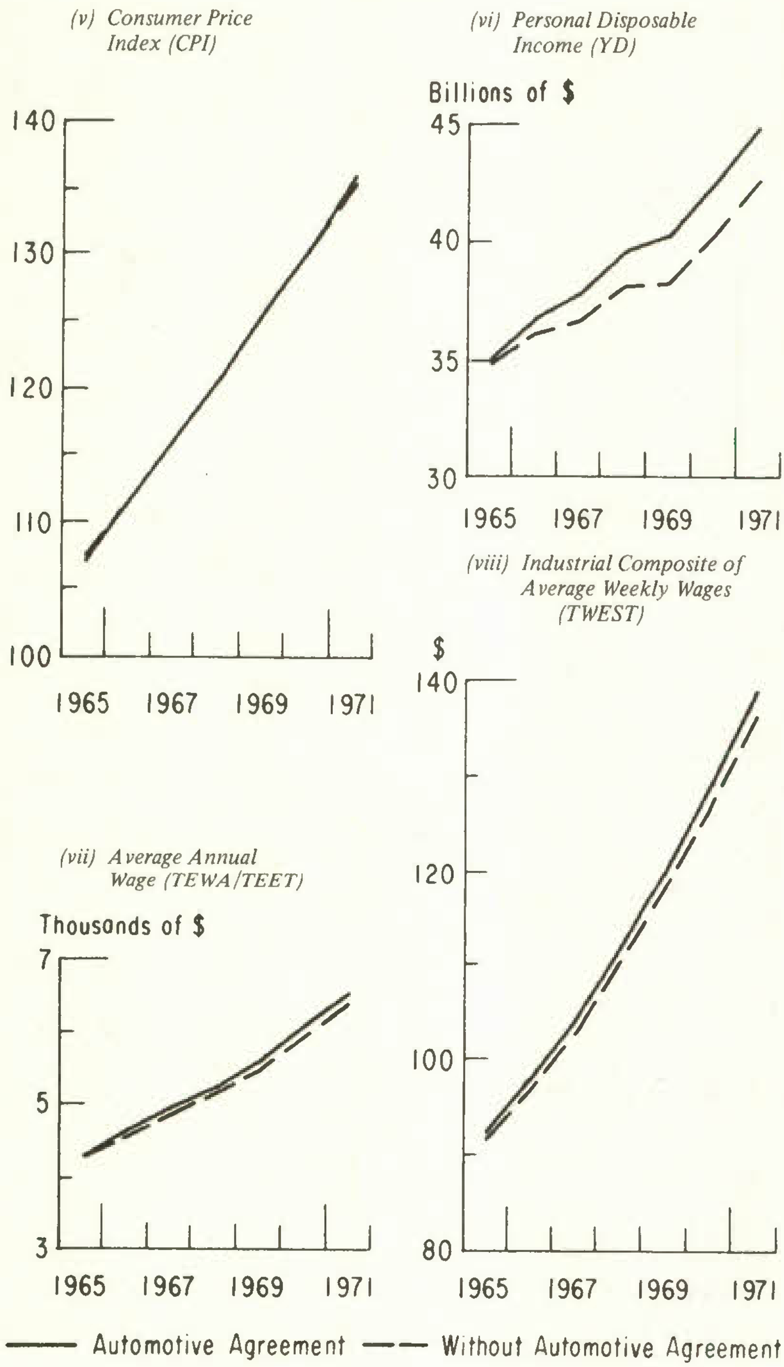
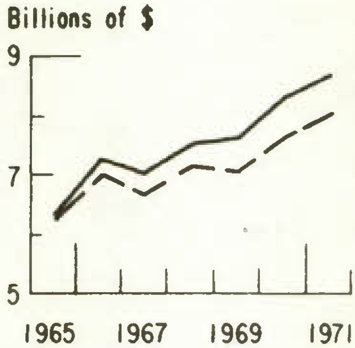


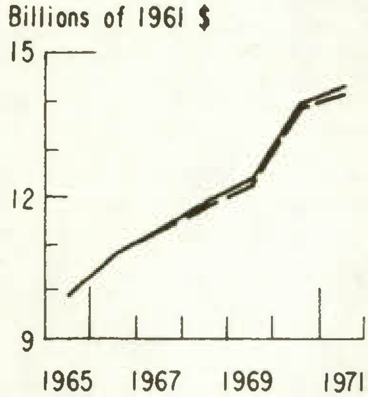
Chart 7-4 (concluded)

Simulated Effects of the Automotive Agreement on the Canadian Economy

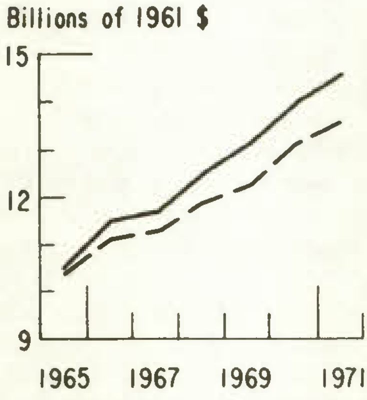
(ix) Corporate Profits Before Taxes (CP)



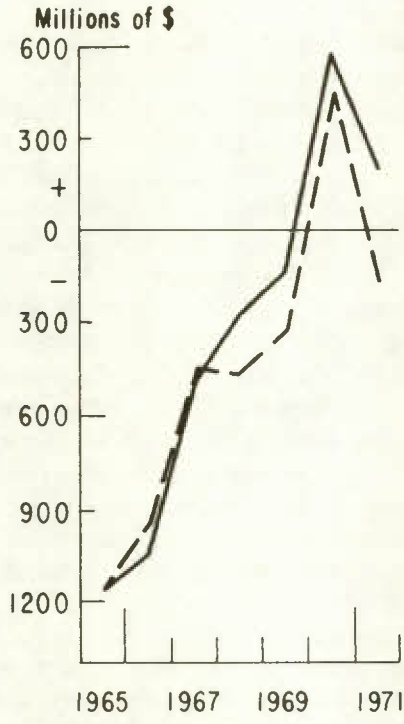
(x) Total Exports of Goods and Services Excluding Automotive Products (XPTTXK–AUTOXK)



(xi) Total Imports of Goods and Services Excluding Automotive Products (IMPTMK–AUTOMK)



(xii) Current Account Balance (CURBAL)



—— Automotive Agreement – – Without Automotive Agreement

Table 7-5

Impact of the Automotive Agreement on Sectoral Employment

	1968		1971	
	(Number)	(Percentage change)	(Number)	(Percentage change)
Agriculture (*AGET*)	-6,064	-1.11	-13,016	-2.45
Forestry (*FOET*)	454	.61	681	.96
Fishing (*FSET*)	- 42	- .18	63	.27
Mining (*MIET*)	1,765	1.52	2,057	1.71
Manufacturing (*MAET*)	50,476	2.95	79,849	4.69
Construction (*COET*)	-3,494	- .74	- 123	- .03
Utilities (*UTET*)	1,288	1.55	2,726	3.14
Transportation (*TSET*)	9,829	1.71	18,556	3.17
Trade (*TRET*)	27,935	2.26	56,866	4.47
Finance (*FIET*)	4,035	1.24	8,082	2.20
Services (*CSET*)	57,799	3.21	129,660	6.73
Public Administration (*ADET*)	6,359	1.42	13,780	2.80
Total Economy (*TEET*)	150,340	2.03	299,184	3.91

Agreement lowered retail automobile prices by approximately 12% (1971), the nonautomobile basket of goods in the CPI increased by only one per cent over the level which would have prevailed without the Automotive Agreement.

