Taxation and Savings in Canada

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Contents

Foreword

This paper is one of the outputs from the Council's three-year study of the taxation of capital income - or of the income derived from savings and investment. The study program had important dimensions in both time and space. The effects of capital taxation on both present and future output and standards of living were scrutinized. Taxes levied by all levels of Canadian government were studied as were international implications of the taxation of capital income. Another important emphasis in the study program was on the interrelationship among specific measures of capital taxation. Here, general equilibrium and other techniques were used to examine the various measures as an interrelated system. Separate studies were also undertaken of specific measures of capital taxation, including personal and corporate income taxes, sales and transaction taxes, property taxes, and resource taxes.

An important characteristic of an annual income tax is its differential treatment of consumed income and saved income. The tax treatment of savings - first, as part of income, and second, on the subsequent flow of returns - can have substantial efficiency implications.

This study provides empirical estimates of the responsiveness of individual savings to changes in the rate of return. Knowledge of the response of individual savings to changes in its rate of return is essential in determining the efficiency costs of alternative forms of capital income taxation. Estimated savings elasticities are also of critical importance in the determination of such parameters for public policy as the social discount rate, monetary policy, the determinants of growth, and the distribution of income.

Professors Beach, Boadway, and Bruce are on the faculty of Queen's University. Professors Boadway and Bruce have published extensively in the field of public finance and welfare economics, and Professor Beach in the field of income distribution and econometrics.

Judith Maxwell
Chairman

Acknowledgment

We would first of all like to thank the Economic Council of Canada for initiating this study, providing research assistance and computing resources, and obtaining unpublished data files from Revenue Canada for the project. We would particularly like to thank David Sewell (formerly of the Council) and Denis Gauthier of the Council for their efforts in this regard, and the detailed comments of several anonymous referees.

We also appreciate very much the helpful comments and thought-provoking queries of a large number of workshop participants where material from this study was presented at seminars at the Universities of Calgary, Cornell, McMaster, Montreal, Queen's, Regina, Saskatchewan, UCLA, Waterloo, and Wilfrid Laurier. We particularly acknowledge with appreciation the comments of David Backus, John Burbidge, James MacKinnon, and David Wilton.

This study involved considerable data organization and computer work. It could not have been done without the excellent research assistance of Paula Peare, David West, and especially Granville Ansong who devoted considerable efforts throughout the project.

Introduction and Summary

The determinants of savings are of utmost importance for the design of economic policy. Recent studies in the United States have suggested, for example, that tax policies affecting savings can have a significant impact on the levels of per capita output, consumption, and welfare in the long run (Summers, 1981; Auerbach, Kotlikoff and Skinner, 1983). These studies have shown that, given reasonable assumptions about the life-cycle savings behaviour of households, the removal of the tax distortion on capital markets could cause per capita welfare to rise permanently by as much as 6 to 10 per cent in the long run. These are very large changes relative to the sorts of estimates of the dead-weight loss of taxes in other contexts.

These estimates of the impact of tax changes in the long run are, however, based on behavioural parameters which are assumed rather than estimated. The reason for this is that empirical estimates of the life-cycle savings behaviour at the household level are scarce. Most previous studies of savings behaviour have used aggregate data rather than data which are disaggregated by age cohort, since the latter type of data are not readily available. With aggregate data, the impact of age on savings cannot be determined. This is clearly inappropriate for the simulation models mentioned above which rely on life-cycle savings behaviour in an overlapping generations model context in which age is an important determinant of cohort savings. One of the main purposes of this study is to construct a data set appropriate for estimating life-cycle savings behaviour by age cohort, and to use that data set to estimate life-cycle savings behaviour and to simulate the effects of tax changes.

In order to place the empirical part of the study into its proper perspective and to understand and exploit its results fully, this study also surveys a number of other relevant issues in savings, especially those relevant for the impact of taxation on savings. These include a survey of the theory of life-cycle savings behaviour and the theoretical effects of taxation on savings over the life cycle, a review of aggregate savings rates for Canada, a discussion of efficiency and equity effects of taxing the return to saving, and a review of policy arguments for and against adopting a form of personal consumption taxation as opposed to income taxation. In this context, it should be noted that consumption taxation differs from income taxation mainly by the absence of a tax distortion on savings.

The remainder of this summary outlines the main topics covered and results obtained in the text.

The study begins with a review of the conventional life-cycle theory of savings behaviour and an analysis of the manner in which taxes affect the life-cycle pattern of savings and consumption. According to the life-cycle theory, individuals consume a proportion of their total wealth, the proportion depending upon both the after-tax interest rate and their age. This theory forms the basis for our empirical estimates later on. Of particular importance is the way in which taxes on capital income work through the after-tax interest rate to affect savings. Changes in the after-tax interest rate affect savings both by changing the propensity to consume wealth (in an ambiguous direction) and in the evaluation of one component of wealth, human wealth. An increase in the after-tax interest rate reduces the present value of future labour earnings (i.e., human wealth), so reduces consumption. This is the so-called "human wealth effect" of interest-rate changes and serves to increase the interest elasticity of savings. The literature which uses this life-cycle model to simulate the effects of capital income tax changes is then surveyed. This survey makes it clear how important underlying assumptions are about life-cycle savings behaviour, especially the interest elasticity of savings.

This theoretical discussion is followed by two chapters on institutional aspects of taxation and savings in Canada. Chapter 1 surveys the relevant provisions of the tax system as they affect capital income. What is noteworthy here is the fact that, despite its name, the income tax system actually includes a number of provisions which effectively eliminate many components of capital income from the tax base. In fact, the system may already be much closer to a consumption tax than to a comprehensive income tax. The next chapter summarizes some of the stylized facts concerning aggregate savings in Canada and undertakes some estimates of aggregate consumption functions. The data show that, contrary to what has occurred in the United States, aggregate savings in Canada has not declined over the past two decades. If anything, it has increased, despite the downward trend in after-tax real interest rates. Also contrary to what has been found in U.S. studies, aggregate consumption does not appear to be significantly affected by real interest rates. These estimates are, however, based on aggregate data which, as suggested above, are inappropriate for savings studies since age is a key determinant of savings. We thus turn to our attempt to remedy this.

In order to estimate life-cycle savings behaviour by age cohort, it is necessary to have age-disaggregated data. Such data are not readily available in Canada, so our first task is to construct data series on consumption, savings, and various forms of wealth holdings in Canada by age cohort. To do this, we have used data published by Revenue Canada in *Taxation Statistics* for the years 1964-81. From these data we obtain items reported on the income tax form for each year by age group. The use of these data to construct wealth and consumption variables involves some manipulation, all of which is described in detail in Chapter 4. The data series constructed conform with *a priori* expectations of the way in which variables change over the life cycle. These data are then used as the basis for estimating consumption functions of three different sorts. The first is a specification which corresponds with the life-cycle theory developed in the first chapter. Here, consumption is a proportion of human and asset wealth, where the proportion depends upon the after-tax interest rate and age. The second is a naive specification in which savings depends upon current income, interest rates and age. The final one is a general form which nests the first two forms and includes both wealth and current income variables, as well as interest rates and age. Equations for the life cycle and general versions fit very well. They consistently show that age has a strong positive effect on consumption out of wealth. We also had made available to us some unpublished micro-data based on income tax files in which we are able to follow groups of cohorts defined by average income class as well as age through portions of their life cycles. Empirical results obtained for these data were very similar to those obtained using the published data.

These consumption functions are then used for two sorts of simulations. In the first, impact effects of interest-rate changes on consumption and savings are calculated. Interest elasticities of savings turn out to vary considerably by age cohort, thus vindicating attempts to incorporate age into savings and consumption function estimates. For life-cycle equations, the interest elasticity falls with age, being positive for younger cohorts and negative for older cohorts. The average interest elasticity of savings over all age groups for the sample period was about 0.5. However, the elasticity depends upon the after-tax real interest rate itself. For example, if we calculate the average elasticity for a year in which the interest rate was high (1971), it turns out to be about 1.2. These estimates are both high relative to what has been obtained elsewhere using aggregate consumption function estimates.

The second sort of simulation calculates the long-run effects over the remainder of the life cycle, resulting from permanent tax reform measures undertaken at a particular point of time. One set of simulations involves replacing the existing tax on capital income with an equal-yield tax on consumer expenditures. The second involves using a wage tax as the replacement tax. Again, the effect depends upon the age of the cohort at the time of the change. For the consumption tax case, asset accumulation rises early in the life cycle and falls later. For the wage tax case, young cohorts still show an increase in asset accumulation, but it is smaller in magnitude. Older cohorts reduce their asset accumulation by more than under the consumption tax.

The aggregate effect of policy measures, or of an exogenous interest-rate change, on asset accumulation obviously depends upon the age structure of the population. Furthermore, changes in the age structure of the population should affect the savings rate. We calculated the extent to which changes in the age structure of the population affected the aggregate savings rate, given the observed savings for each cohort. We find little evidence that aggregate savings over the sample period has been affected by demographic shifts.

The final two chapters discuss welfare economics and policy issues surrounding the taxation of capital income under the personal tax system. First, equity and efficiency differences between income and consumption taxation are outlined. Under both criteria, neither tax is unambiguously superior to the other. In the case of equity, which tax is preferred depends upon a value judgment. We argue that, once equity issues are fully understood, consumption taxation corresponds with reasonable horizontal and vertical equity norms. The efficiency case depends upon the relative magnitudes of the dead-weight loss of the two taxes, which is an empirical question that cannot be fully resolved by our study. We do, however, calculate the dead-weight loss from the tax distortion imposed on capital markets by the income tax and show it to be quite small in a non-inflationary environment, but more significant when inflation is relatively high. However, our estimates are always considerably lower than those reported by Summers (1981) and others. The reason for this is that those authors have included as a part of their welfare gain that arising from the intergenerational component of tax reform and not solely from a change in tax distortions.

The final chapter considers some policy aspects of the choice between income and consumption taxes. We argue that consumption taxation actually has significant administrative advantages over comprehensive income taxation, and that the latter is an unattainable ideal. Indeed, our present system is already closer to consumption taxation than to comprehensive income taxation. Under consumption taxation, there is no need to worry about taxation of capital income on accrual or about indexation of capital income, since accounting is all on a cash-flow basis. Also, problems of treating consumer durables (e.g., housing), unincorporated business income, human capital and imputed asset income, which are insuperable under income taxation, are readily handled under consumption taxation. We conclude that, despite the ambiguous ranking on efficiency grounds, consumption taxation is preferable to income taxation.

1 The Economics of Taxation and Savings

Introduction

Savings is of utmost importance for the growth and prosperity of the economy. In the aggregate, a net increase in Canadian savings by $1 represents an increase in the demand for assets by Canadians which, in turn, will induce a dollar's worth of increase in productive capital in the economy or a reduction in foreign indebtedness or some combination of the two. In either case, Canadians will be better off if the before-tax rate of return on the asset held exceeds the after-tax return on savings to Canadians, as is widely agreed to be the case. More generally, an increase in domestic capital accumulation will increase the level of per capita consumption in the long run if the rate of return on capital exceeds the rate of growth of GNP, a condition which again is likely to be satisfied.[1] The importance of the savings rate and the potential for the tax system to influence it significantly provide the motivation for our investigation.

The ultimate purpose of this study is to investigate empirically the determinants of household or personal savings behaviour in Canada, especially the impact of tax changes. As a prelude to our empirical investigations, this chapter will review the theory of savings at both the household and aggregate levels, and the following chapter will outline the provision of the tax system as it affects savings and as it has evolved over the postwar period. The theoretical discussion will necessarily be somewhat stylized and will rely mainly on the so-called life-cycle model of savings behaviour under fairly simple assumptions. In particular, we shall ignore labour-supply interactions with savings, noting the maintained assumptions that are required to do so. We shall also assume that the consumer behaves as if he had perfect certainty regarding the prices facing him in the future and his length of life. The implications of relaxing these assumptions and of other savings motives will be noted in passing, but without analysis in detail. The simple life-cycle model will be used to analyse both how households take their savings decisions and how aggregate savings is determined.

The purpose of the theoretical analysis will be to arrive at testable hypotheses which can be used in the empirical chapters of the study. The analysis here will therefore be almost entirely positive in nature rather than normative. There are two sorts of normative analyses that one could undertake and the results of both are highly sensitive to the empirical estimates of savings behaviour. The first concerns tax design. Should the personal tax base be income or expenditure, or some combination of the two? How progressive should the tax be? Our analysis will not shed a great deal of light on that since answers to these questions depend not only upon savings behaviour but also upon labour-supply behaviour. Since we are neglecting the latter, we can say little about the tax design question. The other sort of normative question concerns the welfare cost of the distortions implicit in the tax treatment of savings. Here we shall be able to calculate some partial equilibrium welfare cost measures to be compared with those which already exist for the United States. However, since these are partial equilibrium measures which ignore distortions on other markets (particularly for labour and foreign exchange), they must be treated with caution. These calculations will be possible only after the empirical results have been presented.

This chapter begins with an analysis of household life-cycle savings behaviour starting with the simple two-period case. The two-period case has the merit of simplicity and allows many of the important analytical results to be depicted geometrically. The multi-period case is then presented and provides the basis for late empirical estimation. From an analysis of household behaviour, we can aggregate to the economy as a whole. This requires recognition of the fact that generations overlap. The existence of overlapping generations has implications for the theoretical effects of taxation on savings in the aggregate, as well as for empirical investigation. Theoretical analysis in this area becomes highly intractable quickly, and recourse has been had in the literature to simulation results rather than analytical results. Some of the implications of these simulations will be discussed.

Household Savings Behaviour

The Two-Period Case

The attraction of the two-period case lies in the fact that the household has only one decision to take – how much of its lifetime wealth to consume this period, the residual being consumed next period. This case lends itself to a simple algebraic treatment and results can be readily depicted on a diagram. As mentioned earlier, the labour-supply decision of the household is ignored by assuming that the household has an exogenously given stream of earnings. This would be compatible with a variable labour supply if labour were separable from consumption in the utility function and if the separable form were Cobb-Douglas.[2] Similarly, bequests are ignored although the analysis would be unchanged if the present value of bequests were given exogenously. Again, the separable Cobb-Douglas form would yield this. Bequests are introduced in the continuous-time case below.

Suppose the household faces an exogenous stream of earnings (w_1, w_2) and has an initial level of assets a.[3] Capital markets are perfect and the market interest rate is r. The consumer faces proportional taxes on capital income, consumption and earnings at rates t_r, t_c and t_w, respectively, and chooses a consumption stream, c_1, c_2, which exhausts his lifetime revenues. His lifetime budget constraint may be written:

$$\frac{c_1}{1-t_c} + \frac{c_2}{[1+r(1-t_r)](1-t_c)} = w_1(1-t_w) + \frac{w_2(1-t_w)}{1+r(1-t_r)} + a. \qquad (1.1)$$

This says that the present value of before-tax consumer expenditures equals the present value of after-tax earnings, where the discount rate is the after-tax interest rate. This equation can be written in the following familiar form:

$$c_1 + pc_2 = m(w_1, w_2, a, p, t_w, t_c), \qquad (1.2)$$

where p, the price of future consumption, is $1/[1+r(1-t_r)]$, and m, the after-tax lifetime wealth, is $[a + (w_1 + pw_2)(1-t_w)](1-t_c)$. Notice that income m itself depends upon the relative price of c_2 and on other taxes.

The household's utility function will be written in the general form as:

$$u = u(c_1, c_2), \qquad (1.3)$$

where we have suppressed both labour-supply and bequest variables. This could be viewed as a sub-utility function of a more general separable form, where sub-utility functions can be aggregated in the Cobb-Douglas form (see note 2). At this point, we assume 1.3 to be strictly quasi-concave so that it has diminishing marginal rates of substitution everywhere. In addition, we assume both goods are normal (with positive income elasticities). These are the only restrictions imposed for now.

The household's problem is to maximize 1.3 subject to 1.2, treating p and other arguments of m as exogenous. This is a standard consumer problem except for the endogeneity of income m. First-order conditions for this problem are the usual ones:

$$u_1 - \lambda = 0$$

$$u_2 - \lambda p = 0$$

$$c_1 + pc_2 = m(w_1, w_2, a, p, t_w, t_c), \qquad (1.4)$$

where λ is the Lagrange multiplier on 1.2, and u_1, u_2 are corresponding marginal utilities. These three equations can be solved for λ and the uncompensated demands for c_1 and c_2 in terms of exogenous variables, or

$$\lambda = \lambda(p,m)$$

$$c_1 = c_1(p,m)$$

$$c_2 = c_2(p,m). \qquad (1.5)$$

In a similar way, the household's expenditure minimization problem can be written:

$$\min.\ c_1 + pc_2$$

$$\text{s.t. } u(c_1, c_2) = u.$$

The solution to this dual problem yields the compensated demand functions:

$$c_1 = c_1(p,u)$$

$$c_2 = c_2(p,u). \qquad (1.6)$$

From 1.5 and 1.6 and the duality properties of the expenditure function, we can deduce the equivalent of the Slutsky equations for this model:

$$\left.\frac{\delta c_1}{\delta p}\right|_m = \left.\frac{\delta c_1}{\delta p}\right|_u - c_2 \frac{\delta c_1}{\delta m} \qquad (1.7)$$

and

$$\left.\frac{\delta c_2}{\delta p}\right|_m = \left.\frac{\delta c_2}{\delta p}\right|_u - c_2 \frac{\delta c_2}{\delta m}. \qquad (1.8)$$

Notice that since c_1 and c_2 are normal goods, $\delta c_1/\delta p_m \gtrless 0$ and $\delta c_2/\delta p_m < 0$. This is equivalent to saying that a rise in the after-tax interest rate will induce the consumer to increase second-period consumption, but will have an ambiguous effect on present consumption and hence on savings. This reflects the point made by

Feldstein (1978) that, with a rise in interest rates, it takes less savings to generate a dollar's worth of future consumption.