With respect to factor shares and income levels, the effects of the Automotive Agreement are less clear cut. Simulated real disposable personal income was 5.4% higher in 1971 than it would have been without the signing of the Automotive Agreement, and total wages, salaries and supplements increased by 6.5% (nominal dollars). However most of these increases were the result of increases in employment, not increases in wage rates. The average level of wage, salaries and supplements per employee increased by 2.6% in 1971 over the level which would have prevailed without the Automotive Agreement, with the industrial composite of average weekly wages and compensation per man-hour (in manufacturing) increasing by even smaller amounts under the Automotive Agreement (1.6% and .8%, respectively). Corporate profits (before taxes) increased by approximately 700 million dollars (8.8%) in the Automotive Agreement structure over that level which would have existed without the Agreement (for the year 1971). In terms of factor shares, corporate profits increased relative to total Gross National Product from 9.1% in the "no-Agreement" structure to 9.4% under the influence of the Agreement while the share of wages and salaries increased from 55.5% to 56.1%.

The final sector of the Canadian economy reviewed in the context of this comparative Automotive Agreement simulation exercise is the foreign trade sector. Canadian exports of goods and services in real terms increased by almost four billion dollars (1971) over the level which would have prevailed without the Automotive Agreement, an increase of 26%. However, when real exports of automotive products are deleted from this total, the Automotive Agreement-induced export surge is reduced to a mere 133 million dollars (in 1971), less than a 1% increase. On the import side, Canadian purchases of goods and services from all countries increased in 1971 by slightly more than three billion dollars (20.4%) over the "no-Agreement" level. Of this three billion dollars worth of additional imports, approximately two-thirds were automotive products while almost one billion dollars was devoted to additional imports of nonautomotive products (mostly manufactured and processed goods).

Translating these increased trade flows into balance-of-payments terms, Table 7-6 presents the current account simulated balance decomposed by country and by automotive products. On a world basis, the 1964 deficit on current account[26] can be explained by a trade deficit in automotive products, with both deficits dissipating under the influence of the Automotive Agreement. Most of this improvement can be directly traced to the swing on the current account and on the automotive trade balance with the United States. The automotive trade balance with the United States improved by almost 900 million dollars (1964 and 1971 control solution values), while the total current account balance with the United States improved by slightly more than one billion dollars. These United States gains were partially offset by a deterioration in automotive trade balance with the rest of the world, particularly Japan. Without the Automotive Agreement, the deficit on total automotive trade would have widened from over 600 million to 1400 million dollars, in direct contrast to the virtual balance on automotive trade resulting from the Agreement.

Table 7-6

Decomposition of the Simulated Current Account Balance

(In millions of current dollars)

	1964	1971 (Without Automotive Agreement)	1971 (With Automotive Agreement)
United States			
All goods and services	-1570	- 905	-538
Automotive products	- 592	- 915	+307
Rest of World			
All goods and services	+ 938	+ 737	+737
Automotive products	- 67	- 499	-329
Total			
All goods and services	- 632	- 168	+199
Automotive products	- 659	-1414	- 22

26 Values for 1964 are obtained from the sample period control simulations.

In summary, the current account deficit widened slightly in 1966-67 but began to close in 1968-69 resulting in simulated surpluses for the years 1970-71. A comparison of the two simulations for the current account balance suggests that the Automotive Agreement improved this balance by over 200 million dollars per year in the 1968-71 period. This estimate, however, reflects the strong improvement in the current account balance which would have accompanied the recessionary economy of the "no-Agreement" structure (i.e. a real growth rate of approximately 2% and an unemployment rate exceeding 8%). In other words, the large swing in the current account balance from a simulated deficit of 1.2 billion dollars in 1965 to a surplus position in 1970-71 was achieved along with a real growth rate of almost 5% under the Automotive Agreement structure. The next chapter provides further evidence of the favourable effects of the Automotive Agreement on the balance of payments by comparing the Agreement to an alternative policy simulation which matches the Agreement for its growth effects.

8 A Comparative Analysis of an Alternative Industrial Policy Option

In this final chapter an attempt is made to evaluate the impact of the Automotive Agreement on the Canadian economy from a slightly different perspective. In particular, an alternative government policy is postulated which would have resulted in approximately the same simulated output and employment effects as produced by the Automotive Agreement *over the 1965-71 period.* These two alternative policy scenarios, both of which generate a similar level of simulated economic activity in Canada, are then contrasted in terms of their differential effects on inflation, factor shares, sectoral distribution, the balance of payments, etc. This hypothetical alternative policy attempts to measure, via econometric techniques, the opportunity cost of the Automotive Agreement under the assumption that the government would have maintained a similar level of economic activity in Canada regardless of the choice of policy instrument.

In choosing an alternative policy option to compare to the Automotive Agreement, there are two methodological constraints: (i) compatibility of the alternative policy with the basic structure of CANDIDE and (ii) realism in the sense that the government might be reasonably expected to view this alternative policy as a viable alternative. As discussed in Chapter 2, the Automotive Agreement evolved in the context of balance-of-payments difficulties and had a dual goal of improving the balance of payments as well as rationalizing one particular industry. While the structure of CANDIDE does not readily lend itself to alternative balance-of-payments policies such as a devaluation of the Canadian dollar or a change in tariffs,[1] the blend of input-output and Keynesian macroeconomic elements in CANDIDE provides the basis for the specification of an alternative "industrial" policy. It can be argued that the specification of an industrial policy as an alternative to the signing of the Automotive Agreement provides a more "legitimate" comparison than an active fiscal and/or monetary policy to compensate for the

1 The foreign trade block in CANDIDE Model 1.0 (i) does not incorporate tariff rates into the set of explanatory variables, (ii) makes infrequent usage of price effects, (iii) has minimal foreign exchange rate feedbacks, and (iv) has approximately 20% of all exports determined exogenously (see J.R. Downs, *op. cit.*).

simulated short-fall in output (which would have occurred over this seven-year period without the signing of the Auto Pact). An industrial policy alternative is in the general spirit of certain qualifications of the Automotive Agreement which were intended to promote industrial development and rationalization.