The effect of a fall in the price of future consumption holding m constant is depicted in Figure 1-1. This can be interpreted as the case in which w_2 is zero, so all exogenous income occurs in the first period. Otherwise, if w_2 were not zero, m would change with a change in p. The diagram depicts the case where c_1 falls from c_1 to c_1'. Circumstances under which this will occur can readily be derived from 1.7.[4] Let $\propto$ be the elasticity of substitution between c_1 and c_2 so:

$$\propto = \frac{\delta c_1}{\delta p}\frac{p}{c_1}\bigg|_u - \frac{\delta c_2}{\delta p}\frac{p}{c_2}\bigg|_u . \tag{1.9}$$

From the homogeneity of degree zero of compensated demand functions,

$$\frac{\delta c_l}{\delta p}\bigg|_u = -p\frac{\delta c_2}{\delta p}\bigg|_u . \tag{1.10}$$

Substituting 1.10 into 1.9 and the result into 1.7 yields:

$$\frac{\delta c_1}{\delta p}\frac{p}{c_1}\bigg|_m = \frac{pc_2}{c_1 + pc_2}(\propto - \varepsilon), \tag{1.11}$$

where $\varepsilon = (\delta c_1/\delta m)(m/c_1)$ is the income elasticity of demand for c_1. From 1.11, we see that c_1 will rise (savings will fall) with a rise in p, if $\propto > \varepsilon$ and vice versa. Notice that in the Cobb-Douglas case, $\propto = \varepsilon = 1$, so savings will be unaffected by a change in after-tax interest rates.

Let us maintain the assumption that $w_2 = 0$ and investigate the effect of tax changes on savings. Savings in this case may be defined by:

$$s = w_1(1\text{-}t_w) + a - c_1/(1\text{-}t_c), \tag{1.12}$$

where $c_1/(1\text{-}t_c)$ is consumer expenditures in period 1. From the budget constraint 1.1, savings is $pc_2/(1\text{-}t_c)$, the present value of next period's consumer expenditures. Consider the effect of changes in each of the tax rates.

Change in t_r:

$$\frac{\delta s}{\delta t_r} = -\frac{1}{1\text{-}t_c}\frac{\delta c_1}{\delta p}\frac{\delta p}{\delta t_r}$$

$$= -\frac{rp^2}{1\text{-}t_c}\frac{\delta c_1}{\delta p} \gtrless 0, \text{ as } \propto \lessgtr \varepsilon . \tag{1.13}$$

This corresponds with the result obtained in 1.11 above and reflects the ambiguity of the effect of after-tax interest-rate changes on c_1.

Change in t_c:

$$\frac{\delta s}{\delta t_c} = -\frac{c_1}{(1\text{-}t_c)^2} - \frac{1}{1\text{-}t_c}\frac{\delta c_1}{\delta m}\frac{\delta m}{\delta t_c}$$

$$= \frac{c_1}{(1\text{-}t_c)^2}(\varepsilon\text{-}1) \gtrless 0, \text{ as } \varepsilon \gtrless 1. \tag{1.14}$$

In this case, savings will be unaffected by changes in t_c when the income elasticity of demand for c_1 is unity, that is, when the utility function is homothetic. The homothetic case is an important one since it is the one usually adopted in the analysis of the multi-period problem as below.

Change in t_w:

$$\frac{\delta s}{\delta t_w} = -w_1 - \frac{1}{1\text{-}t_c}\frac{\delta c_1}{\delta m}\frac{\delta m}{\delta t_w}$$

$$= -w_1(1 - \delta c_1/\delta m) < 0. \tag{1.15}$$

With c_1 and c_2 normal, a rise in the tax on labour income will always reduce savings since it is equivalent to a reduction in first-period income.

These reasonably simple results are all derived under the assumption that all exogenous income occurs in the first period. It is an assumption that has frequently been used in textbook expositions but one which can give seriously misleading results, as Summers (1981) has pointed out. Let us now allow for the fact that $w_2 > 0$ and therefore that m depends upon p. In this case, the "full" Slutsky equations may be obtained by augmenting 1.7 and 1.8 by a term involving the induced change in m:

$$\frac{\delta c_1}{\delta p} = \frac{\delta c_1}{\delta p}\bigg|_u - c_2\frac{\delta c_1}{\delta m} + w_2\frac{\delta c_1}{\delta m}(1\text{-}t_w)(1\text{-}t_c) \tag{1.16}$$

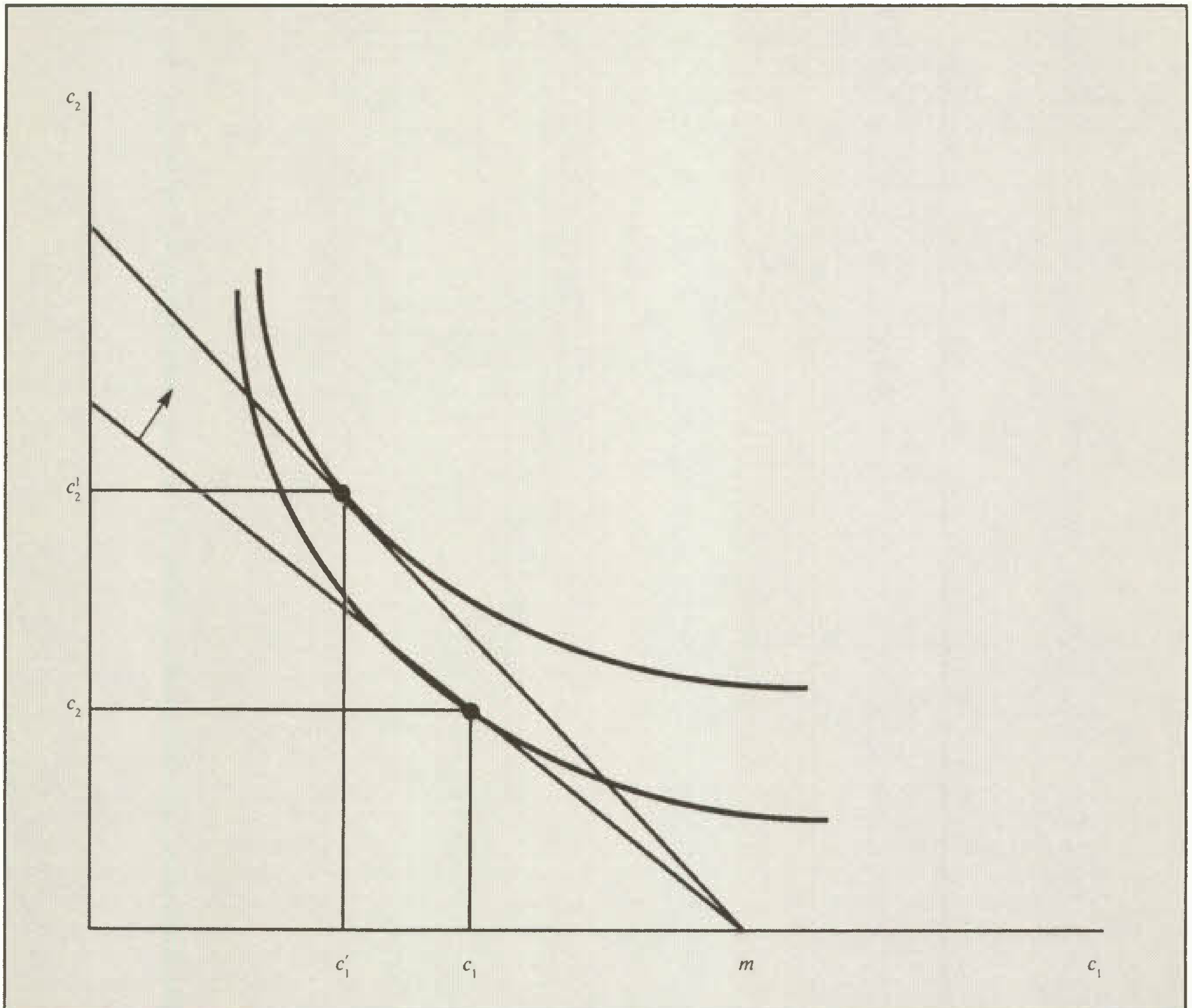
and

$$\frac{\delta c_2}{\delta p} = \frac{\delta c_2}{\delta p}\bigg|_u - c_2\frac{\delta c_2}{\delta m} + w_2\frac{\delta c_2}{\delta m}(1\text{-}t_w)(1\text{-}t_c). \tag{1.17}$$

In addition to the usual income and substitution effects of a price change, these equations include a term that Summers refers to as the *human wealth effect*. It represents the fact that a rise in p (fall in the after-tax interest rate) increases the present value of the exogenous earnings of the second period. Thus the consumer's lifetime wealth rises, inducing him to consume

Figure 1-1

The Effect of a Fall in *p*, *m* Held Constant



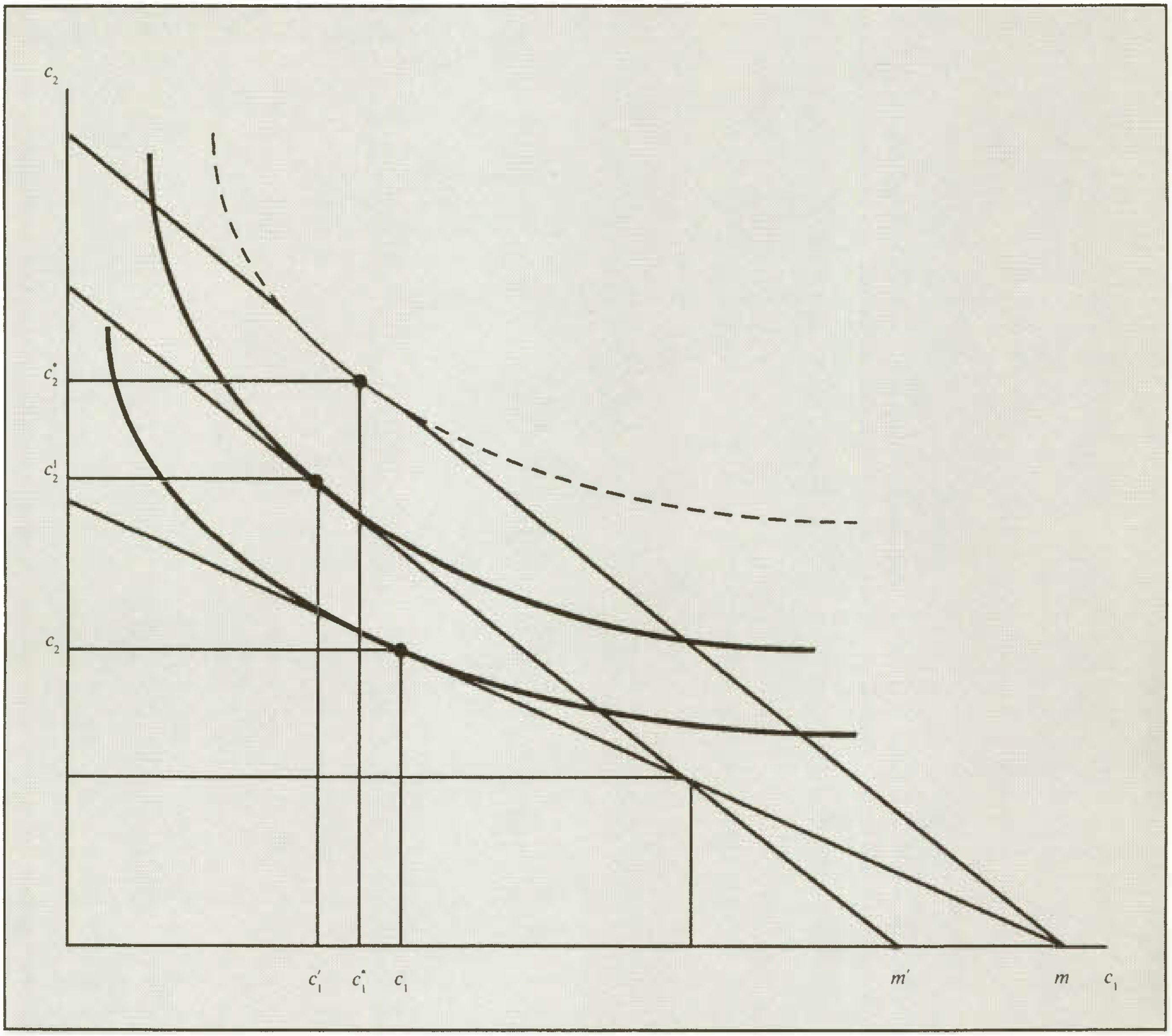
more and save less than otherwise. The term "human wealth effect" is somewhat restrictive since the same phenomenon would occur if the individual were to have other forms of exogenous income occurring in the second period, such as the return on illiquid assets (such as annuities), or transfer income (such as social security).

Now both $\delta c_1/\delta p$ and $\delta c_2/\delta p$ are of ambiguous sign. It will be true, however, that $\delta c_2/\delta p < 0$ whenever $c_2/(1\text{-}t_c) > w_2(1\text{-}t_w)$. This can be seen to be the case if the individual is a net lender in the first period, so is able to consume more than exogenous income in the second period. Similarly, $\delta c_1/\delta p > 0$ whenever $c_2/(1\text{-}t_c) < w_2(1\text{-}t_w)$. This could be the case if the individual is a net borrower in the first period. Figure 1-2 depicts the effect of a fall in p, taking into account the human wealth effect. In this case, the household's present consumption falls from c_1 to c_1', of which $c_1^* - c_1'$ is due to the human wealth effect. Lifetime wealth itself falls from m to m'.

The human wealth effect essentially serves to increase the interest elasticity of savings. This can be seen by rewriting the full Slutsky equation 1.16 in terms of elasticities in the same manner as before:

Figure 1-2

The Effect of a Fall in *p*, *m* Endogenous



$$\frac{\delta c_1}{\delta p}\,\frac{p}{c_1} = \frac{\delta c_1}{\delta p}\,\frac{p}{c_1}\bigg|_m + \varepsilon\,\frac{\delta m}{\delta p}\,\frac{p}{m}, \qquad (1.18)$$

where $(\delta c_1/\delta p)(p/c_1)\,|_m$ was given by 1.11 earlier. Since the latter term is positive due to the human wealth effect, the interest elasticity of c_1 will fall.

The effect of tax changes on savings can be readily derived here, again using the definition of savings in 1.12.

Change in t_r:

$$\frac{\delta s}{\delta t_r} = -\frac{1}{1\text{-}t_c}\,\frac{\delta c_1}{\delta p}\,\frac{\delta p}{\delta t_r}$$

$$= -\frac{rp^2}{1\text{-}t_c}\,\frac{\delta c_1}{\delta p}, \qquad (1.19)$$

where $\delta c_1/\delta p$ is now given by 1.16 and is of ambiguous sign. The impact of the human wealth effect is to increase the positive responsiveness of savings to falls in the tax rate on capital income, the more so the greater the proportion of earnings coming in the second period.

Change in t_c:

$$\frac{\delta s}{\delta t_c} = -\frac{c_1}{(1-t_c)^2} - \frac{1}{1-t_c}\frac{\delta c_1}{\delta m}\frac{\delta m}{\delta t_c}$$

$$= \frac{c_1}{(1-t_c)^2}(\varepsilon-1) \gtrless 0, \text{ as } \varepsilon \gtrless 1. \qquad (1.20)$$

This is the same expression as before and shows that the timing of earnings is irrelevant for the direction of impact of consumption tax changes on savings. Again, for the homothetic utility function case, savings is completely unresponsive to changes in t_c.

Change in t_w:

$$\frac{\delta s}{\delta t_w} = -w_1 - \frac{1}{1-t_c}\frac{\delta c_1}{\delta m}\frac{\delta m}{\delta t_w}$$

$$= -w_1(1 - \delta c_1/\delta m) + pw_2\delta c_1/\delta m$$

$$= -w_1 p\delta c_2/\delta m + w_2 p\delta c_1/\delta m \gtrless 0. \qquad (1.21)$$

In this case, provided earnings are large enough in the first period relative to the second, the wage tax will reduce savings. As second-period earnings rise, so will the responsiveness of savings to t_w. The reason is essentially that the later in life is taxable income earned, the greater must be the savings in earlier periods required to finance tax liabilities. The importance of the timing of tax liabilities on the savings decision has been noted by Summers (1981) and has been instrumental in generating some of the main results of the simulation models of Summers and of Auerbach, Kotlikoff, and Skinner (1983) discussed below.

To complete this section, it is worth drawing out some of the implications of various tax substitutions and other exogenous changes in this simple model.

Substitution of t_c for t_r

If preferences are Cobb-Douglas, substitution of a consumption tax for a capital income tax will increase savings if some earnings occur in the second period. This will remain true for the homothetic case ($\varepsilon = 1$), if $\propto \geq 1$. However, if $\propto$ falls far enough below unity, the direction of the change in savings could be reversed.

Substitution of t_w for t_r

If earnings occurred in both periods and if $\propto > \varepsilon$, substitution of a tax on wages for a tax on capital income could cause savings to rise. However, as more and more wages are earned in the first period, savings would rise less and less and could eventually fall with the tax substitution. Indeed, if all earnings were in the first period so there is no human wealth effect, substitution would cause savings to fall, if $\propto \geq \varepsilon$.

Substitution of t_c for t_w

In the absence of a human wealth effect, substituting t_c for t_w would cause savings to rise, if $\varepsilon \geq 1$. The effect would be less pronounced as more earnings are obtained in the second period, and could even be reversed.

The Effect of Interest-Rate Changes

The effect on savings of changes in r can be obtained by differentiating 1.12 to give:

$$\frac{\delta s}{\delta r} = \frac{1-t_r}{1-t_c}p^2\frac{\delta c_1}{\delta p}. \qquad (1.22)$$

The savings responsiveness to interest changes varies with $\delta c_1/\delta p$. For $\propto \geq \varepsilon$, $\delta s/\delta r > 0$ and takes on larger values, the greater is the human wealth effect ($\delta m/\delta p$). This illustrates the importance of the timing of income for the interest elasticity of savings, a point that was emphasized by Summers (1981).

Unfunded Social Security

An unfunded social security scheme is equivalent to a rise in t_w accompanied by an increase in second-period earnings. If labour earnings are all in the first period, this would be predicted to reduce savings, as noted by Feldstein (1974*a*). Furthermore, the existence of social security benefits represents a source of second-period earnings which will tend to give rise to a human wealth effect and make savings more responsive to interest-rate and capital income tax changes.

What is apparent from this simple two-period case is that, although certain unambiguous predictions can be made under certain conditions, in general the impact of tax and interest-rate changes on savings is not clear-cut. It depends upon the household's preferences. This can only be resolved through empirical analysis. To prepare ourselves for that analysis, we extend the two-period case to many periods and we put much more structure on the household's preferences in order to obtain savings equations in a form which can be estimated.

The Multi-Period Case

The multi-period consumption-savings problem can readily be illustrated using the extreme case of continuous time. To do so requires imposing fairly restrictive assumptions on the utility function, assumptions of the sort which would be needed to obtain tractable results for purposes of estimation in any case. The household consumes a flow of consumption c_t over its lifetime which ends with certainty at time T.[5] At each instant, it obtains utility of $u(c_t)$, where the same utility function applies at each instant. Its lifetime utility is then the sum of instantaneous utilities discounted at a "pure time preference rate" δ (which could be zero):

$$U = \int_0^T e^{-\delta t} u(c_t)dt. \tag{1.23}$$

For the purpose of this analysis, time zero could be taken to be "now," the beginning of the planning period for a person who has T more years to live. For the time being we ignore bequests but will return to them later.

The household has a given initial level of assets a_o, either inherited or previously accumulated, and faces an exogenous stream of labour earnings w_t which could be zero in some periods such as retirement. The interest rate is r and the same tax rates t_r, t_c, and t_w apply, and all are expected to be constant for the remainder of its life. The consumer's lifetime budget constraint may be written:

$$\int_0^T e^{-r(1-t_r)t} c_t dt = a_o(1-t_c) + \int_0^T e^{-r(1-t_r)t} W_t(1-t_u)(1-t_c)dt = M_o(1-t_c), \tag{1.24}$$

where M_o is now defined to be "lifetime" wealth before consumption taxes at time zero. Notice that this formulation presumes perfect capital markets as well as perfect certainty.

The problem for this consumer is to choose the path of consumption c_t which maximizes 1.23 subject to 1.24. If we denote by λ the Lagrange multiplier on the budget constraint 1.24, the first-order conditions for this problem are:

$$e^{-\delta t}u'(c_t) - \lambda e^{-r(1-t_r)t} = 0 \text{ for all } t \tag{1.25}$$

and the budget constraint 1.24. Taking the time derivative of 1.25 and noting that λ is time-independent, we obtain:

$$-\frac{\hat{u}'(c_t)}{u'(c_t)} = r(1-t_r)-\delta. \tag{1.26}$$

Define the elasticity of the marginal utility of consumption to be:

$$\eta = -\frac{u''(c_t)}{u'(c_t)}c_t . \tag{1.27}$$

If we assume η to be constant, 1.26 may be written:

$$c_t = \frac{r(1-t_r)-\delta}{\eta} c_t . \tag{1.28}$$

This is the conventional life-cycle consumption result that consumption rises (or falls) exponentially at the rate $[r(1-t_r)-\delta]/\eta$. We can, following Summers (1981), obtain an explicit expression for the consumption stream by first solving the first-order differential equation 1.28 to yield:

$$c_t = c_o e^{\frac{r(1-t_r)-\delta}{\eta}t} . \tag{1.29}$$

Next, substitute 1.29 into the budget constraint 1.24 to get an expression for c_o:

$$c_o = \frac{M_o(1-t_c)\left[\frac{r(1-t_r)-\delta}{\eta} - r(1-t_r)\right]}{\left[\frac{r(1-t_r)-\delta}{\eta} - r(1-t_r)\right]T} . \tag{1.30}$$

Since we are actually more interested in consumer expenditures rather than consumption, we can use 1.30 and 1.29 to obtain:

$$\frac{c_o}{1-t_c} = \frac{M_o\left[\frac{r(1-t_r)-\delta}{\eta} - r(1-t_r)\right]}{e^{\left[\frac{r(1-t_r)-\delta}{\eta} - r(1-t_r)\right]T} - 1}$$

$$= \alpha[r(1-t_r),T]\cdot M_o \tag{1.31}$$

and

$$\frac{c_t}{1-t_c} = \frac{M_o\left[\frac{r(1-t_r)-\delta}{\eta} - r(1-t_r)\right]e^{\frac{r(1-t_r)-\delta}{\eta}t}}{e^{\left[\frac{r(1-t_r)-\delta}{\eta} - r(1-t_r)\right]T} - 1}$$

$$= \alpha[r(1-t_r),T]\cdot M_o e^{\frac{r(1-t_r)-\delta}{\eta}t} , \tag{1.32}$$

where α is the marginal propensity to consume out of wealth and depends upon $r(1\text{-}t_r)$ and T (as well as tastes). These expressions for consumer expenditures are depicted geometrically in Figure 1-3 for the case in which $r(1\text{-}t_r) > \delta$.

These equations, especially 1.31, are of utmost importance for empirical estimation purposes, so it is worth pointing out several of their relevant properties. At each point of time, we would observe an individual with a given amount of wealth M_o spending $c_o/(1\text{-}t_c)$ on consumer goods. He would plan to consume $c_t/(1\text{-}t_c)$ in the future, but we would only observe that if his expectations concerning interest rates and taxes were fulfilled. Any unexpected changes in these things would induce him to revise his plans and choose a new c_o at the beginning of each planning period. At time zero, the consumer would consume a proportion α of the wealth M_o he had accumulated, where wealth consists of assets a_o and the present value of future earnings after the wage tax. The propensity to consume out of wealth α depends upon the after-tax interest rate, the tastes of the household (δ, η), and the stage in the life cycle, as indicated by the number of years left to live, T. It can readily be seen that the propensity to consume out of wealth rises with age ($\delta\alpha/\delta T < 0$). On the other hand, the effect of changes in the after-tax interest rate on the propensity to spend wealth is ambiguous ($\delta\alpha/\delta[r(1\text{-}t_r)] \gtrless 0$). It could either rise or fall as in the two-period case.

The human wealth effect occurs here because the value of wealth itself depends upon the after-tax rate of return $r(1\text{-}t_r)$ if earnings occur in the future. A rise in the net-of-tax rate of return will reduce the present value of future labour earnings and thus reduce M_o. This will serve to reduce the magnitude of the fall of $c_o/(1\text{-}t_c)$ to changes in the after-tax rate of return and thus increase the response of saving, the more so the more the earnings are spread into the future.

One of the attractive properties of 1.31 from an empirical point of view is that variables on the right-hand side can be treated as exogenous and those on the left as endogenous, at least for a single household. This makes it highly suitable as a structural equation for estimation purposes. This basic sort of equation has been exploited most recently in the literature by Summers (1982), but in earlier years by Friedman (1957), and Ando and Modigliani (1963). In aggregate studies, one might argue that r is not exogenous. However, for small open economies such as Canada, it is not unreasonable to think of r as being exogenously determined on world capital markets.

Savings in this model are equivalent to asset accumulation and may be written:

$$s_t = \dot{a}_t = r(1\text{-}t_r)a_t + w_t(1\text{-}t_w) - c_t/(1\text{-}t_c). \qquad (1.33)$$

This equation can be solved for the planned asset holdings of the household over the lifetime to yield:

$$a_t = a_o e^{r(1\text{-}t_r)t} + e^{r(1\text{-}t_r)t} \int_0^T e^{-r(1\text{-}t_r)s} [w_t(1\text{-}t_w) - c_t/(1\text{-}t_c)]ds \, . \qquad (1.34)$$

For the consumer for whom earnings cease at retirement and who leaves no bequests, the asset accumulation profile given by 1.34 would exhibit the hump shape of Figure 1-3. The addition of bequests would increase the value of terminal assets a_T above zero and make the hump less pronounced.

Again, this profile of asset holdings would only be observed if the household's expectations were fulfilled. If tax or interest parameters were to change unexpectedly, the household would revaluate its life-cycle plan and change its asset accumulation decision $\dot{a}_t$. What we would observe at each point of time would be $\dot{a}_o$, savings the consumer undertakes at the time of planning given his expectations of future interest rates and taxes.

Let us now consider the effect of tax changes on the life-cycle behaviour of the individual. We consider both the effect of each tax change on current (short-run) behaviour of the individual and the effect on longer run life-cycle behaviour.

Consumption Tax Changes

Since $c_t/(1\text{-}t_c)$ is independent of t_c by equations 1.31 and 1.32, consumer expenditures and savings will be unaffected by t_c changes. Therefore, the life-cycle profiles of Figure 1-3 remain unaltered. When t_c rises, consumer expenditures remain unchanged, and actual consumption falls. This corresponds to the result of 1.20 in the two-period case. The pattern of asset holdings over the life cycle will be unchanged.

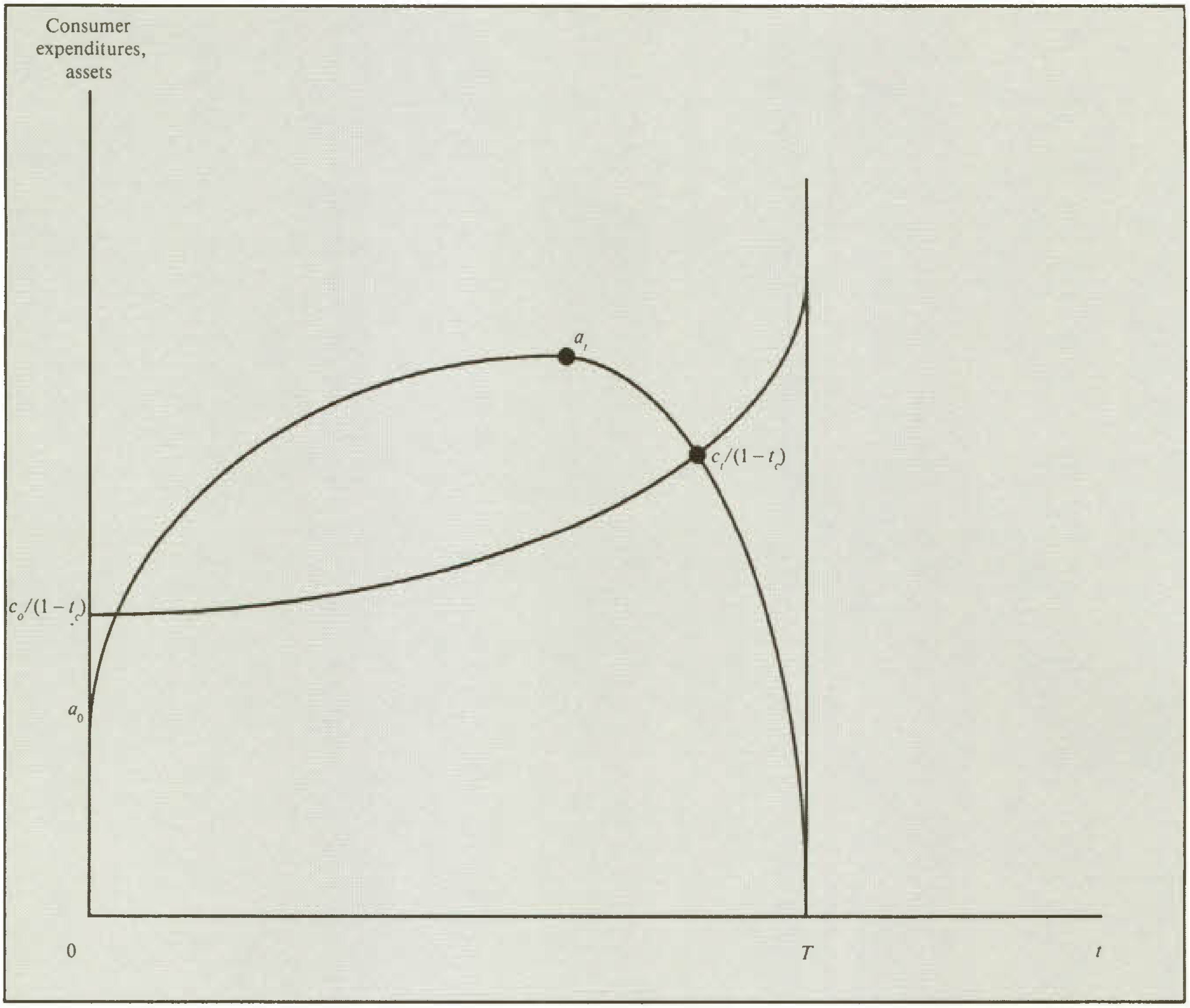
Wage Tax Changes

Since $\delta M_o/\delta t_w < 0$, wage tax increases will reduce the profile of consumer expenditures throughout the life cycle without affecting their rate of increase. This is depicted in Figure 1-4. As for savings, the short-run effect will be found by differentiating 1.33 to obtain:

$$\frac{\delta s_o}{\delta t_w} = - w_o - \alpha_T \frac{\delta M_o}{\delta t_w} \, , \qquad (1.35)$$

Figure 1-3

Life-Cycle Consumption and Asset Accumulation Profiles



where α_T is the marginal propensity to consume out of lifetime wealth for a person with T years to live. Since $\alpha_T > 0$ and $\delta M_0/\delta t_w < 0$, the change in s_o will be ambiguous. The more likely is it that earnings will occur in the future, the more likely savings will rise when t_w is increased. As in the two-period case, timing of the expected tax payment is important as households must plan to save to pay future taxes.

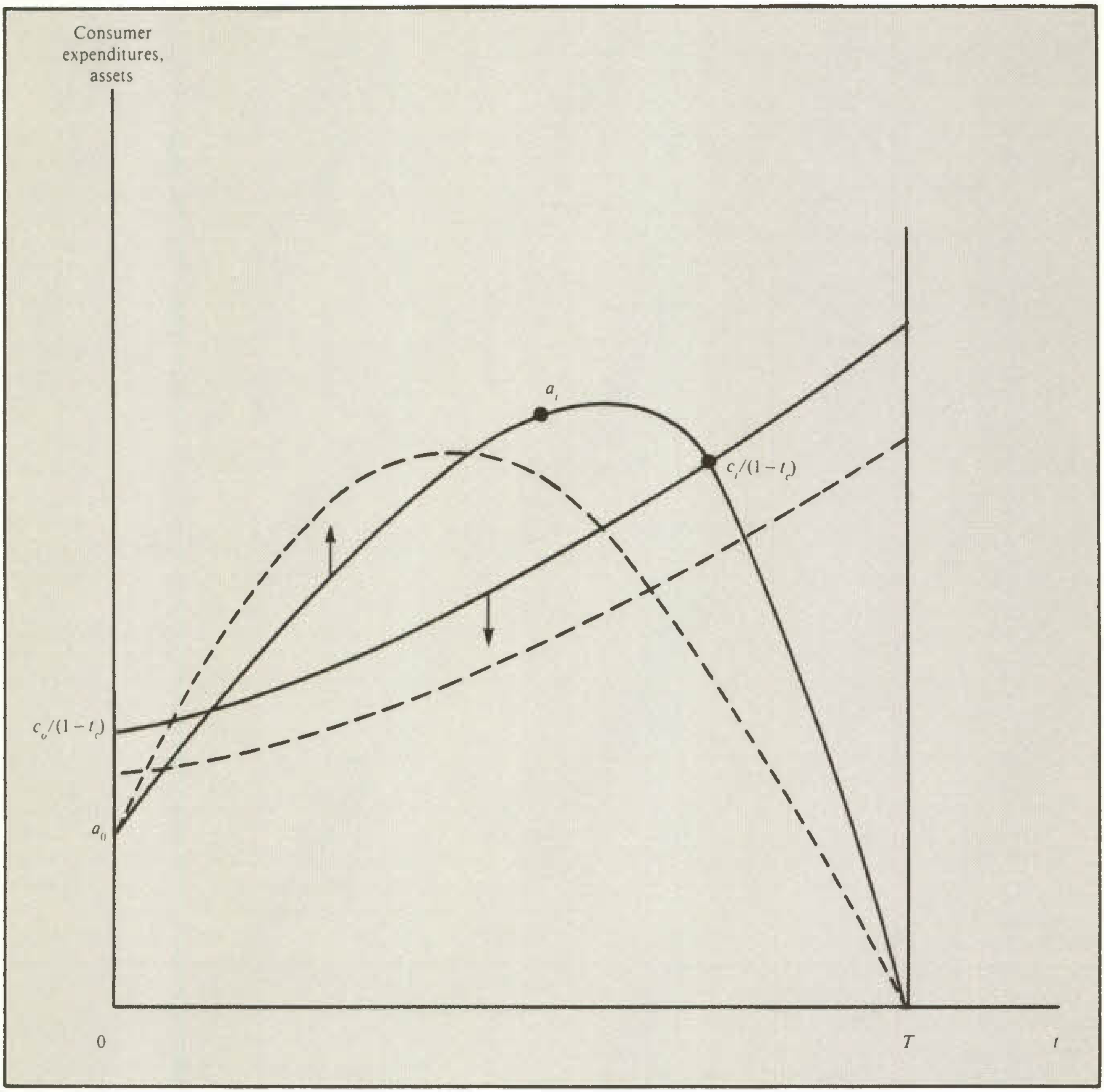
As far as life-cycle asset accumulation is concerned, suppose s_o rises initially to accumulate funds to pay the wage tax later on. (This case is depicted in Figure 1-4.) At some point, asset demand will be less than it otherwise was since less assets are required to support the lower level of consumption once earnings have ceased in retirement. The shape of the asset demand curve is, of course, highly dependent upon the lifetime earnings profile. If s_o falls initially, the lifetime asset accumulation profile could lie everywhere below that before the change.

Capital Income Tax Changes

The effect of a change in t_r on consumption is somewhat more complicated. From 1.31,

Figure 1-4

The Effect of an Increase in t_w on Life-Cycle Behaviour when $\delta s_o / \delta t_w > 0$



$$\frac{\delta[c_o/(1\text{-}t_c)]}{\delta t_r} = \alpha_T \frac{\delta M_o}{\delta t_r} + M_o \frac{\delta \alpha_T}{\delta t_r} . \qquad (1.36)$$

The first term, the human wealth effect, is unambiguously positive since a rise in t_r will reduce the after-tax discount rate and increase the present value of future earnings.[6] The second term may be expressed as follows:

$$M_o \frac{\delta \alpha_T}{\delta t_r} = \frac{M_o r(1\text{-}1/\eta)}{e^{[\frac{r(1-t_r)-\delta}{\eta} - r(1-t_r)]T} - 1} \cdot \left(1 - \alpha_T T e^{[\frac{r(1-t_r)-\delta}{\eta} - r(1-t_r)]T}\right). \qquad (1.37)$$

If $\eta = 1$, this term is zero and initial consumer expenditures will rise. The rate at which consumer expenditures rise, $[r(1\text{-}t_r)\text{-}\delta]/\eta$, will necessarily fall. The change in consumer spending over the life cycle will be as depicted in Figure 1-5. The same figure will also apply whenever the value of 1.37 is positive, which in general we cannot assume to be the case.