In specifying the particular features of an industrial strategy to impose as an alternative policy, government actions in the late 1960s and early 1970s were taken as a rough guideline to policy priorities. Accelerated depreciation allowances and investment tax credits have been a frequently used tool of the federal government[2] to encourage investment in particular sectors, usually the manufacturing sector. More specifically, the reduction of the corporate tax rate in the manufacturing sector coupled with accelerated depreciation allowances contained in the May 1973 budget suggest a government preference to promote a larger manufacturing sector in Canada through the encouragement of new investment. An alternative policy option to stimulate investment in the manufacturing sector is consistent both with recent government initiatives and with one of the goals of the Automotive Agreement (increased efficiency in a highly industrialized sector).

The entry point in CANDIDE for such an industrial policy simulation is the block of investment equations for the manufacturing sector. Although these thirty-eight structural equations in CANDIDE are patterned after the Jorgenson model, at present they contain no explicit tax rates or depreciation allowance instruments.[3] Consequently, the only mechanism available to stimulate investment exogenously in CANDIDE is to shift the intercepts in the individual equations (quaintly referred to as "con adjustments") to reflect a new investment policy. The simple shifting of these intercepts by several hundreds of millions of dollars begs the crucial question of how the government is able to stimulate these new higher investment flows. For our purposes it is assumed that an appropriate set of policy investments or incentives exist which the government can "fine-tune" to produce the desired new additional investment.[4]

Given the availability of thirty-eight component manufacturing investment equations in CANDIDE (requiring adjustments for seven different years), an infinite number of combinations exist to produce a given output target (the level of simulated economic activity under the Automotive Agreement). To limit the range of experimentation, it is assumed that the relative sizes of the component capital stocks for the year 1964 is an appropriate measure for

2 For example, depreciation allowances have been altered in the following years: 1961, 1963, 1965, 1970, 1971 and 1973.

3 See D.A. White, *op. cit.*

4 Implicit in this assumption and the subsequent simulations is the added constraint that the government can accomplish this increased investment objective without changing the structure or parameters of the government revenue accounts (i.e. no other con adjustments are made in terms of tax credits or added depreciation allowances to induce this investment stimulus).

apportioning an annual total intercept shift in the manufacturing investment equations. The percentage distributions for the total con adjustments are recorded in Table 8-1.[5] Thus, for each of the seven years, 1965-71, a total investment intercept shift (displayed in Table 8-2) is apportioned over thirty-eight investment equations and feeds throughout the entire CANDIDE system (in which the Automotive Agreement-induced structural shift has been suppressed).

Table 8-1

Sectoral Distribution of Annual Intercept Shifts for Investment Equations

	Investment in machinery and equipment	Investment in structures
	(Per cent)	
Food and Beverages	8.9	5.6
Tobacco	.3	.3
Rubber	.9	.5
Leather	.2	.3
Textiles	3.7	1.4
Knitting and Clothing	1.2	.6
Wood Products	2.7	1.4
Furniture and Fixtures	.4	.3
Paper and Allied Products	11.4	5.8
Printing and Publishing	2.4	1.3
Primary Metals	9.8	5.5
Metal Fabricating	3.0	2.1
Machinery	1.4	.8
Transportation Equipment	4.4	2.4
Electrical Products	2.4	1.1
Nonmetallic Mineral Products	3.1	2.0
Petroleum and Coal	1.5	.4
Chemicals	5.7	3.4
Miscellaneous Manufacturing	.7	.7
Total Manufacturing	64.1	35.9

Preliminary simulation experimentation suggested that the Automotive Agreement level of real output and employment could not be simultaneously simulated in a "no-Agreement" economy with only one set of con adjustments on the intercepts in the investment equations. The principal reason for this result rests in the CANDIDE-derived labour demand equations which substitute some of this new investment (capital) for employment.[6] To

5 For example, 9.8% of the total con adjustment enters the investment expenditures equation for machinery and equipment within the primary metals industry.

6 The demand for labour in CANDIDE Model 1.0 is determined by a series of equations in which current labour demand adjusts to the "desired" level of labour input obtained by inverting a Cobb-Douglas production function. Thus, an increase in the capital stock will, *ceteris paribus*, lower the desired labour input. (For further details see W.M. Illing, *CANDIDE Model 1.0: Labour Demand*, CANDIDE Project Paper No. 10, Economic Council of Canada, November 1973.)

overcome this effect, a complementary set of adjustments are performed to diminish the growth rate in the capital stock variables (which generate the lower employment levels, *ceteris paribus*). It is assumed that 50 percent of the investment intercept shift in the investment expenditure equation does *not* enter the capital stock (identity), thus substantially reducing the depressant effects on labour demands. This additional adjustment is tantamount to stipulating that the new investment policy must have safeguard provisions for employment.

Table 8-2 presents simulation results for real output and total employment under the three policy alternatives: (i) the Automotive Agreement, (ii) no Automotive Agreement, annual investment incentives, and (iii) no Automotive Agreement, annual investment incentives with employment safeguards.

Table 8-2

Alternative Policy Simulation Results for Real Output and Employment

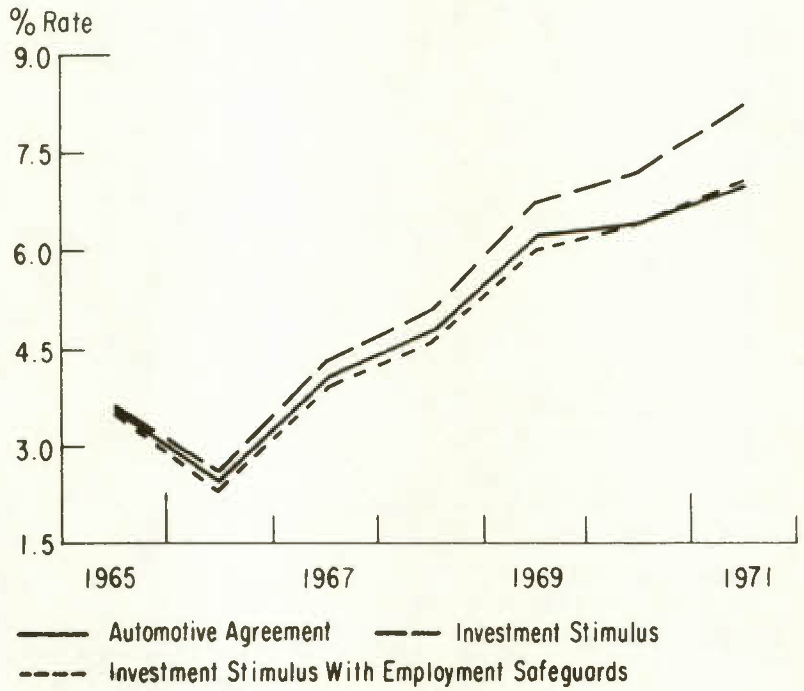
	Total investment intercept shift[1]	Automotive agreement		Investment incentives with employment safeguards		Investment incentives without employment safeguards	
		Real output[1]	Employment[2]	Real output[1]	Employment[2]	Real output[1]	Employment[2]
1965	.33	51.66	6.92	51.66	6.93	51.65	6.92
1966	.66	54.87	7.25	54.86	7.26	54.80	7.25
1967	1.06	55.92	7.42	55.92	7.44	55.84	7.40
1968	1.81	58.98	7.56	58.98	7.59	58.91	7.54
1969	2.61	60.93	7.65	60.93	7.68	60.80	7.61
1970	2.695	63.95	7.81	63.91	7.83	63.65	7.73
1971	3.225	66.65	7.96	66.60	7.96	66.23	7.84