The effect on asset accumulation is equally ambiguous. Differentiating 1.33 with respect to t_r:

$$\frac{\delta s_o}{\delta t_r} = -ra_o - M_o \frac{\delta \alpha_T}{\delta t_r} - \alpha_T \frac{\delta M_o}{\delta t_r} .$$

The first term is negative, the second ambiguous and the third, the human wealth effect, is also negative. Overall, as in the two-period case, the impact on s_o is ambiguous. In the case where $\eta = 1$, $\delta s_o/\delta t_r < 0$ by 1.36. In that case, the asset demand profile might look like that in Figure 1-5. Asset demand over the entire life cycle would fall.

So far we have concentrated upon the individual household. We now turn our attention to aggregate savings behaviour. What we have established so far is that the effect of tax changes on savings is ambiguous. We have also obtained an equation for current consumption spending, 1.31, which could be estimated, in principle. Estimates of this equation give the *current* response to tax and interest-rate changes. From those current responses, we would deduce long-run implications from other equations of the life-cycle model.

The Addition of Bequests

So far we have assumed that individuals plan to leave no bequests. This is clearly not consistent with available evidence. In this section, we show how bequests might be added to the above model and that their presence need not change the qualitative results derived thus far. Suppose we assume that an individual obtains utility both from his own consumption and from the level of bequests given. We can write lifetime utility as:

$$U = \int_0^T e^{-\delta t} U(c_t)dt + v(b_T), \qquad (1.38)$$

where b_T is the level of bequests assumed to be given at death.[7] The lifetime budget constraint now becomes:

$$\int_0^T e^{-r(1-t_r)t} \frac{c_t}{1\text{-}t_c} dt + e^{-r(1-t_r)T} b_T$$
$$= a_o + \int_0^T e^{-r(1-t_r)t} W_t(1-t_w)dt = M_o, \qquad (1.39)$$

where a_o includes inheritances received.

The individual's problem is to choose b_T and a pattern of consumption c_t to maximize 1.38 subject to 1.39. First-order conditions are:

$$(1\text{-}t_c)e^{-\delta t}u' - \lambda e^{-r(1-t_r)t} = 0 \text{ for all } t \qquad (1.40)$$

and

$$v' - \lambda e^{-r(1-t_r)t} = 0. \qquad (1.41)$$

From 1.40 we derive as before the same differential equation 1.28 for c_t whose solution is, as before,

$$c_t = c_o e^{\frac{r(1-t_r)-\delta}{\eta} t} . \qquad (1.29)$$

Substituting 1.29 into the budget constraint 1.39 yields:

$$\frac{c_o}{1\text{-}t_c} = \alpha[r(1\text{-}t_r), T] \cdot [M_o - e^{-r(1-t_r)T} b_T] , \qquad (1.42)$$

where $\alpha(\cdot)$ is the same function as earlier. This equation shows that consumer expenditures are a proportion of current wealth net of the present value of bequests.

Equation 1.42 is not in a satisfactory form for estimation since b_T is actually a choice variable. We can eliminate b_T from the problem by use of the first-order conditions. From 1.40, at $t=0$,

$$\lambda = u'(c_o)(1\text{-}t_c) = c_o^{-\eta}(1\text{-}t_c), \qquad (1.43)$$

where we maintain the assumption that the utility function has a constant elasticity of the marginal utility of consumption. Suppose that the utility-of-bequest function v is also constant elasticity and that we can write the marginal utility of bequests as:

$$v'(b_T) = b_T^{-\gamma} e^{-\delta T}.$$

Then, from 1.43 and 1.41, we derive:

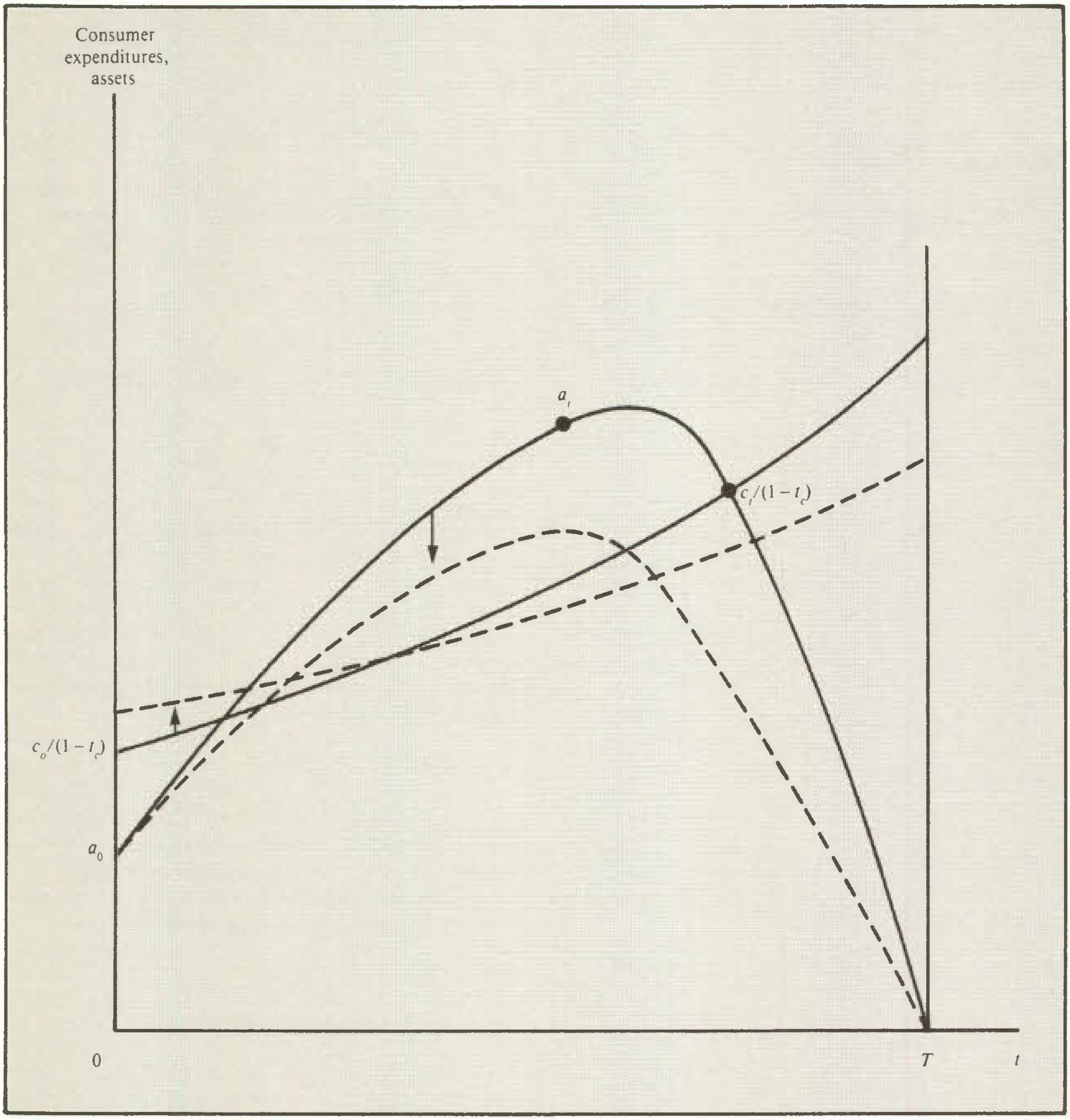
$$b_T = e^{[\frac{r(1-t_r)-\delta}{\gamma}] T} c_o^{\frac{\eta}{\gamma}} (1\text{-}t_c)^{-1} . \qquad (1.44)$$

Finally, assume that $\eta = \gamma$ so the elasticity of the marginal utility of consumption and bequests is the same. Equations 1.42 and 1.44 yield:

$$\frac{c_o}{1\text{-}t_c} = \frac{\alpha M_o}{1 + \alpha e^{[\frac{r(1-t_r)-\delta}{\eta} - r(1-t_r)]T}}$$
$$= \beta[r(1\text{-}t_r), T] \cdot M_o . \qquad (1.45)$$

Figure 1-5

The Effect of an Increase in t_w on Life-Cycle Behaviour when $\delta[c_o/(1-t_c)]/\delta t_r > 0$



The above analysis indicates that, even with bequests, the life-cycle theory can be taken to imply that consumer expenditures are a proportion of an individual's wealth, the proportion again depending upon the after-tax interest rate and the age of the individual. It can be shown that $\delta\beta/\delta T < 0$, so the propensity to consume wealth rises with age. As before, the sign of $\delta\beta/\delta[r(1\text{-}t_r)]$ is indeterminate.

It should also be noted that from the above analysis we could also derive an equation for planned bequests. Assuming $\eta = \gamma$ as above, substitution of 1.45 into 1.44 yields:

$$b_T = e^{\frac{r(1-t_r)-\delta}{\gamma} T} \cdot \beta M_o$$

$$= \phi[r(1\text{-}t_r),\ T]\ M_o\ . \qquad (1.46)$$

This indicates the bequests that an individual with T years left to live would plan to leave if wealth were M_o and his interest rate were $r(1\text{-}t_r)$. This equation is difficult to implement empirically since planned bequests are not observed.

Aggregate Savings Behaviour

We have so far concentrated on the savings behaviour of an individual with a planning period consisting of the remaining T periods of his life. The population will be made up of a distribution of persons of different ages and therefore with different values of T. Persons of different cohorts will be indexed by T. If we assume all households to have the same utility function, the behaviour of households will differ systematically by cohort T, but for each cohort the propensity to consume out of wealth will be identical as long as t_r is identical for all. Therefore, consumer expenditures could be aggregated over all persons of a given age cohort regardless of differences in preferences arising from different family sizes, physical states, location, etc., but it allows us to concentrate on the influence of the age structure of the population on savings behaviour. In this way, essential implications of the so-called "overlapping generations model" of the economy for taxation and savings can be drawn out.

The importance of the age structure for the analysis of tax changes is twofold. First, persons of different ages have different propensities to consume out of wealth. In particular, older persons (i.e., those with lower T) have higher propensities to consume α_T. This implies that the responsiveness to tax changes will vary by age since, as we have seen in 1.35 and 1.36, the effect on savings of tax changes varies with α_T. Thus, for a given reduction in wealth due to a tax change, the reduction in savings will be higher for younger than for older persons.

Secondly, the holding of wealth, both human and non-human, varies by age. As we have seen, asset accumulation will typically follow a single-peaked path while human wealth monotonically declines over the life cycle.[8] Since part of the effect of tax changes (particularly t_r and t_w) is to change the value of lifetime wealth, these wealth effects, both human and non-human, will vary significantly by age and will give rise to what economists have referred to as intergenerational transfers. Some of the most important short-run effects of taxation on savings and consumption come about precisely because of the implicit redistribution of wealth among generations. To take a simple example, if a tax on wages is substituted for a tax on consumption, there will be an implicit transfer of purchasing power from younger to older persons. Older persons will consume more for the rest of their lives since the smaller is T, the less is expected future labour earnings. This will represent a windfall gain for older generations. Younger generations might consume more or less over their lifetime, depending on the relative magnitudes of t_w and t_c changes. If the rise in t_w must be sufficient to cover lost revenues from the fall in t_c, we might expect the youngest to consume less in the short run. Thus the tax change will cause a transfer of consumption from current younger to current older generations. Over the longer run, when the economy has adjusted to the new tax regime, the level of consumption achieved by the typical person may be higher or lower than before, as shown in Figure 1-4.

This example can be used to indicate some of the other complications that arise when we move from the individual to the aggregate. For one thing, when the effects of tax changes are contemplated, it is necessary to be explicit about the government's budget constraint. One possible assumption, and one which has typically been used in the literature (e.g., Summers [1981], Auerbach, Kotlikoff, and Skinner [1983]), is to require government budget balance at each instant. This yields significantly different results than when the government can use debt policy during the transition period to smooth out the otherwise dramatic changes in tax rates. Another important effect that must be considered in the aggregate is the general equilibrium aspect of the problem. In the above example, when the wage tax is substituted for the consumption tax, households may be induced to hold less assets (i.e., to save less), even though their streams of consumption may not have changed because taxes are being paid earlier in the lifetime than before. If all cohorts demand less assets over their lifetime, there would be less capital in the economy as a whole if the economy were closed since capital is the ultimate asset that is held for life-cycle smoothing and passed from one generation to the next. If so, the rate of return on capital might be expected to rise and that will affect the chosen stream of consumption.

If the economy were open, these general equilibrium effects would be considerably smaller, possibly negligible. The amount of capital in the economy would be determined by a rate of return given by world capital markets and the savings and investment decisions would be, to a greater or lesser extent, segmented. In this case, changes in the domestic demand for assets would at least partly be reflected in changes in the net holdings of foreign assets rather than in the domestic stock of capital (see Boadway and Bruce, 1984).

These complications that arise in an aggregate overlapping generations context make it very difficult to rely on purely analytical reasoning to generate results. For that reason, much of the work in this area has taken the form of simulation. We return to a discussion of some of it in Chapter 3. First, let us discuss the aggregate relationships one might expect to observe and estimate in practice.

Estimating Aggregate Consumption, Savings, and Wealth Accumulation

We shall adopt the continuous-time version of life-cycle behaviour outlined in the previous section. According to that model, at each point in time households will spend a proportion of their remaining lifetime wealth. The wealth will include the value of their assets plus the present value of the future stream of predetermined after-tax income. For illustrative purposes, we assume the latter to include only labour earnings, but in general (and in our empirical work) it will include any other predetermined income as well, such as pensions.[9] The proportion of full wealth consumed, α_T, depends on the after-tax (real) return on capital, tastes and age.[10] As mentioned, we assume all persons to have identical tastes and to have the same after-tax return on capital so that we may think of the propensity to consume wealth α_T as being the same within cohorts but to increase monotonically with age across cohorts.[11]

The data we use allow us to observe individual savings and consumption behaviour by age cohort. The behavioural equation to be estimated is the consumption function of equation 1.31:

$$c_o/(1\text{-}t_c) = \alpha[r(1\text{-}t_r), T] \cdot M_o.$$

From this estimated consumption function, we can in turn construct estimated savings and asset demands by age cohort. Estimates for aggregate consumption in each year can be obtained by aggregating individual consumption, savings and asset demands by the distribution of population by age cohort. For example, suppose that at a given point in time the frequency distribution of the population by age cohort is given by $g(T)$, so $g(T)$ represents the number of persons of cohort T. Then, aggregate consumer expenditures E would be given by:

$$E = \sum_{T=0}^{55} g(T)c_o/(1\text{-}t_c)\,, \tag{1.47}$$

where we assume the youngest cohort has 55 years of economic life remaining. In a similar manner, we can obtain aggregate savings and asset demands.

Using 1.47 and its analogy for aggregate savings and asset demands, we can simulate what the level of savings and the demand for assets might have been had a different tax system been in existence.

What sorts of results might one expect to obtain from various tax changes? At this time, there is very little econometric evidence of the long-run impact of tax changes on asset accumulation, consumption and savings. There has been considerable work on estimating current consumption and savings functions, but little of it has been used as the basis for simulating the long-run effects of such tax changes. Almost all of the long-run analysis of tax changes has been done in the context of simulation models. Since these models tend to shed some light on the qualitative results that the theory might predict (rather than on the quantitative results that econometric methods might obtain), it is worth reviewing the simulation results here.

Long-Run Effects of Tax Changes in Aggregate Simulation Models

Long-run growth models simulating the effects of tax changes have been around for some time,[12] but only recently have they incorporated savings behaviour based on optimizing life-cycle behaviour and overlapping generations. The paper by Summers (1981) was an important watershed, and many of the subsequent contributions have been a response to, or elaboration of, this model.[13] Summers' computations had led him to argue that the welfare gain from eliminating taxes on capital income either by a payroll tax or a consumption tax would likely be extremely large, at least 10 per cent of GNP annually in the case of consumption taxation. This gain was largely due to the effect of the tax on the long-run equilibrium capital stock. It is worth recounting his argument in some detail since it illustrates most of the important forces at work which had previously not been recognized.

Summers' basic model was of a series of identical households each of whom lived for a given economic life, received no inheritances and made no bequests, and who worked for a fixed proportion of their life during which they all earned the same wage which grew exponentially due to exogenous productivity growth. Households overlapped continuously with the instantaneous birth (and death) rate growing exponentially. They had an additively separable constant elasticity utility-of-consumption function with a given pure time preference rate. They choose their consumption profiles to maximize lifetime utility. As in the previous section, this gives an exponentially rising lifetime consumption stream and a hump-shaped demand for asset stream which starts and ends at zero. The only asset in the model is real capital and it serves two purposes. It is the store of wealth by which households save for future consumption. This store of wealth passes continuously from one generation to the next as each one saves first and dissaves later. The real capital also serves as a reproducible factor of production in a neoclassical aggregate production function which produces output using capital stock and labour. Capital is assumed not to depreciate, though this is not essential. There is no other form of wealth endogenous to the model.

The fact that capital fulfils these two roles is of some importance since there is no guarantee that the amount of capital which is demanded and held as a store of wealth, as determined by household savings, is that which is welfare-maximizing in the long run. It is well known that per capita utility in the steady state will not be maximized unless the rate of return on capital equals the growth rate of GNP (natural growth rate). This is the so-called *Golden Rule*.[14] If the rate of return on capital exceeds the natural growth rate, there is too little capital, and per capita welfare is less than it otherwise could be. It is widely believed that the United States has too little capital in this sense.[15]

Summers proceeds by considering the steady-state characteristics of this model. To begin with, he derives an expression for aggregate savings in the steady state of his overlapping generations model. The steady state will grow at the natural growth rate (the rate of population growth plus the increase in productivity), and the level of output and consumption in the steady state will depend upon the capital-labour ratio which, in turn, will depend upon savings behaviour. Taking as exogenously given the interest rate, he assumes plausible values for the population and productivity growth rates and for the taste parameters of households and calculates the long-run interest elasticity of aggregate savings for the economy. These are long-run in the sense of comparing one steady state with another. They are also partial equilibrium since the interest rate is taken as exogenous rather than being determined jointly with the production side of the economy. He finds plausible interest elasticities to be quite large, of the order of 1.87 to 3.36. These are much larger than empirical estimates have been able to obtain.[16]

These large simulated interest elasticities of aggregate saving are attributed by Summers primarily to the human wealth effect, which we discussed in detail earlier. Since households have rising earnings over their lifetime, the present value of this stream of earnings will vary inversely with the interest rate. A rise in interest rates will reduce human wealth, thereby reducing consumption and increasing savings. He argues that previous empirical estimates, by treating wealth as exogenous, have neglected this channel of influence of the interest rate. In our empirical work, we shall take this effect explicitly into account.