1 Billions of 1961 dollars
2 Millions

The first alternative is drawn from simulation output of the previous chapter while the latter two alternatives are new simulations based on the suppression of the Automotive Agreement structural shift variables (*WAFT*) and the con adjustment of the manufacturing investment and capital stock equations. The determination of the level of the annual con adjustments to manufacturing investment and capital stock was done on an iterative basis until simulated real output and employment levels approximated those found under the Automotive Agreement. In general, this investment-employment safeguards policy simulation achieves virtually the same level of simulated output and employment as achieved by the Automotive Agreement control simulation (the largest discrepancy occurs in 1969 for employment, a difference of only .4%). Without the second set of adjustments to capital stock (the employment safeguards), there is a considerable reduction in employment. Comparing the two investment policy simulations for the year 1971, real output falls by .5% without the employment safeguards while employment diminishes by 1.6% (125,000 jobs). These differential employment effects are highlighted in Chart 8-1 which displays the simulated unemployment rate under each of the three alternative policies.

Chart 8-1

Simulated Unemployment Rate under Three Different Policies



One of the most striking features of this investment, employment-safeguards simulation experiment is the massive amounts of investment in the manufacturing sector required to maintain the same level of simulated economic activity as achieved during the first seven years of the Automotive Agreement. In partial equilibrium terms, over 12 billion dollars worth of con adjustments (spread over seven years) are required to obtain this Auto Pact simulated level of output. The simulated general equilibrium results (see Chart 8-2) reveal that *manufacturing* investment in machinery and equipment for the year 1971 is 1.7 billion dollars (117%) higher under the alternative investment policy than under the Automotive Agreement, while *manufacturing* investment in structures is 1.0 billion dollars (150%) higher in 1971. In terms of *total economy* investment expenditures on machinery

Chart 8-2

Comparative Simulation Results for the Automotive Agreement, an Alternative Investment Policy, and No Policy Initiative

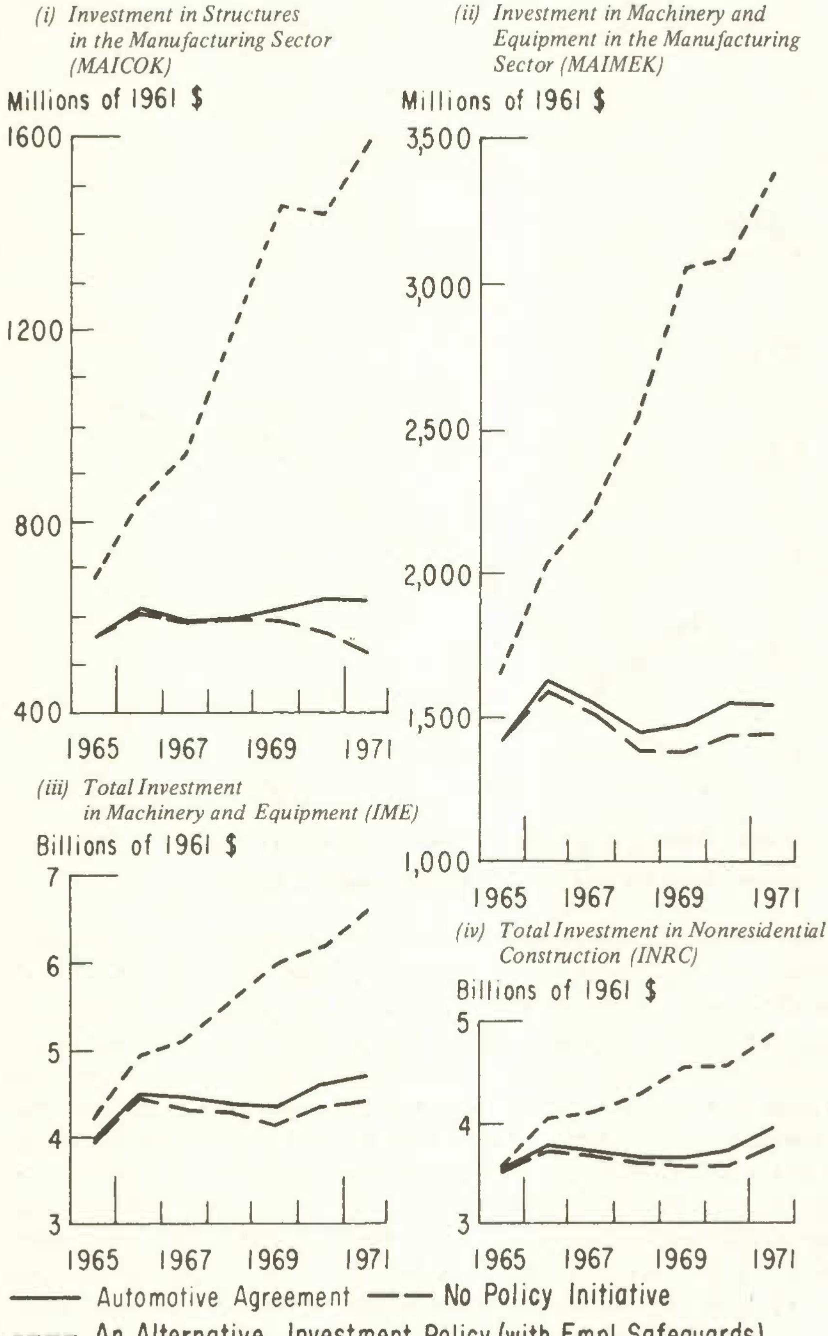


Chart 8-2 (continued)

Comparative Simulation Results for the Automotive Agreement, an Alternative Investment Policy, and No Policy Initiative