These partial equilibrium exercises are preliminary to a full general equilibrium simulation by Summers of the effect on the steady state of various tax changes. For this purpose, a single sector production technology is appended to the economy, using the CES technology. Using stylized facts on the growth rate, savings rate and factor shares of the economy, and plausible parameter values for utility and production functions, steady-state characteristics of three sorts of tax systems are calculated. One is the existing system which is viewed as a combination of a payroll tax and a tax on capital income. Another is a pure payroll tax. The third is a tax on consumer expenditures. The rates under the latter two are chosen to yield the same steady-state tax revenues as the former.

The results are as follows. The move from the existing system to a payroll tax increases income by 14 per cent, consumption by 14.2 per cent, and steady-state utility by 5 per cent of lifetime real income. When the current system is replaced by the consumption tax, changes are even more dramatic. Income rises by 18 per cent, consumption by 17.1 per cent and welfare by 12 per cent of lifetime income. In both cases, capital intensity rises significantly, more so in the consumption tax case, causing the rate of return on capital to fall and the wage rate to rise.

The reasons for these results are easy to infer. The switch from the current system to the payroll tax increases the after-tax rate of return on savings and, due to the high interest elasticity of savings, aggregate capital accumulation rises. Much of this high interest elasticity is due to the human wealth effect of the interest-rate rise which is reinforced by the increased payroll tax on earnings. The rise in capital causes a significant rise in welfare because of the existing "underaccumulation of capital" in the economy. The gross rate of return assumed on capital is of the order of 10.5 per cent, while the natural growth rate is 3.5 per cent. Thus an increase in capital would increase the level of per capita welfare in the long run. The move to a payroll tax causes the gross return to capital to fall to 6.9 per cent.

The comparison of consumption tax with payroll tax is also instructive. Both benefit from the interest-rate effect since both exempt capital income from the tax base. However, consumption tax differs from payroll tax in the timing of tax payments. From the individual's point of view, consumption tax liabilities occur later in life than payroll tax liabilities, so the individual is induced to hold more assets over his life to meet these tax liabilities later on. This difference in timing turns out to be particularly important in analysing the transition to the steady state, as subsequent work (discussed below) will show. In the steady state, however, its main effect is to increase the average asset demand of households. The effect is strengthened by the fact that the government is able to charge a lower tax rate in the steady state under consumption taxation than under payroll taxation. This is because the implicit discount rate facing the government is the natural growth rate, which is less than that facing the household. The government is able to arrange efficient intergenerational transfers at the natural growth rate which then get invested at the pre-tax rate of return.

It should be noted that this timing effect also works in the transition from the current system to the payroll tax, though in the opposite direction. The payroll tax moves the receipts forward in time relative to the present system, thus depressing saving. However, such is the strength of the interest elasticity that the net effect on saving of moving to the payroll tax is strongly positive.

Summers' results elicited a great deal of attention, not least because of their apparently overwhelming implications for the benefits of moving to consumption taxation. However, results depend critically upon the underlying model and parameter assumptions. Verifications and contradictions of the results have proceeded by revising some of these assumptions. Some of the more critical assumptions of the model which, as Summers himself recognized could be important, are as follows.

Lack of bequests. In Summers' model, households are assumed to consume all their lifetime wealth, yet we know this is contrary to fact. Kotlikoff and Summers (1981) earlier argued that most saving took the form of savings for bequest rather than life-cycle smoothing. Summers recognizes this and argues that if bequest savings is motivated by interdependent utility functions in the manner of Barro (1974), this can only strengthen his results. Of course, bequests could be a result of other motives such as uncertainty or the utility of holding wealth *per se*.

Labour-leisure choice. The fixing of labour supply implies that consumption taxation will be superior to income taxation, at least in static efficiency terms. Since both consumption and payroll taxation distort the labour-leisure choice, it would be useful to include that choice in the analysis.

The corporate tax distortion. Part of the distortion from the existing system on capital income is due to the corporate tax. In fact, Summers assumes the existing system taxes capital income at 50 per cent and labour income at 20 per cent. This presumption is based partly on effective tax rates on corporate income, which use average rather than marginal tax rates. Much theoretical work on the corporate tax has argued that at the margin, the corporate tax need not be distortionary, and recent measures of the effective marginal tax rate have confirmed this. A lower assumed tax rate on capital income would reduce the magnitude of the benefits of consumption taxation.

Wage profile assumptions. Summers assumes that wages increase exponentially over the working life for each household. In fact, actual age-earnings profiles tend to peak at age 50. This implies that earnings do not tend to occur as late in life as in the simulated model, so the human wealth effect would not be as pronounced.

The transition period. Summers' analysis compares one steady state with another without considering the transition period. As he notes in his paper, the higher steady-state level of consumption is partly obtained at the expense of lower short-run consumption levels as capital stock is built up. Thus, while future generations gain from tax changes, current generations may well lose. A comparison for policy purposes would have to weigh these gains and losses appropriately.

Sensitivity analysis. Results in any simulation analysis depend upon the parameter values chosen. Other parameter values may well give considerably differing results.

A number of studies have appeared which have taken up one or more of these shortcomings. What follows is a brief synopsis of a number of these.

Seidman (1983). This paper recomputes Summers' results allowing for a utility-of-bequests function. Households may therefore save for bequests as well as for life-cycle smoothing. The basic result is to confirm that consumption taxes are superior to payroll taxes which are superior to the current system, again across steady states. He also shows that introducing a tax on bequests reduces steady-state utility because of the depressing effect on savings.

Evans (1983). Evans challenges the robustness of Summers' simulation results on several grounds. First, he shows that the partial equilibrium interest elasticity of aggregate savings is very sensitive to the pure time preference rate, all of which were treated as unassailable by Summers. Evans finds that elasticities of negligible size could be obtained with plausible assumptions about these parameters. Next he considers the transition period and calculates that for interest elasticities of the magnitude regarded as reasonable by Summers, the savings rate would dramatically overshoot and exhibit fluctuations of a magnitude never observed historically. He then shows that adding bequests to the model can reduce the interest elasticity of savings significantly and even turn it negative. Finally, in the general equilibrium simulation context, he shows that Summers' results are sensitive to the production technology chosen, the utility function and the existence of bequests. These sorts of counter-examples cast doubt on the reliability of simulation estimates and reinforce the need for good empirical work.

Auerbach, Kotlikoff, and Skinner (1983). This work refines and extends Summers' simulations in a number of directions. They simulate the transition path in going from one steady state to another using an overlapping generations model of life-cycle savers. As in Summers, households make no bequests. However, they are allowed a variable labour supply and endogenous retirement age, and their age-earnings profiles are more realistic than the simple exponential growth pattern assumed by Summers. Also, individuals are assumed to possess rational expectations about future prices, incomes and interest rates. That is, they foresee perfectly the equilibrium path that the economy will follow. On the production side, a general CES production technology is used, but regrettably technical progress is assumed away in order to be able to obtain a steady-state solution. Three sorts of tax bases are used: an income tax (the base case), a wage tax, and a consumption tax. Both progressive and proportional taxes are simulated.

Simulations involve starting in the steady state with income tax and using a variety of plausible parameter estimates which yield equilibrium variable values similar to the stylized facts. Then, income tax is replaced by a consumption tax or a wage tax as the case may be in such a way as to keep per capita government expenditures constant. (Population grows at 1 per cent per year.) The move to a consumption tax is found to reduce the welfare of current older generations and improve the welfare of younger and future generations. As in Summers, the long-run effect is to improve the welfare of future generations in the new steady state, in this case by 6 per cent of the consumer's lifetime resources. For the wage tax, older generations have an improvement in welfare, while younger and future generations lose welfare. In the long-run new state, welfare is actually lower for each individual by 4 per cent of lifetime resources, despite the higher capital-output ratio obtained.

The difference in these transition paths is easy to understand. In the case of consumption tax, older generations face a windfall loss since they will unexpectedly be faced with a tax on their remaining consumption which otherwise would not be taxed. It is as if they were hit by a lump-sum tax. This higher tax on the older generation permits lower taxes to be paid by younger and future generations. Eventually, welfare is improved for future generations for similar sorts of reasons advanced by Summers. Savings are very elastic with respect to rates of return. This, combined with the postponed timing of tax payments, increases capital stock, and society is much better off because of the dynamic inefficiency of the economy discussed above. Welfare gains here are lessened by the variability of labour supply.

For the wage tax, older generations obtain a windfall gain since they no longer have to pay an income tax in retirement. They consume this windfall gain. The fact that they face much higher wage tax rates is of no great consequence since their labour-supply elasticity late in life is very low. The young bear the brunt of the costs of transition since they must finance the gain to the older generation by higher wage tax rates. Despite the removal of capital market distortion and the consequent increase of capital accumulation, welfare never recovers in the long run to its income tax level. This is attributable to the fact that tax rates under the wage tax are higher than under the income tax, and these higher rates strike earlier in the life cycle when labour supply is more elastic.

The introduction of progressivity into the tax structure magnifies the above effects, the more so the more progressive is the rate structure. Other changes have less effect. Qualitative results are not too sensitive for the consumption tax, though the wage tax can be made welfare-improving for particular choices of utility function parameters, especially those involving lower labour-supply elasticities. Computations are also done for the case in which the central government is assumed to be able to make lump-sum redistributions among generations so as to avoid losses imposed during the transition. Simulations performed when these (unrealistic) transfers are allowed to take place also do not change the ranking of taxes in the long run.

As in Summers, these results are highly suggestive. They show that long-run gains can be obtained by moving to a consumption tax, but apparently partly at the cost of short-run losses. For the wage tax, a less likely reform in any case, long-run losses can occur if labour elasticities are high enough. As with any simulation work, results are only as reliable as the assumptions built into them. There are a number of reasons for exercising caution here, many of which were also pointed out above in connection with Summers' work. Only limited sensitivity was carried out here, and that was with respect to production and utility function parameters. No bequests were allowed, nor was the pure time preference rate allowed to vary. Technical progress was ignored and population growth was not allowed to vary. Most of Evans' other comments apply here as well. In addition, the manner in which consumption tax was substituted for income tax was rather extreme. It was assumed that from the point of transition, all future consumption would be fully taxed, even that arising out of wealth previously accumulated out of after-tax savings. It is actually quite a straightforward matter to phase in a consumption tax in a manner which avoids this retroactive type of taxation. More will be discussed about tax design in the following chapter.

Probably the most important lesson to be learned from these simulation exercises is that the effect on savings and welfare effects of reforming the tax on capital can be substantial. However, we cannot place a great deal of confidence in the results from simulations since they depend so much on the model used and its parameterization. That underlines the need for more empirical investigation of the savers' response to tax incentives. Before embarking on that for Canada, we first review the relevant characteristics of the Canadian tax treatment of capital income in the postwar period.

2 The Taxation of Households in the Canadian Tax System

Households are taxed in four main ways in Canada: by personal income tax, payroll taxes, commodity taxes, and property taxes. For the purposes of this study, we are primarily interested in the manner in which these taxes impinge upon capital income (t_r) and wage income (t_w). Those which are primarily taxes on consumption (t_c) are less relevant since, as we saw in Chapter 1, under the homotheticity assumption, consumption taxes do not affect the savings decision. We shall view the taxation of capital income under the personal income tax as being the main determinant of t_r, while t_w is determined by the combination of the personal tax on employment income and payroll taxes. Various commodity taxes, including provincial sales and excise taxes, the federal manufacturer's sales tax, and federal customs and excise taxes, are all taxes on consumption. Property taxes can also be thought of as taxes on the consumption of housing services, a component of t_c. In this chapter we review the tax treatment of capital and labour income under personal income and payroll tax systems, as it has evolved over the post-war period.

There are other taxes which primarily impinge on corporations such as the corporation income tax and various taxes on resources. We shall ignore the impact of these on household savings decisions. Any effect they have on savings would work through r, the market rate of return. In our empirical work, we shall treat r as exogenous by assuming that Canada is a small open economy in world capital markets.

Taxation of Capital Income

Capital income represents the return from holding assets. It can take several forms including interest on debt, dividends and capital gains on equity, business income on real capital, rent on real property and the imputed rent on owner-occupied housing and other consumer durables. The Canadian personal tax system is ostensibly a tax on all sources of income, but the income base taxed is far from "comprehensive income" as outlined, say, by the *Report of the Royal Commission on Taxation* (1966), the so-called *Carter Report*. Under a comprehensive income tax, all above sources of income (on an accrual basis and adjusted for inflation) would enter the tax base on a par with labour income and be taxed accordingly. Such is not the case in Canada. Apart from the fact that labour income bears some special payroll taxes not levied on capital income (see "Taxation of Non-Asset Income" below), there are several ways in which capital income is given preferential treatment over labour income. In this section we classify the special treatment of capital income into four categories and discuss each. They are the exemption of certain types of capital income from tax, the sheltering of savings, the preferential treatment of capital income and the non-taxability of imputed capital income. As we shall indicate, the existence of these various forms of special treatment of capital income makes the Canadian system of personal taxation as much a consumption tax as an income tax.[1]

Exempt Capital Income

Currently there are two sorts of explicit exemptions for capital income. The first $1,000 of interest, dividends and taxable capital gains is tax exempt and has been since 1974.[2] This exemption will affect the average tax rate on capital income for all persons earning such income. However, it will affect the marginal rate significantly only for persons earning less than the $1,000 limit. For them, the marginal tax rate on capital income is zero, while for persons earning above the limit, the marginal tax rate is the rate given by their income tax bracket. The fact that the nominal level of exemption has remained fixed at $1,000 while prices and incomes have been rising means that the real value of the exemption is falling. A lower proportion of taxpayers will be affected at the margin as time passes.

The other source of exempt capital income is the first $1,000 of pension income. Here again, for persons above the limit there is no effect on the marginal tax rate. One would expect this to include most retired persons. In this case, the exemption represents a windfall gain, the amount of which varies with the recipient's marginal tax rate.

One relevant aspect of the $1,000 pension deduction that might be noted for policy significance is that pension income on which the exemption is given is income accumulated out of sheltered savings. That is, contributions to pension funds are deductible from taxable income at the time and accumulate tax free. The $1,000 pension income exemption therefore represents a double deduction of capital income from the tax base.

Note that, to the extent that capital income is exempt from the tax base, the tax is like a progressive payroll tax. In present value terms, the base is equivalent to a consumption tax.

Sheltered Savings

The term "sheltered savings" refers to the fact that some sorts of savings may be deductible when made, accumulate tax free while in sheltered form, and become taxable in full when cumulated savings are taken out for use by the household. One of the well-known properties of the tax-sheltering of savings is that such sheltering is equivalent to the exemption of capital income on assets. That is, given the tax rate, the present value of taxes that a household pays would be identical if the household were allowed to exempt capital income on $x worth of initial savings as if the household were allowed to shelter the $x worth of savings. This has relevance for tax policy. A tax system which allows a taxpayer to shelter all his savings would be essentially an expenditure tax system. The tax base would be income less savings, or consumer expenditures. In present value terms, this expenditure tax system is equivalent to a tax system which exempts all capital income. For our purposes, sheltering of savings is equivalent to having a marginal tax rate on capital income on sheltered assets (t_r) of zero. The personal tax is a tax on consumption reflected in the consumption tax rate t_c.

In the Canadian tax system, there are, or have been, several vehicles for sheltering savings.

Registered Pension Plans (RPP)

Taxpayers who contribute to an employer-sponsored pension plan are able to deduct up to $3,500 per year in employee contributions to RPPs. The employer may, in addition, deduct up to $3,500 if the plan is a money purchase plan, or an amount sufficient to finance the maximum allowable pension benefits[3] in the case of defined benefit plans. There is, in addition, allowance made for past service contributions in certain cases where the taxpayer was unable to contribute in the past. RPP contributions are like sheltered savings in the sense that they accumulate tax free. However, they do differ from the sheltering of savings under a pure expenditure tax system. First, there exist upper limits which are defined in nominal terms and are not indexed to inflation. Secondly, savings held in pension funds do not benefit from such measures as exist to integrate the personal and corporate tax systems. They are not eligible for the dividend tax credit, for example. Thirdly, the funds are restricted to be held at least 80 per cent in Canadian assets. Finally, after retirement, sheltered funds must be converted to an annuity by age 70 whether or not they are used for consumption.

Deferred Profit-Sharing Plans (DPSP)

DPSPs are analogous to RPPs, except that they represent sheltered assets accumulated in the equity of the firm employing the taxpayer. The plan is funded by employers and the limits for deduction are similar. Up to $3,500 less contributions to RPPs may be deducted from the taxable income of the firm.

Registered Retirement Savings Plans (RRSP)

Contributions to RRSPs can be deducted to the extent of $5,500 (up to 20 per cent of earned income) for persons not in employer-sponsored pension plans. For those contributing to RPPs, the limit on RRSP contributions is $3,500 less RPP contributions. Sheltering of savings in RRSPs is basically similar to RPPs, except that the taxpayer has discretion over the timing of contributions. As with RPPs, limits are fixed in nominal terms.

Income-Averaging Annuity Contracts (IAAC)

Up to 1981, IAACs could be used as a short-term sheltering (and income-averaging) device for persons who had a large increment of income in a particular year due to royalties, sports salaries and the like. Contracts allowed for the lump sum to be spread over a number of years in a sheltered form. They were terminated with the November 1981 budget when a system of forward-averaging was instituted.

Registered Home-Ownership Savings Plans (RHOSP)

Taxpayers who have never owned a home before can contribute up to $1,000 per year to a cumulative total of $10,000 to sheltered assets for the purposes of saving to purchase a house. Unlike other forms of sheltered savings, the sheltered funds remain untaxed when they are used, provided they are used to finance a home purchase. Since a house itself is an asset whose return is untaxed (see below), sheltering of savings to purchase an untaxed asset represents more than a simple exemption of capital income; it also represents a subsidy on the purchase of the asset. The amount of the subsidy depends upon the marginal tax rate of the contributor. Thus the value of t_r in this case would actually be negative. This sheltering is not available to the general population, only to those who have not owned a home.

Quebec Stock Purchase Plan (QSPP)

In Quebec, taxpayers purchasing equity in Quebec corporations can also deduct the amount of their purchase from taxable income.

Overall, these forms of sheltering introduce varying amounts of expenditure taxation into the tax system. One might expect that, due to fixed limits, sheltering of savings will be more complete for persons with lower incomes. On the other hand, tax saving per dollar of sheltering will be higher for higher income groups whose marginal tax rates are higher.

It should be noted that, while under an expenditure tax system, capital income is effectively untaxed, it will also be the case that negative capital income (e.g., interest on debt) is not tax-deductible. Accordingly, currently in Canada interest on debt used to finance sheltered savings is not tax-deductible, while interest on debt used to finance assets whose return is taxable is itself tax-deductible. This is as it should be. However, prior to 1981, interest could be deducted on funds borrowed to finance sheltered savings.

Preferentially Treated Capital Income

Not all taxable capital income bears the same effective rate of tax as ordinary income. This is not due to differences in the actual rates that apply, but is a result of the fact that capital income does not enter fully into the tax base, as would be the case under a comprehensive income tax. The main reason is that certain types of capital income are not taxed on accrual but can be deferred until realization. For practical reasons, capital gains are taxed on realization rather than on accrual, which means that such gains can be accumulated tax free until they are finally realized. Certain types of interest-bearing assets also benefit from tax deferral. Canada Savings Bond interest is only taxed when it is taken in cash, and Guaranteed Investment Certificate interest can be taxed on a realization basis as well. A final example is life insurance. Interest on whole life policies accumulates tax free.

In addition to being taxed on a realization basis, only one-half of capital gains are taxable. Prior to 1972, they were not taxed at all. There are two sorts of reasons for this preferential treatment. The first is to compensate holders for the fact that some capital gains arise from retained earnings on which corporate taxes have already been paid. Thus it is a rough-and-ready form of integration. Secondly, in times of inflation, part of capital gains would typically represent only a rise in the nominal value of assets to keep pace with inflation. Since these gains do not reflect any rise in purchasing power, they should not be treated as income for tax purposes. In the absence of any indexing of the tax base, this preferential treatment of capital gains serves partly to relieve the illusory element in capital gains income. The half-taxation of capital gains only represents a rough way of accounting for these two problems.

Non-Taxable Imputed Rents

Some assets yield a return in the form of imputed rent rather than market interest. These rents do not enter the tax base as they would under a comprehensive income tax, and to that extent the return to savings held in these assets goes untaxed. The main example of this is the imputed rent on the equity held by a taxpayer in owner-occupied housing. (For mortgage-financed housing, there is tax paid since the borrower is unable to deduct mortgage interest from tax, but has to pay an interest rate to lenders which is sufficient to cover the tax payable on such interest.) Owner-occupied housing is but a special case, albeit an important one, of the non-taxability of imputed rent on consumer durables. The same principle applies to the ownership of automobiles, household goods, cottages, etc. Another sort of asset whose return is untaxed is cash balances. The demand for cash balances presumably yields the holder an imputed return reflecting the liquidity value the balances have to the consumer.

The inability to tax imputed rents easily represents one of the drawbacks of an income as opposed to an expenditure tax system. It implies that it is virtually impossible to have a fully comprehensive income tax system, and that any income tax system will inevitably discriminate among different sorts of capital income. Under an expenditure tax system, there is simply no need to worry about the imputed rents on durables and other assets. Because of the equivalence between expenditure taxation and the non-taxability of capital income, an expenditure tax system could simply ignore imputed rents by including the acquisition of such assets on a cash-flow basis (i.e., by not deducting the acquisition of such assets from the base and not taxing their returns).[4]

All in all, the taxability of capital income in Canada is highly varied. Some assets are treated on an income tax basis and their returns are fully taxed; others are treated on an expenditure tax basis and their returns are untaxed. Others are partially taxed; still others are subsidized. Any given household will likely hold at least some taxed and some untaxed assets in its portfolio. For our empirical work, what is relevant is the marginal tax rate applicable to an individual taxpayer since that is what determines his after-tax real rate of return for determining his savings behaviour. For that purpose, it will be useful to divide the population (or a given cohort) into two categories – those whose marginal savings are sheltered or bear no capital income tax, and those whose are not. Since there are upper limits both to the sheltering of savings in RRSPs and RPPs and to the exemption of capital income, the rational saver will want to exploit those limits as much as possible. Since RRSPs are completely at the discretion of the taxpayer, we can presume that any taxpayer who has not contributed to the limit in RRSPs will effectively have a zero marginal tax rate on capital income. If they have not exhausted their RRSP limit, they may still have exhausted their $1,000 capital income limit and be in a taxpaying position on non-sheltered capital income. However, we shall view them as being non-taxable at the margin of their savings since additional savings could be contributed to sheltered RRSPs at the margin. Capital income which has exceeded the $1,000 exemption will represent assets which have been accumulated in the past. For those who have exhausted their RRSP limit, they may still have a zero marginal tax rate if their existing capital income is below the $1,000 limit. If they are above the $1,000, we shall treat them as having a marginal tax rate associated with their tax bracket. One of the difficult empirical problems concerns the fact that what is relevant for the savings decision is not only the current after-tax rate of return, but that in the future as well. It is quite possible, indeed likely, that as households accumulate assets over their lifetime, they move from having a zero marginal tax rate on capital income to a positive one. Only if we can follow a householder through his lifetime can we establish the actual pattern of marginal tax rates on capital income. When only cross-sectional data are used, it will be necessary to make some arbitrary assumptions to arrive at expected after-tax real rates of return on which savings decisions are based.

It should be stressed that although it is the *real* rate of return that should determine the savings decision, that real return may not be independent of inflation when capital income is taxed. It is well known from the economics literature that, except in special circumstances, the real after-tax rate of return will vary with inflation. The special circumstances are that all persons bear the same rate of tax on nominal capital income. If that tax rate is t_r, the real after-tax rate of return on capital r^* may be written:

$$r^* = r(1-t_r) - \pi^e,$$

where π^e is the expected rate of inflation and r is the nominal rate of return. If all persons, both debtors and creditors included, bear the same rate of tax so t_r is a parameter for all, the real return r^* will stay constant with inflation if the nominal return rises by $1/(1-t_r)$ times the inflation rate. This is referred to as the *tax-adjusted Fisher Effect* (see Feldstein, 1976). Provided creditors incur the rate of tax t_r on nominal capital income and debtors can deduct nominal capital costs fully from income taxed at the rate t_r, the real return facing both will remain unchanged and inflation will be neutral.

There are, however, two reasons why inflation may not be neutral in the real world and may be expected to influence real rates of return. The first is that debtors and creditors may well face different marginal tax rates. For example, creditors may, on average, be in higher tax brackets than debtors. Or capital income may be taxable in the hands of creditors but not deductible by debtors, as in the case of housing. Conversely, capital costs may be deductible, for example, in the case of debt issued by a firm, but capital income may go untaxed in the hands of creditors if it is held in sheltered form (e.g., pension funds). For any of these cases, the real return cannot remain unchanged for everyone. Market forces will determine how the nominal cost of capital changes with inflation. In general, we might expect an increase in r^* for debtors whose costs of capital are not deductible (e.g., mortgage holders), and a reduction for those whose capital costs are deductible (e.g., corporations). Similarly, r^* should rise for creditors who obtain capital income in sheltered or untaxed form (e.g., pension funds), and r^* should fall for creditors whose nominal income is fully taxed.

The other reason why the real return may vary with inflation has to do with the openness of the economy to world capital markets. If Canada is a price taker in world markets, the real return paid on assets owned by foreigners (i.e., Americans) is essentially fixed.[5]

Taxation of Non-Asset Income

Non-capital earnings comprises a myriad of things. The most important components are income from employment (wages, salaries, commissions) and income from self-employment (business and professional income, income from farming and fishing). These earnings can be thought of as primarily labour income, although there is obviously a component of capital income in self-employment earnings. In addition to income from employment and self-employment, there are two other forms of income which we include in non-capital income - income transfers and social insurance. Income transfers include family allowances, welfare payments, Old Age Security (OAS) and the Guaranteed Income Supplement (GIS), provincial guaranteed annual income schemes for the elderly, war veterans pensions, and the like. Social insurance includes Unemployment Insurance (UI), Canada and Quebec Pension Plan benefits (CPP/QPP), and Workmen's Compensation schemes. In principle, in-kind social insurance such as Medicare could be included. There is considerable overlap between transfers and social insurance, and we have followed the arbitrary convention of including as social insurance those items at least partly "funded" by a contributory scheme. Thus CPP/QPP is thought of as social insurance, while OAS/GIS is treated as a transfer. Let us consider the treatment of each of these sources of income under the personal income and payroll tax systems.

The Personal Income Tax Base

First, consider how each of the four sources of non-asset income enters into the personal income tax base, with the deductions that are allowed in each case.

Employment Income

All earnings from employment enter fully into the tax base. However, certain deductions are allowed which represent the costs of earning the income. These include union and professional dues, a general employment expense of 3 per cent of earnings to a maximum of $500, other employment expenses, child care expenses in the case of working parents, tuition fees and an educational deduction of $50 per month for full-time students (these latter as costs of acquiring human capital). There is also a disability deduction ($2,360 in 1983 and indexed), an old age exemption of the same amount to persons over 64, and a deduction for medical expenses in excess of 3 per cent of income. (The latter is replaced by either a standard deduction of $100 or a deduction for charitable donations, whichever of the three is larger.)

Income from Self-Employment

Again, all income from self-employment is taxable, but deductions are allowed for business expenses of both a current and a capital nature. Current expenses include wages, fuel, materials and supplies, insurance, utilities, property taxes, rents, advertising, travel and any other expense of a current nature incurred in the process of generating income. Capital expenses include mainly a Capital Cost Allowance to account for depreciation of physical capital, and interest payments on debt used to finance the business. The rules for computing net income from self-employment are basically the same as those used to compute taxable business income for corporations. In general, business losses can be deducted from other income, or they can be carried back three years and forward seven years if need be (prior to 1983, this was one and five years).

Transfers

Most income transfers are included in taxable income. An exception to this is GIS. Since it is typically obtained only by persons in a non-taxpaying position, its non-taxable status is of little consequence. There are no deductions applicable to the earning of income transfers.

Social Insurance

Social insurance receipts, except those in kind, are also fully taxable in the year in which they are received. The financing of some of these transfers are by payroll tax (i.e., UI, CPP/QPP, Medicare). These payroll taxes, discussed below, are deductible from the tax base.

Personal Income Taxes

Taxes owing under the personal income tax are calculated in three steps. First, taxable income is obtained by aggregating the above sources of income and deducting from it a standard exemption and exemptions for a spouse, dependants, disability, and old age where applicable. The federal tax payable (Basic Federal Tax) is computed by applying the federal rate structure to taxable income. The level of exemptions and the tax brackets defined in the rate structure are indexed annually for inflation using the consumer price index.

Second, for all provinces except Quebec, the provincial income tax is calculated by applying a provincially determined tax rate to the Basic Federal Tax. The federal government collects these taxes on behalf of the nine provinces. Note that this method of calculation ensures that federal and provincial income tax bases are identical, and that the degree of progressivity inherent in the federal rate structure carries over to the provinces. Quebec is not party to this arrangement and collects its own personal income taxes.

Finally, certain tax credits are deductible from tax payable. They include the dividend tax credit, the investment tax credit, foreign tax credits, tax credits for contributions to federal and provincial political parties, and certain provincial tax credits. One thus arrives at taxes owing to the federal and provincial governments.

Payroll Taxes

Payroll taxes are taxes which are calculated on the basis of earnings from employment and, under some circumstances, from self-employment earnings as well. There are two main forms of payroll taxes, CPP and UI contributions. We discuss these in turn.

Canada Pension Plan Contributions

Virtually all employed and self-employed persons must contribute to the CPP (and thus are eligible for benefits). The contributions are a form of payroll taxation. A proportional tax rate of 3.6 per cent of earnings (shared equally between employers and employees) is applied to earnings in excess of an exemption level and up to an upper bound called "maximum pensionable earnings." In 1983, the exemption level stood at $1,800 per year and maximum pensionable earnings was $18,500. The limits rise annually at the rate of increase of average industrial earnings. The schedule of contributions is thus like a linear progressive tax and therefore progressive on earnings up to the maximum pensionable earnings level, but regressive thereafter. CPP contributions are tax-deductible.

Unemployment Insurance Contributions

UI contributions are compulsory for all employed workers. Contributions take the form of a proportional payroll tax on employment earnings up to a maximum, referred to as maximum insured earnings. Both employers and employees pay contributions with the rate for the former being 1.4 times the rate for the latter. The actual level of rates set is such that private sector contributions cover the operating costs of the scheme plus the normal benefits payable, other than regionally extended benefits. The latter is covered by the federal government out of general revenues. In 1983, employee contributions were 2.3 per cent of earnings up to $385 per week. Employers paid 3.22 per cent. Both sets of contributions are tax-deductible.

In the theoretical discussion of the previous chapter, we argued that if households behaved according to the life-cycle hypothesis, they would choose to consume a given proportion of their total wealth, where the latter consisted of the value of assets held at the time plus human wealth. Human wealth can be taken to be the present value of the future stream of non-asset income net of tax. We can think of that stream as including employment earnings, income from self-employment, income transfers and social insurance less the sum of personal income and payroll taxes paid. This stream is then discounted at the after-tax rate of return on savings. Ideally, this is the concept of human wealth we would like to use for empirical purposes in estimating the propensity to consume, and therefore to save, for various cohorts in the population.

3 Aggregate Saving in Canada

In this chapter we review the trends and the determining factors in Canadian savings behaviour and present some estimates for Canada of aggregate regression equations recently estimated for the United States. The chapter provides some empirical and econometric background for the main body of applied work in subsequent chapters of the study. It analyses aggregate savings behaviour as reported in the annual National Accounts data over the 1950-81 period.

Aggregate saving, defined as net national saving, is the sum of personal saving by households and unincorporated business, corporate (or "business") saving consisting of the undistributed profits of the corporate sector net of capital consumption, public saving by the consolidated government sector, and non-resident saving which consists of net capital inflows. We also consider the sub-aggregates of private saving (personal plus corporate) and domestic saving (private plus public).

After considering the descriptive statistics on Canadian savings in terms of saving to net national product (NNP) ratios, we examine the results of aggregate consumption studies. In particular, we examine Canadian versions of the Boskin (1978) and Summers (1982) studies which found a high real interest elasticity of saving in the United States.

Trends in Canadian Savings Ratios

The net national saving (NNS) rate, which is defined as the fraction of net national product saved from all sources (persons, firms, governments and non-residents), averaged 13.6 per cent in Canada over the 1950-81 period. This fraction varies over the 32-year time interval but it displays no significant time trend. Of the average NNS rate, 11.9 percentage points (or 88.5 per cent) came from domestic sources. The share of domestic saving (DS) in net national saving rose over the period with the largest rise coming in the last half of the period.

Of the average DS rate, 9.6 percentage points (or 81 per cent) came from private (i.e., non-government) sources. Private saving (PRS) rises significantly over the period both as a percentage of net national product and as a percentage of domestic saving.

Of the average PRS rate, 5.4 percentage points (or 56 per cent) came from persons and unincorporated businesses, as opposed to corporate sources.[1] The contribution of corporate saving (CS) to domestic saving (DS) averaged 4.2 percentage points (or 44 per cent) of private saving (PRS). In absolute terms, this component remained relatively constant (although it declined slightly in the latter part of the period), but it fell relative to private saving over the period. In other words, the rise in private saving relative to net national product mainly reflects the rise in personal saving (PES) relative to net national product.

These trends in Canadian savings by source are depicted in more detail in Tables 3-1 and 3-2 and Figures 3-1 and 3-2. Table 3-1 gives net saving according to source as a share of net national product by year along with decade and total period averages. Figure 3-1 plots the PES, PRS, DS, and NNS ratios. All ratios display a falling trend from 1950 to 1961, generally rising thereafter. The general upward trend in the PRS rate, which reflects increased personal saving, is particularly evident.

Table 3-2 presents personal, private, and domestic net saving as a percentage of net national saving by year and with decade and period averages. Figure 3-2 plots domestic, private, and personal saving as a fraction of net national saving.

Together these tables and figures give a fairly clear picture of the measured Canadian savings experience. Saving from all sources has not declined relative to net national product although it has fluctuated over the period, and the contribution to *measured* saving by source has changed over the period.[2]

In short, there does not seem to be a Canadian "savings problem." This is in contrast to the relatively sharp decline in U.S. saving rates that has attracted much attention and concern (*Economist*, 1986).

The Problem of Inflation and Measured Saving

Inflation distorts measured saving (MS) rates by source depending on whether the source is a net creditor or debtor in fixed-value financial securities. Part of saving by a creditor in fixed-value securities is needed

Table 3-1

Canadian Savings/NNP Ratios, 1950-81

Year	Personal (1)	Corporate (2)	Private (1) + (2) = (3)	Government (4)	Domestic (3) + (4) = (5)	Non-resident (6)	Net national saving (5) + (6) = (7)
				(Per cent)			
1981	9.4	2.6	12.1	0	12.1	2.0	14.1
1980	8.7	4.6	13.3	-0.9	12.4	0.7	13.1
1979	8.5	4.9	13.4	-0.7	12.6	2.1	14.7
1978	8.5	3.7	12.2	-1.9	10.4	2.3	12.7
1977	7.2	3.7	10.9	-0.7	10.2	2.3	12.5
1976	7.4	4.6	12.0	0.2	12.2	2.3	14.5
1975	8.2	3.5	11.6	-0.2	11.5	3.2	14.7
1974	7.5	3.7	11.3	4.7	15.9	1.4	17.3
1973	6.6	4.4	11.0	3.5	14.5	0.2	14.7
1972	5.3	3.8	9.1	2.7	11.8	0.6	12.4
1971	4.3	3.6	7.8	3.0	10.8	-0.2	10.6
1970	3.9	3.7	7.7	3.6	11.3	-1.1	10.2
1969	3.9	4.1	7.9	5.5	13.4	1.4	14.8
1968	3.7	4.7	8.4	3.9	12.3	0.4	12.7
1967	4.5	4.4	8.9	3.8	12.7	0.9	13.6
1966	5.2	4.5	9.7	4.4	14.1	2.0	16.1
1965	4.0	4.9	8.9	3.8	12.8	2.1	14.9
1964	3.4	5.1	8.5	3.1	11.7	0.8	12.5
1963	4.6	4.1	8.7	1.8	10.4	1.1	11.5
1962	4.4	4.0	8.4	1.6	10.0	1.8	11.8
1961	2.2	4.0	6.2	0.9	7.1	2.2	9.3
1960	2.6	4.0	6.6	1.1	7.7	3.0	10.7
1959	2.6	4.2	6.7	1.7	8.4	3.9	12.3
1958	4.2	4.9	9.0	-0.2	8.8	3.1	11.9
1957	3.5	4.4	8.0	3.1	11.0	4.2	15.2
1956	3.8	5.1	8.9	3.7	12.6	4.2	16.8
1955	3.4	5.4	8.7	2.3	11.1	2.3	14.4
1954	3.4	5.2	8.6	1.3	9.9	1.6	11.5
1953	6.0	5.0	10.9	2.4	13.3	1.7	15.0
1952	7.7	5.1	12.8	2.9	15.6	-0.8	14.8
1951	7.6	2.0	9.7	6.1	15.8	2.4	18.2
1950	5.3	3.0	8.3	5.1	13.4	1.7	15.1
Average:							
1980-81	9.1	3.6	12.7	-0.5	12.2	1.4	13.6
1970-79	6.7	4.0	10.7	1.6	12.3	1.3	13.6
1960-69	3.9	4.4	8.3	3.0	11.3	1.6	12.9
1950-59	4.8	4.4	9.2	2.5	11.7	2.3	14.0
1950-81	5.4	4.2	9.6	2.3	11.9	1.7	13.6

NOTE Some rows may not add up exactly due to rounding.
SOURCE Revenue Canada, CANSIM, University Base.

as compensation for the inflation-induced loss in the purchasing power of these assets. Thus "real" saving by the creditor, which excludes this component, is smaller than measured saving. On the other hand, "real" saving by debtors in fixed-value securities will be larger than measured by the same sort of reasoning.