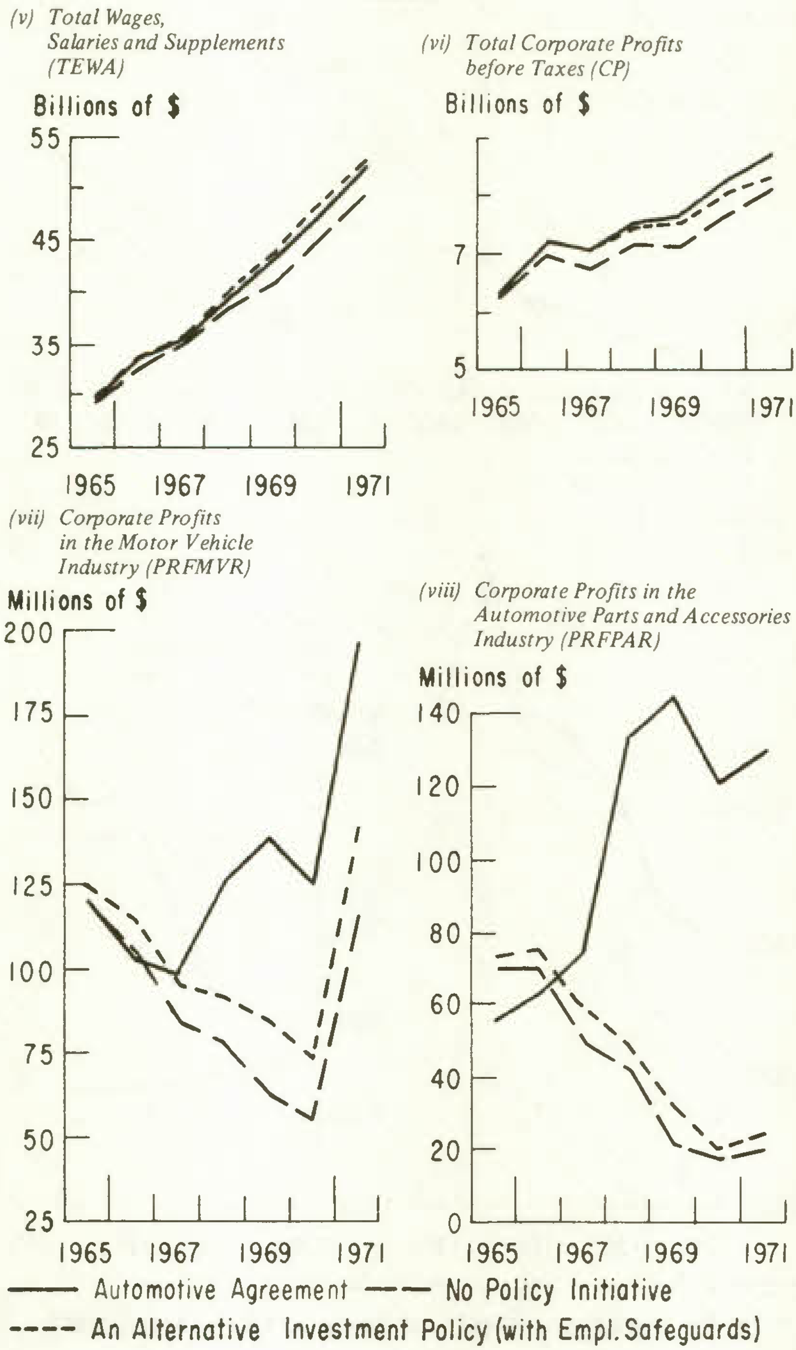
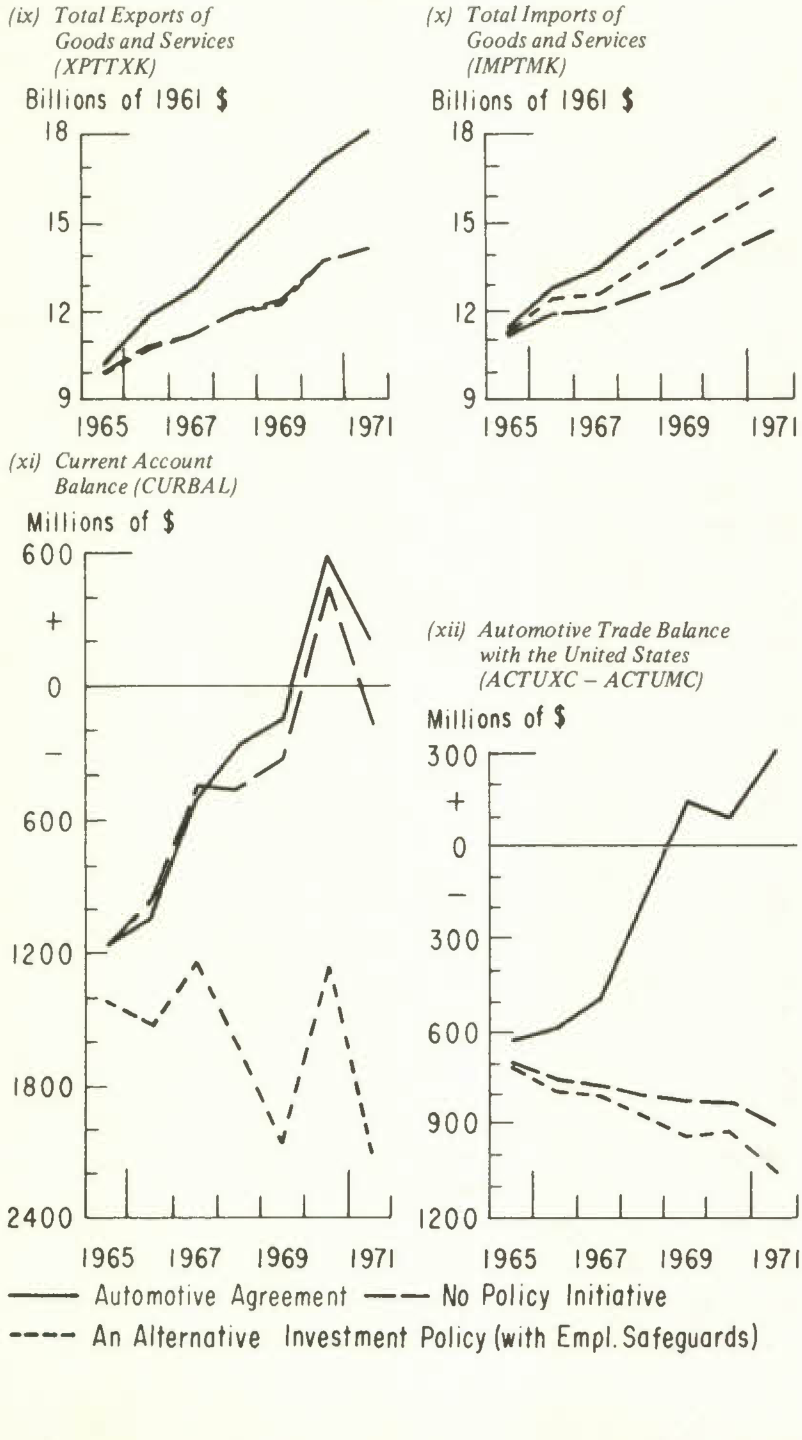