In terms of the source of saving discussed in the previous section, personal and non-resident sources are net creditors, while corporate and government sources are net debtors. Consequently, at high rates of inflation, measured personal and non-resident sources overstate real saving by corporate and government sources. Note that the NNS rate includes all sources and is therefore unaffected by the inflation rate.

Implications of the inflation adjustment for the observed trends in saving by source are significant. The

Table 3-2

Canadian Savings by Source/NNS Ratios, 1950-81

Year	Personal	Private	Domestic
		(Per cent)	
1981	0.78	1.01	1.01
1980	0.66	1.02	0.95
1979	0.58	0.91	0.86
1978	0.67	0.96	0.82
1977	0.58	0.87	0.82
1976	0.51	0.83	0.84
1975	0.56	0.79	0.78
1974	0.43	0.65	0.92
1973	0.45	0.75	0.99
1972	0.43	0.73	0.95
1971	0.41	0.74	1.02
1970	0.38	0.75	1.11
1969	0.26	0.53	0.91
1968	0.29	0.66	0.97
1967	0.33	0.65	0.93
1966	0.32	0.60	0.88
1965	0.27	0.60	0.86
1964	0.27	0.68	0.94
1963	0.40	0.76	0.90
1962	0.37	0.71	0.85
1961	0.24	0.67	0.76
1960	0.21	0.54	0.68
1959	0.22	0.76	0.74
1958	0.35	0.76	0.74
1957	0.23	0.53	0.72
1956	0.27	0.53	0.75
1955	0.24	0.60	0.77
1954	0.30	0.75	0.86
1953	0.40	0.73	0.89
1952	0.52	0.86	1.05
1951	0.42	0.53	0.87
1950	0.35	0.55	0.89
Average:			
1980-81	0.72	1.02	0.98
1970-79	0.50	0.80	0.91
1960-69	0.30	0.64	0.87
1950-59	0.33	0.66	0.83

SOURCE See Table 3-1.

rise in absolute and relative (to NNS) savings rates by private (and particularly personal) sources is most pronounced after the late 1960s. This is a period of rising inflation so there is a good possibility that these upward trends are spurious rather than real. Similarly, the decline in the contribution to net national saving by governments which drops off sharply after the mid-1970s is, at least in part, spurious.

On the other hand, the rise in domestic relative to foreign sources of net national saving runs counter to the inflation-induced bias. Consequently, the rise in domestic contribution is probably understated by MS rates.

Adjusting the savings rates for inflation bias is a major job since the net value of outstanding fixed-value securities by source is required. If we ignore the inflation bias in the DS rate (i.e., assume, counterfactually, that Canada is neither a net debtor nor creditor in fixed-value securities), savings rates by each domestic source can be adjusted for inflation. To begin with, the Department of Finance publishes inflation-adjusted PES rates in its *Economic Review*. This publication reports ratios of saving to personal disposable income (PDI) and ratios of adjusted saving to adjusted PDI. We can calculate the PES adjustment relative to net national product according to the equation

$$\frac{A}{NNP} = \frac{PDI}{NNP}\left(\frac{s - s'}{1 - s'}\right), \tag{3.1}$$

where A is the inflation adjustment to personal saving, and s, s' are the unadjusted and adjusted PES rates reported in the *Economic Review*. Subtracting A/Y from PES to NNP rates given in Table 3-1 gives the inflation-adjusted PES to NNP rates of Table 3-3.

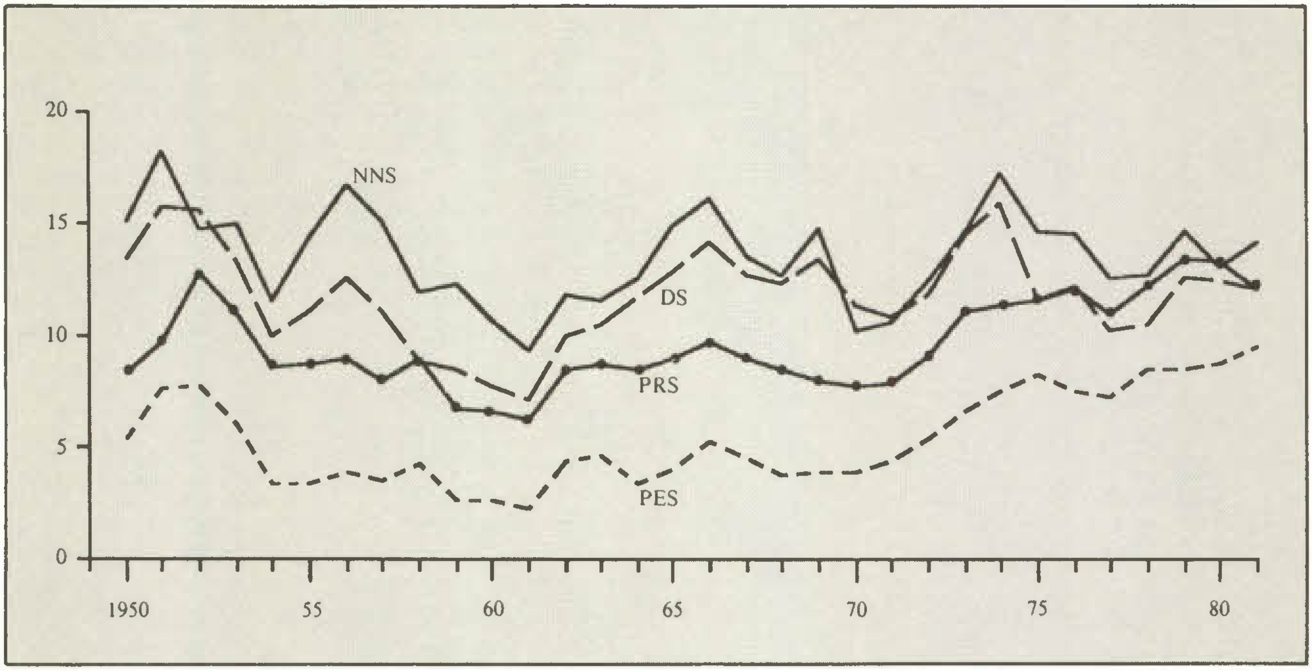
Inflation adjustments to PRS and GS rates are made using the inflation adjustment to the consolidated government deficit reported by the Department of Finance in *The Federal Deficit in Perspective* (1983). This adjustment is made on the basis of net fixed-value liabilities position of the consolidated public sector. Using this adjustment, we obtain the inflation-adjusted PRS and GS to NNP series in Table 3-3. Finally, we obtain the inflation-adjusted CS rate by subtracting the inflation-adjusted PES rate from the inflation-adjusted PRS rate. Further, the DS rate and the adjusted PRS and PES rates are diagrammed in Figure 3-3.

The main conclusion one can draw from the inflation-adjusted savings rates is that trends in MS rates by source seriously exaggerate the changes that have occurred in saving by source. The rise in the PES rate, while still evident, is far less pronounced. Moreover, real saving by corporations has actually increased relative to net national product. Also, the rise in private saving and fall in public saving, while real, is much less pronounced in the adjusted figures.

In summary, the NNS rate displays no significant trend in Canada. However, the contribution of domestic versus foreign sources has definitely risen, particularly in view of the downward bias in the measured domestic rate caused by increasing inflation. As for domestic saving, there has been a slight upward trend in all private sources relative to government sources, particularly after the mid-1970s. Overall, however, changes in savings rates have not been dramatic.[3]

Figure 3-1

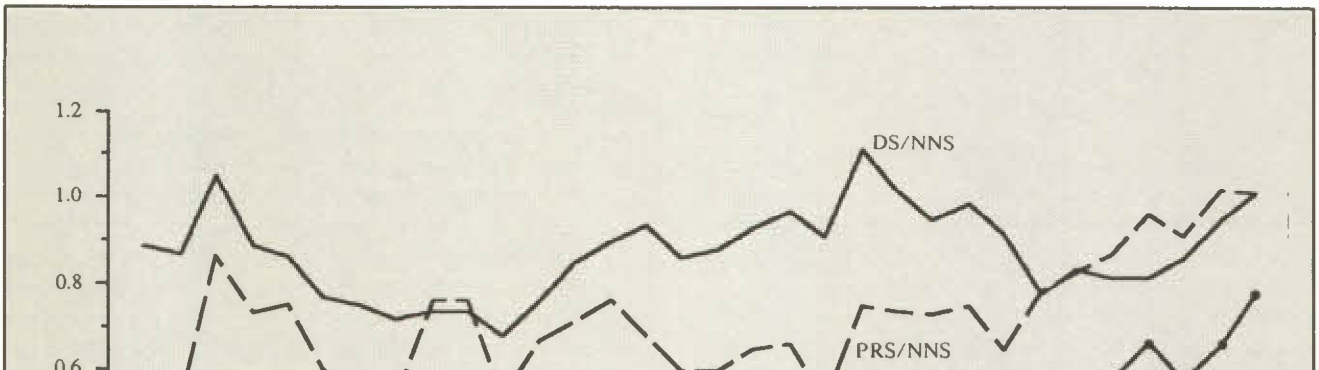
Canadian Savings/NNP Ratios, 1950-81



SOURCE See Table 3-1.

Figure 3-2

Canadian Savings by Source/NNS Ratios, 1950-81



SOURCE See Table 3-2.

Table 3-3

Inflation-Adjusted Savings/NNP Ratios, 1964-81

Year	Personal	Corporate	Private	Government	Domestic
			(Per cent)		
1981	4.0	5.8	9.8	2.3	12.1
1980	3.2	8.3	11.5	0.9	12.4
1979	4.1	7.7	11.8	0.9	12.6
1978	5.1	4.9	10.0	0.3	10.4
1977	3.2	6.6	9.8	0.4	10.2
1976	4.1	7.0	11.1	1.1	12.2
1975	3.9	6.7	10.6	0.8	11.5
1974	1.1	9.0	10.1	5.9	15.9
1973	2.1	7.8	9.9	4.6	14.5
1972	2.9	5.5	8.4	3.4	11.8
1971	2.6	4.7	7.3	3.5	10.8
1970	2.5	4.1	6.6	4.7	11.3
1969	1.5	n.a.	n.a.	n.a.	n.a.
1968	1.1	n.a.	n.a.	n.a.	n.a.
1967	2.3	n.a.	n.a.	n.a.	n.a.
1966	3.0	n.a.	n.a.	n.a.	n.a.
1965	2.5	n.a.	n.a.	n.a.	n.a.
1964	2.3	n.a.	n.a.	n.a.	n.a.
Average:					
1980-81	3.6	7.1	10.7	1.6	12.2
1970-79	3.2	6.4	9.6	2.6	12.1
1964-69	2.1	n.a.	n.a.	n.a.	n.a.

SOURCE Personal was adjusted using inflation-adjusted personal rates in *Economic Review*, 1984. Government was adjusted using inflation adjustment for consolidated government sector in *The Deficit in Perspective* (1983). Private and Corporate were then derived assuming there is no inflation adjustment required for domestic saving in total.

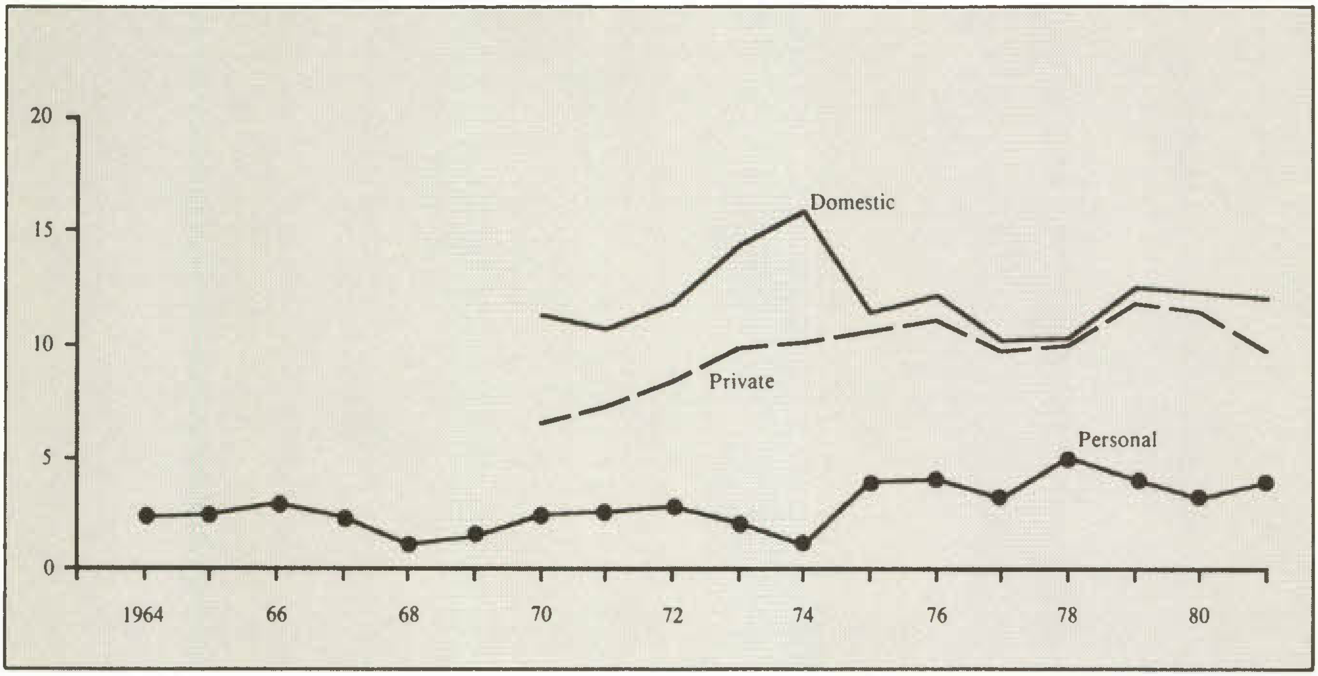
Aggregation of Savings Decisions by Source

When analysing savings behaviour, it is necessary to consider whether savings decisions by different sources are made independently. The issues here are sometimes framed in terms of whether households are, in fact, the ultimate savers who see through corporate and government "veils" and consider savings done by these sources as being done on their (the household's) behalf. We will define the "private-rational" case as the one where households see through the corporate veil in this way, and the "super-rational" case as the one where households see through both the corporate and government veils. The case of households seeing through the government veil has received considerable attention recently in connection with Barro's (1974) revival of the Ricardian public debt neutrality doctrine.

On the basis of *a priori* reasoning, there is no reason, even if households are "rational" in the above sense, that they should treat $1 saving done by another source as equivalent to private saving. At the corporate level, a household is probably able to calculate its share of current corporate saving based on its known holdings of corporate shares (unlike the case of government saving considered below); however, the tax treatment of corporate saving is generally different from that of personal saving. Specifically, corporate saving is a use of funds which are net of corporate income taxes but not of personal income taxes. Personal saving in non-registered assets is a use of funds which are net of all taxes. Thus an extra dollar of corporate saving would not compensate for an extra dollar of personal saving to the extent that personal saving is in non-registered (i.e., non-tax-deductible) forms. Also, personal taxes which are levied on the principal saved at the corporate level are uncertain to the individual household. This would prevent any simple relationship between corporate and non-corporate saving based on the personal tax rates of the household.

Figure 3-3

Inflation-Adjusted Savings/NNP Ratios, 1964-81



SOURCE See Table 3-3.

The simple equivalence of government and personal saving is even more problematic. Unlike the case of corporate saving, there is no simple way for the individual household to calculate its share of government saving on its behalf. The most natural way would be through tax rates, but it is future marginal tax rates which are relevant, and these are uncertain. Moreover, the household is ignorant of which future tax rates will be changed to satisfy the government budget constraint. Furthermore, unlike in the case of corporate saving where a household can sell off its shares, there is no way it can liquidate its "share" of saving done by the government. Consequently, government and personal saving are not equivalent to the extent that households face borrowing constraints even if we overlook the attribution problem.

While the above discussion militates against the view that corporate and government saving are perfect substitutes for personal saving, it does not imply that saving by each source is independent of saving by other sources. We now examine empirically the hypothesis that households take into account, at least to some degree, saving done at the level of the corporation and the government in making their own savings decisions. Specifically, we are interested in whether there is a negative relationship between the PES rate and those of the corporate and government sources.

A casual examination of Table 3-1 and Figure 3-1 gives some support to the hypothesis that households offset saving done by other sources. After 1960, the PES rate rose, while the GS rate and, to a lesser extent, the CS rate, fell. It should be stressed, however, that these trends are seriously biased by the inflation rate which is rising throughout the period. Recall that the government and corporate sectors are debtors in fixed-value securities, whereas the household sector is a creditor. Thus the trends displayed may simply reflect an increasing inflation rate which increasingly biases the CS and GS rates downward, and the PES rate upward over the 1970s.