Chart 8-2 (concluded)

Comparative Simulation Results for the Automotive Agreement, an Alternative Investment Policy, and No Policy Initiative



and equipment and on structures, the simulated investment policy results in 1971 increases of 40% and 24% respectively over the level of simulated investment flows which existed under the Automotive Agreement. In short, an investment boom of historical proportions[7] is required to generate as much stimulus to the Canadian economy as provided by the Automotive Agreement during these first seven years.

The differential sectoral distribution of the additional output and employment generated under the two alternative policies for the year 1971 is presented in Table 8-3. The major sectoral redistribution, when the investment employment safeguard policy is substituted for the Automotive Agreement, occurs in the manufacturing and construction sectors. There is a loss of approximately 80,000 jobs in the manufacturing sector under the alternative simulated investment policy (vis-à-vis the Auto Pact simulation) with most of these jobs being transferred to the construction sector. In fact, the new investment, employment-safeguards policy simulation provides only 200 new jobs in the manufacturing sector (for the year 1971) over a simulation which suppresses both policy alternatives, i.e., the "no-Agreement" solution of the previous chapter.[8] A similar directional effect occurs for real output, although the sectoral displacement is more moderate. The 1971

Table 8-3

Differential Impact of the Alternate Investment Policy Compared to the Automotive Agreement, 1971

	Real Output (Millions of 1961 dollars)	Employment
Agriculture	15	-234
Forestry	10	1,428
Fishing	0	59
Mining	64	4,184
Manufacturing	-275	-79,636
Construction	409	56,508
Utilities	9	681
Transportation	42	2,366
Trade	93	15,155
Finance	0	-138
Services	10	6,111
Public Administration	-2	-252

7 The ratio of total real investment to Gross National Expenditures in the investment policy simulation exceeds .17 in 1971. In terms of the Automotive Agreement-control simulation, the maximum value for this ratio over a twenty-year period was .16 (in 1957).

8 Without the second set of con adjustments (to capital stock), the level of employment in the manufacturing sector from the investment stimulus declines substantially (95,000 jobs) over a "no-policy" alternative. This again highlights the employment reductions from increased investment (capital) which characterize the CANDIDE model's portrayal of the Canadian economy.

simulated growth in *manufacturing* real output of 1.4 billion dollars (9.2%) under the Automotive Agreement is cut back to 1.1 million dollars (7.3%) under this alternative investment policy. If the policy objective is to increase activity in the manufacturing sector, these simulation results for the 1965-71 period clearly suggest that the Automotive Agreement outperforms an alternative manufacturing investment incentive program (particularly with respect to employment).

Differences between the investment policy simulation and the Automotive Agreement simulation are very slight for the inflation rate in wages and prices in Canada (and are not shown in Chart 8-2). For the year 1971, the average weekly wage is 86 cents higher (.6%)[9] and the level of the Consumer Price Index is also .6% higher under the alternative investment policy simulation. Thus, simulations for the augmented CANDIDE model suggest that the inflationary consequences of either policy alternative are virtually the same (nil).

In terms of factor shares, the investment policy simulation does produce a small shift toward labour income (and away from corporate profits) over the Automotive Agreement simulation. The 1971 increase in corporate profits is a moderate 286 million dollars (3.5%) under the new investment policy in contrast to the $706 million (8.8%) increase under the Automotive Agreement (see Chart 8-2). Of this $420 million simulated difference in 1971 corporate profits between the Automotive Agreement and the investment policy alternative, almost 40% of it occurs in the automotive sector (particularly in the automotive parts and accessories industry). As shown in Chart 8-2, the 1971 Auto Pact simulated gain in labour income of $3,171 million (6.4%) is extended to 3,536 million dollars (7.2%) under the investment policy scenario.

Undoubtedly the most substantive differences in these two policy simulations rests in the impact on foreign trade flows and the balance of payments. Without the large Auto Pact-induced export trade in automotive products, simulated Canadian exports (under the investment policy alternative) decline by 3.8 billion dollars in 1971 to a level of $14.3 billion, virtually the same level which existed in the "no-Agreement" simulation of the previous chapter. In short, none of the increase in exports which can be attributed to the Auto Pact would have taken place under the investment incentive simulated program. On the other hand, the increase in the level of economic activity arising from the new investment policy would have increased 1971 simulated imports by 1.5 billion dollars (9.9 %) over the level which would have existed without either policy. Even though this represents only half of the simulated import surge which took place under the Automotive Pact, the lack of a comparable rise in simulated exports produces a massive simulated deficit on current account. As shown in Chart 8-2, the 1971 simulated

9 Average hourly earnings in the manufacturing sector is identical under both policy simulations.

current account deficit under the investment incentives program widens to an amount in excess of two billion dollars in direct contrast to the small simulated surplus achieved under the Automotive Agreement simulation (for the year 1971). Of this two billion dollar simulated deficit, approximately half can be attributed to a deficit with the United States on automotive trade (see Chart 8-2), as the Canadian automotive trade deficit with the United States more than doubles (in the investment simulation) over its pre-Agreement simulated level of 400-500 million dollars.[10] In short, if the imbalance on automotive trade was a problem in the early 1960s, it would have reached crisis proportions under a manufacturing investment incentive program in lieu of the Automotive Agreement. The economic cost of this simulated deterioration in the balance of payments (and ensuing restrictive government actions) arising from the alternative expansionary investment incentives policy is perhaps the most important simulated effect associated with the Automotive Agreement. Notwithstanding the many caveats expressed throughout this study, the simulation results of Chapters 7 and 8 clearly indicate that during the first seven years of its existence, the Automotive Agreement has simultaneously produced a substantial increase in economic activity (without added inflation) and an unequivocal improvement in the balance of payments.[11]

10 In addition, the automotive trade deficit with the rest of the world reaches approximately one half billion dollars in 1971 under the investment policy simulation.

11 As discussed in Chapter 1, an extrapolation of the simulated effects of the Automotive Agreement beyond these first seven years is likely to be very misleading given the changing structural conditions in the United States economy during the 1973-75 period.

APPENDIX

Description of Mnemonics and Miscellaneous Identities

MNEMONIC	**Description of Variable**
AHEMV	– average hourly earnings in the motor vehicle industry, dollars
AHEPA	– average hourly earnings in the automotive parts and accessories industry, dollars
APUSK †	– United States personal consumption of automotive products, billions of 1961 dollars
AWNPMV	– average annual wage for nonproduction employees in the motor vehicle industry, dollars
AWNPPA	– average annual wage for nonproduction employees in the automotive parts and accessories industry, dollars
BASEMV	– "negotiated" portion of the basic wage rate in the motor vehicle industry
BEWMV	– basic wage rate in the motor vehicle industry, dollars
C63 *	– unity from 1949 to 1963, zero thereafter
C64 *	– unity from 1949 to 1964, zero thereafter
C66 *	– unity from 1949 to 1966, zero thereafter
CARRMC	– imports of automobiles from the rest of the world, millions of dollars
CARRXK	– exports of automobiles to the rest of the world, millions of 1961 dollars
CARUMK	– imports of automobiles from the United States, millions of 1961 dollars
CARUXK	– exports of automobiles to the United States, millions of 1961 dollars
CATOTK †	– total consumer expenditures on goods and services, millions of 1961 dollars
CATOTP †	– implicit price deflator for total consumer expenditures on goods and services (1961 = 1.0)
CCAMV	– capital cost allowances in the motor vehicle industry, millions of dollars

* Exogenous Variable
† Original CANDIDE Variable

CCAPA	– capital cost allowances in the automotive parts and accessories industry, millions of dollars
*CDT*10*K* †	– consumer expenditures on new and used automobiles, millions of 1961 dollars
*CDT*10*P* †	– implicit price deflator for consumer expenditures on automobiles (1961 = 1.0)
*CDT*11*C*	– consumer expenditures on new automobiles, millions of dollars
*CDT*11*K*	– consumer expenditures on new automobiles, millions of 1961 dollars
*CDT*12*K*	– consumer expenditures on used automobiles, millions of 1961 dollars
*CDT*20*K*	– consumer expenditures on automotive parts and accessories, millions of 1961 dollars
*CDT*20*P*	– implicit price deflator for consumer expenditures on automotive parts and accessories (1961 = 1.0)
COMRMC	– imports of commercial vehicles from the rest of the world, millions of dollars
COMRXK	– exports of commercial vehicles to the rest of the world, millions of 1961 dollars
COMUMK	– imports of commercial vehicles from the United States, millions of 1961 dollars
COMUXK	– exports of commercial vehicles to the United States, millions of 1961 dollars.
CPI †	– Consumer Price Index (1961 = 1.0)
*D*64 *	– dummy variable, 1 in 1964, zero otherwise
DPSIXT †	– dummy variable, 1 in 1961 and after, zero before
EMV	– accumulated escalator for the basic wage rate in the motor vehicle industry, dollars
ESCAL *	– escalator factor applied to changes in the CPI
ESCIS *	– excise tax rate on motor vehicles
GKSMVK	– gross capital stock in the motor vehicle industry, millions of 1961 dollars
GKSPAK	– gross capital stock in the automotive parts and accessories industry, millions of 1961 dollars
GOMVC	– gross output in the motor vehicle industry, millions of dollars
GOMVK	– gross output in the motor vehicle industry, millions of 1961 dollars
GOMVKE	– five-year weighted average of gross output in the motor vehicle industry, millions of 1961 dollars
GOPAC	– gross output in the automotive parts and accessories industry, millions of dollars

* Exogenous Variable
† Original CANDIDE Variable

GOPAK – gross output in the automotive parts and accessories industry, millions of 1961 dollars

GOPAKE – five-year weighted average of gross output in the automotive parts and accessories industry, millions of 1961 dollars

HMV – average number of hours worked per year in the motor vehicle industry

HPA – average number of hours worked per year in the automotive parts and accessories industry

IME † – investment in machinery and equipment, millions of 1961 dollars

IMEZ † – investment in machinery and equipment, millions of dollars

LEFMV – production-worker-equivalent man-hours in the motor vehicle industry, thousands

LEFPA – production-worker-equivalent man-hours in the automotive parts and accessories industry, thousands

*M*15*ICP* † – Implicit price deflator for structures investment in transportation durables (1961 = 1.0)

*M*15*IMP* † – Implicit price deflator for machinery and equipment investment in transportation durables (1961 = 1.0)

MA 15*P* † – value-added deflator for motor vehicles (1961 = 1.0)

MA 150*Y* † – domestic product of motor vehicles and trailers, millions of 1961 dollars

MA 152*P* † – value-added deflator for truck bodies and trailers (1961 = 1.0)

MA 153*P* † – value-added deflator for the automotive parts and accessories industry (1961 = 1.0)

MA 153*Y* † – domestic product in the automotive parts and accessories industry, millions of 1961 dollars

MACK † – total gross capital stock in the manufacturing sector, millions of 1961 dollars

MACKR – total gross capital stock in the nonautomotive manufacturing sector, millions of 1961 dollars

MAET † – total employment in the manufacturing sector, thousands

MAETH † – total man-hours in the manufacturing sector, thousands

MAETHR – total man-hours in the nonautomotive manufacturing sector, thousands

MAETR – total employment in the nonautomotive manufacturing sector, thousands

MATMVC – total material inputs into the motor vehicle industry, millions of dollars

MATMVK – total material inputs into the motor vehicle industry, millions of 1961 dollars

* Exogenous Variable
† Original CANDIDE Variable

MATPAC – total material inputs into the automotive parts and accessories industry, millions of 1961 dollars

MATPAK – total material inputs into the automotive parts and accessories industry, millions of 1961 dollars

MAWA † – wages, salaries, supplementary labour income, and military pay and allowances in Canada, millions of dollars

MAWAR – wages, salaries, supplementary labour income, and military pay and allowances, excluding automotive related income, millions of dollars

MAWH † – compensation per man-hour worked in manufacturing, dollars

MAY † – total domestic product in the manufacturing sector, millions of 1961 dollars

MAYR – total domestic product in the nonautomotive manufacturing sector, millions of 1961 dollars

MOTVYRG – input-output calculated gross output in the motor vehicle industry, millions of 1961 dollars

MOTVYRM – input-output calculated material inputs into the motor vehicle industry, millions of 1961 dollars.

NPEMV – number of nonproduction workers in the motor vehicle industry

NPEPA – number of nonproduction workers in the automotive parts and accessories industry

PARRMC – imports of automotive parts and accessories from the rest of the world, millions of dollars

PARRXK – exports of automotive parts and accessories to the rest of the world, millions of 1961 dollars

PARUMK – imports of automotive parts and accessories from the United States, millions of 1961 dollars

PARUXK – exports of automotive parts and accessories to the United States, millions of 1961 dollars

PATBYRG – input-output calculated gross output in the automotive parts and accessories industry, millions of 1961 dollars

PATBYRM – input-output calculated material inputs into the automotive parts and accessories industry, millions of 1961 dollars

PCCAMV – proxy for capital cost allowances in the motor vehicle industry, millions of dollars

PCCAPA – proxy for capital cost allowances in the automotive parts and accessories industry, millions of dollars

PDE † – United States investment in machinery and equipment, billions of 1961 dollars

PEMV – number of production workers in the motor vehicle industry

* Exogenous Variable
† Original CANDIDE Variable

PEPA	– number of production workers in the automotive parts and accessories industry
PEWBMV	– production employment wage bill in the motor vehicle industry, thousands of dollars
PEWBPA	– production employment wage bill in the automotive parts and accessories industry, thousands of dollars
PMATMV	– implicit price deflator for material input into the motor vehicle industry (1961 = 1.0)
PMATPA	– implicit price deflator for material input into the automotive parts and accessories industry (1961 = 1.0)
PMHMV	– production man-hours in the motor vehicle industry, thousands
PMHPA	– production man-hours in the automotive parts and accessories industry, thousands
POP †	– population, thousands
PPRFMV	– proxy for profits in the motor vehicle industry, millions of dollars
PPRFPA	– proxy for profits in the automotive parts and accessories industry, millions of dollars
PRFMV	– profits in the motor vehicle industry, millions of dollars
PRFPA	– profits in the automotive parts and accessories industry, millions of dollars
*PRMA*15*P*	– proxy implicit price deflator for the motor vehicle industry, (1961 = 1.0)
*PRMA*152*P*	– proxy implicit price deflator for the automotive parts and accessories industry (1961 = 1.0)
REXN †	– exchange rate, Canadian dollars per unit of United States dollars
RSC †	– federal sales tax rate applicable to consumer goods
SDLMV *	– man-days lost in strike activity in the motor vehicle industry, millions
*TDT*10*R* †	– average provincial sales tax on automobile purchases
*TDT*20*R* †	– average provincial sales tax on consumer purchases of automotive parts and accessories
TEMV	– total number of workers in the motor vehicle industry
TEPA	– total number of workers in the automotive parts and accessories industry
TEWBMV	– total employment wage bill in the motor vehicle industry, thousands of dollars
TEWBPA	– total employment wage bill in the automotive parts and accessories industry, thousands of dollars
TGSTK	– gross consumer stock of automobiles, millions of 1961 dollars

* Exogenous Variable
† Original CANDIDE Variable

TIME †	– time trend (last two digits of the year)
*TIME*52 *	– time trend (1952 = 1, 1953 = 2, etc.)
TMVRMC	– total imports of motor vehicles from the rest of the world, millions of dollars
TMVRXK	– total exports of motor vehicles to the rest of the world, millions of 1961 dollars
TT *	– time trend (1954 = 1, 1955 = 2, etc.)
ULCPAT	– trended average unit labour costs in the automotive parts and accessories industry, dollars
VAMVK	– value-added in the motor vehicle industry, millions of 1961 dollars
VAPAK	– value-added in the automotive parts and accessories industry, millions of 1961 dollars
VMEMVC	– investment expenditures on machinery and equipment in the motor vehicle industry, millions of dollars
VMEMVK	– investment expenditures on machinery and equipment in the motor vehicle industry, millions of 1961 dollars
VMEPAC	– investment expenditures on machinery and equipment in the automotive parts and accessories industry, millions of dollars
VMEPAK	– investment expenditures on machinery and equipment in the automotive parts and accessories industry, millions of 1961 dollars
VSMVC	– investment expenditures on structures in the motor vehicle industry, millions of dollars
VSMVK	– investment expenditures on structures in the motor vehicle industry, millions of 1961 dollars
VSPAC	– investment expenditures on structures in the automotive parts and accessories industry, millions of dollars
VSPAK	– investment expenditures on structures in the automotive parts and accessories industry, millions of 1961 dollars
WAFT *	– Automotive Agreement shift variable (zero from 1949 to 1964, values 1,2,3,4,5,5,...,5 thereafter)
*WAFT*6 *	– Automotive Agreement shift variable (zero from 1949 to 1964, values 1,2,3,4,5,6,6,...,6 thereafter)
WMVUS *	– basic negotiated wage rate in the United States motor vehicle industry, dollars
WPMV	– wholesale price index of motor vehicles (1961 = 1.0)
WPMVAJ	– wholesale price index for motor vehicles adjusted for federal sales and excise taxes
WPPA	– wholesale price index for automotive parts and accessories (1961 = 1.0)

* Exogenous Variable
† Original CANDIDE Variable

WPPAAJ – wholesale price index for automotive parts and accessories adjusted for federal sales tax

WPUSMV * – United States wholesale price index for motor vehicles (1961 = 1.0)

*WR*1 * – unity from 1964-71 (last three wage rounds), zero otherwise

*WR*2 * – unity from 1967-71 (last two wage rounds), zero otherwise

*WR*3 * – unity in 1971 (last wage round), zero otherwise

* Exogenous Variable
† Original CANDIDE Variable

Miscellaneous Identities

[I29]	*GOMVC*	≡	*GOMVK* · *WPMV*
[I30]	*GOPAC*	≡	*GOPAK* · *WPPA*
[I31]	*VAMVK*	≡	*GOMVK* – *MATMVK*
[I32]	*VAPAK*	≡	*GOPAK* – *MATPAK*
[I33]	*VMEMVC*	≡	*VMEMVK* · *M*15*IMP*
[I34]	*VMEPAC*	≡	*VMEPAK* · *M*15*IMP*
[I35]	*VSMVC*	≡	*VSMVK* · *M*15*ICP*
[I36]	*VSPAC*	≡	*VSPAK* · *M*15*ICP*
[I37]	*CDT*11*C*	≡	*CDT*11*K* · *CDT*10*P*
[I38]	*MATMVC*	≡	*MATMVK* · *PMATMV*
[I39]	*MATPAC*	≡	*MATPAK* · *PMATPA*
[I40]	*PEWBMV*	≡	*PEMV* · *HMV* · *AHEMV*/1000
[I41]	*PEWBPA*	≡	*PEPA* · *HPA* · *AHEPA*/1000
[I42]	*TEMV*	≡	*PEMV* + *NPEMV*
[I43]	*TEPA*	≡	*PEPA* + *NPEPA*
[I44]	*TEWBMV*	≡	*PEWBMV* + [*NPEMV* · *AWNPMV*]
[I45]	*TEWBPA*	≡	*PEWBPA* + [*NPEPA* · *AWNPPA*]

Date Due

JUL	21 1977
FEB	27 1978