To avoid this problem, we restrict our attention to the inflation-adjusted savings rates of Table 3-3 and Figure 3-3. We regressed the inflation-adjusted PES rate on the inflation-adjusted CS and GS rates. We also regressed deviations from trends in the same variables to eliminate secular influences. As Table 3-4 indicates, both corporate and government savings are significantly associated with reduced personal saving. Lest this reflect cyclical variations, we also include deviations from trend in the log of real net national product. Different variations were tried in an attempt to account for the negative relationships revealed. They are not reported here because no difference was found.

Table 3-4

Regressions of PES Rates on Saving Rates of Other Sources

(1) Dependent variable = *ASPE*

Constant	*ASC*	*ASG*		$\bar{R}^2$	$F(2, 9)$
5.67	−0.20	−0.48		0.82	21.16
(8.4)	(−2.0)	(−6.1)			

(2) Dependent variable = *DASPE*

Constant	*DASC*	*DASG*		$\bar{R}^2$	$F(2, 9)$
0.015	−0.29	−0.35		0.78	15.90
(0.118)	(−2.8)	(−3.4)			

(3) Dependent variable = *DASPE*

Constant	*DASC*	*DASG*	*DNNP*	$\bar{R}^2$	$F(2, 8)$
0.01	−0.56	−0.25	9.04	0.85	14.66
(0.09)	(−3.34)	(−2.18)	(1.932)		

NOTE *ASPE* = PES rate adjusted for inflation as a fraction of NNP.
ASC = CS rate adjusted for inflation as a fraction of NNP.
ASG = consolidated GS rate adjusted for inflation as a fraction of NNP.
NNP = log of real net national product (base year = 1971).
DX = deviation from linear time trend in variable *X*.
Figures in parentheses are absolute *t*-ratios.

Apparently, the table indicates that both the inflation-adjusted CS and GS rates are significantly and negatively associated with PES rates and, according to the $\bar{R}^2$, a significant fraction of the variation in the PES rate is explained by variations in savings rates by these other sources. Based on our preferred equation (3), an extra percentage point of corporate saving would reduce personal saving by over half a percentage point, while an extra percentage point of government saving would reduce personal saving by a quarter of a percentage point. While these tests are crude and do imply less than the full offset required by rationality, they do suggest caution in proceeding, as we do in this study, on the assumption that household savings behaviour is independent of that done by corporations and governments.[4]

Aggregate Consumption Behaviour in Canada

Aggregate savings behaviour is typically analysed by the estimation of aggregate consumption functions. There are three basic approaches which can be followed, of which two are followed in this study.

The first approach is the standard linear estimation of the consumption function. However, unlike the early Keynesian studies, careful attention should be paid to the independent variables used. Specifically, a wealth variable and a real interest rate are included as independent variables as suggested by consumer theory. The best example of this approach for the United States is that of Boskin (1978). Unlike earlier studies, Boskin found a large and significant negative effect of the real interest rate on consumption. This implied a high elasticity of saving with respect to the real interest rate; Boskin's preferred equation gave a value of about 0.4 for this elasticity.

The second approach is to estimate a structural life-cycle consumption function. This approach was followed by Summers (1982) and others for the United States. It allows one to directly estimate the elasticity of intertemporal substitution. Summers' estimation yielded values which supported Boskin's funding of a high interest elasticity of saving.

The third approach which is not pursued in this study is the so-called Euler equation estimation approach. The first-order conditions for lifetime utility maximization can be solved for a first-order difference equation in aggregate consumption. Estimated coefficients of this difference equation can be used to calculate the elasticity of intertemporal substitution. Estimation of these Euler equations has been done in the United States by

Hall (1978), although his primary concern lay in testing the so-called over-identifying restrictions rather than estimated intertemporal substitution effects.

In conjunction with this study, West (1984) estimated a standard (Boskin-type) aggregate consumption function and a structural life-cycle (Summers-type) aggregate consumption function using Canadian National Accounts data over the 1952-80 period.

Before proceeding to the results of the regressions, we will discuss the data used in estimating the aggregate equations of this chapter. Most of the data were drawn directly from the CANSIM University Base data set. Consumption, disposable personal income, and labour income are expressed in constant 1971 dollars per capita. The wealth series is the real market value of financial wealth constructed by Helliwell and used in the MACE econometric model. The after-tax real interest rate (R) was constructed using the federal government long-term bond rate (RL) as the nominal interest rate, a fourth-order autoregressive equation was used to generate the expected inflation rate, and a marginal tax of 30 per cent was assumed.

In order to take into account the role of sheltered saving, an attempt was made to derive the fraction of sheltered saving to private saving. Gross contributions (GC) to sheltered savings plans (including employer and employee contributions) to registered pension plans, registered retirement savings plans and registered home-ownership plans were taken from *Taxation Statistics* for the years 1952-81. Since interest on these assets accumulates tax free, we calculated the stock of sheltered saving (SW) according to the algorithm

$$SW_t = GC_t + (1 + RL_{t-1}) \times SW_{t-1}, \qquad (3.2)$$

where RL_{t-1} is the 5- to 10-year government bond rate. Tax-sheltered saving in year t is then calculated as $SW_t - SW_{t-1} = C_t + (RL_{t-1} \times SW_{t-1})$. This series of increments is shown as SS (sheltered saving) in Table 3-5. Also shown in Table 3-5 is the ratio of sheltered saving to private saving (the sum of personal and corporate saving) and the ratio of gross contributions to private saving.

The table shows that sheltered saving has risen as a fraction of private saving. This is partially because of the fact that reported contributions to sheltered savings plans have been rising relative to private saving, but mostly because of the implicit contributions to sheltered saving, as interest on these plans accumulates tax free. It should be noted that the SS/PRS series probably overstates the fraction of sheltered saving since it does not take into account withdrawals from these plans.

In any case, the fraction of unsheltered saving ($PRS - SS/PRS$) was used to calculate an adjusted tax rate by multiplying this fraction by 0.3, our assumed marginal tax rate. Thus an after-tax real interest rate was calculated as $R_t = RL_t\,[1\text{-}0.3(PRS_t - SS_t)/PRS_t] - \pi_t^e$. Also, another series $R_t = RL_t - \pi_t^e$ was calculated on the presumption that, at the margin, all saving is sheltered.

Table 3-6 is representative of the results one obtains using Boskin-type consumption function regressions with Canadian aggregate data, as estimated by West. The first equation uses a marginal tax rate of 0.3 × ($PRS - SS/PRS$), and the second equation uses a marginal tax rate of zero.

These estimates, which are based on Canadian annual aggregate data over 1953-81, are quite different from those Boskin obtained in the United States. The relationship between consumption and disposable income is larger and stronger than Boskin found. The interest-rate coefficient is positive rather than negative as expected, and insignificant. There is little difference found between assuming a zero marginal tax rate and a marginal tax rate equal to 0.3 times the fraction of unsheltered saving. Unexpectedly, the financial wealth variable enters with a significantly negative coefficient. Finally, the estimated first-order autocorrelation coefficient ϱ is significantly positive.

The next attempt at explaining aggregate consumption behaviour makes use of a life-cycle consumption function explicitly derived from a life-cycle utility maximizing model. The life-cycle consumption function, as derived by Summers, is of the form

$$C_t = \alpha + (\beta_1 + \beta_2 R_t)\,(A_t + \frac{YL_t^e}{R_t + \delta}), \qquad (3.3)$$

where C_t, YL_t^e, and A_t are consumption, expected labour income, and financial wealth in real terms per capita of the cohort, R_t is the relevant real interest rate, and δ is a risk coefficient for discounting future labour incomes. Summers ran regressions of this equation. However, this approach ignores cohort aggregation difficulties. In fact, the discount rate used in evaluating human wealth should be cohort-age-specific rather than as if labour income were received in perpetuity. We attempted to rectify this disregard of the aggregation problem in an ad hoc way. Specifically, we enter dependency ratios consisting of the percentage of the population under 20 and the percentage of the population over 65 in the marginal propensity-to-consume out-of-wealth term.

Table 3-5

Tax-Sheltered Savings, Canada, 1952-81

Year	Private saving (*PRS*) (1)	Gross contributions (*GC*) (2)	Sheltered saving (*SS*) (3)	(2)/(1)	(3)/(1)
1952	4,206.3	467.44	505.2	0.1111286	0.120110
1953	3,787.6	544.84	569.6	0.1438483	0.150382
1954	2,925.1	698.22	759.2	0.2386995	0.259557
1955	3,256.9	722.93	815.4	0.2219688	0.250364
1956	3,686.0	810.44	916.7	0.2198698	0.248689
1957	3,300.9	961.88	1,073.6	0.2913993	0.325242
1958	3,785.2	1,008.76	1,180.9	0.2665011	0.311971
1959	2,971.0	1,166.66	1,438.3	0.3926826	0.484108
1960	2,994.5	1,245.12	1,520.9	0.4158023	0.507907
1961	2,891.4	1,360.59	1,776.1	0.4705644	0.614257
1962	4,172.6	1,429.34	1,973.2	0.3425538	0.472887
1963	4,525.3	1,561.48	2,137.9	0.3450556	0.472437
1964	4,792.0	1,690.82	2,347.1	0.3528422	0.489804
1965	5,405.8	1,827.92	2,600.8	0.3381405	0.481114
1966	6,303.3	1,619.74	2,506.3	0.2569670	0.397626
1967	6,021.8	1,747.71	2,543.1	0.2902305	0.422320
1968	5,970.3	1,905.03	3,107.1	0.3190845	0.520426
1969	5,977.0	2,069.47	3,422.0	0.3462389	0.572528
1970	5,967.7	2,288.17	4,044.9	0.3834257	0.677805
1971	6,584.0	2,567.59	4,707.3	0.3899742	0.714966
1972	8,113.0	3,145.04	5,744.1	0.3876544	0.708009
1973	10,723.5	3,482.74	5,802.5	0.3247764	0.541101
1974	11,834.4	4,033.30	6,448.4	0.3408115	0.544886
1975	12,342.1	4,505.47	7,257.5	0.3650489	0.588027
1976	13,751.9	5,377.55	8,865.2	0.3910405	0.644652
1977	12,627.4	5,521.29	9,257.7	0.4372468	0.733146
1978	14,277.1	5,595.26	10,271.8	0.3919045	0.719459
1979	16,195.4	5,708.95	10,460.9	0.3525044	0.645913
1980	16,330.8	5,959.49	11,341.1	0.3649234	0.694462
1981	14,974.6	5,773.85	12,080.6	0.3855762	0.806737

SOURCE Revenue Canada, CANSIM, University Base, *Taxation Statistics*. Calculations by authors.

Table 3-6

Coefficients of Boskin-Type Consumption Function Regressions for Canada

(Dependent variable = log of real per capita consumption)

	Constant	R	log DPI	log $DPI(-1)$	log Wealth	ϱ
(1)	0.065	0.065	0.70	0.14	−0.026	0.44
	(3.46)	(0.59)	(11.69)	(2.30)	(2.90)	(2.64)
	$\bar{R}^2 = 0.998$ $F(4, 24) = 2{,}455$ $DW = 1.66$					
(2)	0.065	0.58	0.70	0.14	−0.26	0.44
	(3.45)	(0.51)	(11.67)	(2.29)	(−2.95)	(2.64)
	$\bar{R}^2 = 0.998$ $F(4, 24) = 2{,}447$ $DW = 1.66$					

NOTE Figures in parentheses are absolute t-ratios.

The specific regressed equation is:

$$C_t = \alpha + (\beta_0 + \beta_1 \cdot R_t + \beta_2 \cdot YDR_t + \beta_3 \cdot ODR_t)$$

$$(A_{t-1} + \frac{YL_t^e}{R_t + \delta}), \quad (3.4)$$

where YDR_t and ODR_t are the young and old dependency ratios. YL_t^e was calculated, as in Summers, as

$$YL^e = \gamma_0 \, ATLY_t + \gamma_1 \, ATLY_{t-1} + \gamma_2 + ATLY_{t-2}, \quad (3.5)$$

where $ATLY$ is after-tax labour income, $\gamma_0 + \gamma_1 + \gamma_2 = 1$, and A_t and R_t are calculated as in the Boskin-type regressions. This equation was estimated using non-linear least squares with a first-order autoregressive error adjustment. Some representative values of the coefficients of the marginal propensity to consume out of wealth are shown in Table 3-7.

Table 3-7

Coefficients of Summers-Type Consumption Function Regressions for Canada

	β_0	β_1	β_2	β_3
(1)	0.0004 (0.053)	0.005 (0.05)	−0.0006 (0.05)	−0.002 (0.55)
(2)	−0.011 (0.33)	−0.057 (1.38)	0.017 (0.36)	0.55 (0.30)

NOTE See Table 3-6.

It is evident from this table that none of the variables that determine the marginal propensity to consume out of wealth are significant. In equation (1), which uses the partially sheltered real interest rate, β_2 and β_3 have the expected signs for dependency ratios. However, the interest-rate coefficient (β_1) is positive. Note, however, that this only means that the marginal propensity to consume out of wealth is increasing in the interest rate (i.e., the intertemporal elasticity of substitution is less than one), not that consumption rises with the interest rate. This is because the "human wealth" effect is negative and may offset the marginal propensity-to-consume effect.

When the fully sheltered real interest rate is used, as in equation (2), the real interest-rate coefficient is insignificantly negative while the coefficients on the dependency ratios are positive, contradicting the *a priori* expectations.

West calculates the savings elasticities for the Boskin- and Summers-type regressions using various definitions of the interest-rate variable and without regard to the significance of the coefficients used. These elasticities range from −0.008 to +0.12 for the Boskin-type regressions, and from −0.15 to +0.78 for the Summers-type regressions. However, in both cases, the highest elasticities are obtained using a nominal interest-rate variable. Real interest-rate variables uniformly give savings elasticities which are close to zero or negative.

Further to West's study, Boskin- and Summers-type regression equations were estimated with a more carefully defined real interest-rate variable. First of all, an ARIMA model was fitted to the log of prices to derive the expected inflation-rate series. Then, a weighted average marginal tax rate across income classes and provinces was calculated from *Taxation Statistics*, and using the tax schedules for each year. There was little improvement in the significance of the coefficients or the fit of the regression in either case.

Concluding Remarks

In summary, estimates of Boskin- and Summers-type equations with Canadian aggregate data do not produce large and significant interest-rate effects on the consumption-savings decision, as U.S. authors found. Indeed, the highest savings elasticities with Canadian data were obtained with nominal interest-rate variables, whereas this type of "misspecification" yielded insignificant savings elasticities with U.S. data.

A consideration of the general savings trends in the two countries suggests why this is so. In the United States, the after-tax real interest rate fell in the 1960s and 1970s, as did the DS rates. In Canada, the same declining trend in the after-tax real interest rate (without adjustments for tax-sheltered saving) occurred, but the Canadian DS rate rose, if anything, over the period. If, however, an increasing fraction of Canadian savings could be tax-sheltered as seems likely from the data, the effective after-tax real interest rate in Canada may well have exhibited no significant trend. Thus the trends in savings rates and real interest rates that probably lie behind the strong Boskin and Summers results did not exist in Canada. In this sense, the divergence of Canadian savings rates from those in the United States may well be explained by Canadian tax policies toward saving.

4 Data Sources and Variable Construction

The last chapter looked at aggregate savings behaviour in Canada. We now turn to a more in-depth empirical analysis of disaggregative savings behaviour that makes use of age-disaggregated data and thus explicitly incorporates an age dimension in the empirical analysis of consumption and savings.

This chapter discusses data sources and the construction of variables subsequently used in the estimation of life-cycle savings behaviour in the Canadian context. The formal regression analysis based on these data series is undertaken in Chapters 5 and 6. The major data source for the empirical analysis is the annual volumes on *Taxation Statistics* published by Revenue Canada covering the 18-year period 1964-81. The principal disaggregation is by 10 age groups for each year, so that one can infer the life-cycle behaviour of various age cohorts for this period of time. These data allow us to separate age and time effects on savings, and to control demographic shifts in the age distribution of the population. This is particularly important in the case of Canada where demographic changes have been quite dramatic since the Second World War. The analysis can be viewed as an intermediate stage of disaggregation, lying between two extremes of purely aggregate estimates of consumption and savings functions based on National Income Accounts series, and purely disaggregate estimates based on longitudinal micro-data from Revenue Canada or elsewhere.

Results reported in this chapter involve the generation of several wealth series for the Canadian household sector, and thus provide a useful contribution to Canadian household accounts in their own right. The series may be usefully compared, for example, to standard sources in the area in such as King and Dicks-Mireaux (1982), the Statistics Canada surveys on incomes, assets, and indebtedness for 1964, 1970, and 1977, and the wealth estimates used by Helliwell in his MACE model and by Irvine (1980), and Wolfson (1977). The present series differ from standard sources in having a disaggregated age dimension for each of the years covered.

The basic data series constructed and used in the following empirical analysis are for human capital stock, unsheltered (non-human) capital stock, tax-sheltered (non-human) capital stock, and consumer expenditures. The first two sections of this chapter provide details on data sources and initial data generation. The next section describes the construction of the human capital stock series. The following sections review the generation of unsheltered and sheltered capital stock series. The consumption and savings series generated are then examined.

Data Sources

The empirical analysis in this study makes use of two general data sources. The first and major source is *Taxation Statistics, 1966 Edition - 1983 Edition*, referring to the years 1964-81, published annually by Revenue Canada. For each of these years, data from all tax returns are available for each of 10 age groups:

Under 25
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65 and over.

(See, for example, Table 4, pp. 106-113, of the *1983 Edition* for the year 1981.) The basic data matrix of the study thus consists of 10 age groups for each of 18 years - or 180 "cells" of observations. From *Taxation Statistics*, we obtain data on 12 series for each cell:

Total number of returns;
Capital income;
Miscellaneous income;
Sheltered savings;
Registered pension plan contributions;
Net earnings;
Transfers and social insurance;
Child tax credits;
Payroll taxes;
Income tax rate;
Total net tax payable; and
Other pensions or superannuation.

More complete descriptions of the components of each of these series are presented in Table 4-1. Precise

Table 4-1

Components of Basic Data Series

	Item
Total number of returns	3
Capital income	
Taxable amount of dividends	17
Bond interest	18
Bank interest	19
Mortgage interest	20
Income from trusts	21
Annuity income	22
Other Canadian investment income	23
Foreign investment income	24
Net rental income	25
Net taxable capital gains	26
Miscellaneous income	27
Sheltered savings	
Registered pension plan contributions	37
Retirement savings plan premiums	38
Registered home-ownership contributions	39
Registered pension plan contributions	37
Net earnings	
Wages and salaries	4
Commissions from employment	5
Other employment earnings	6
Net business income	12
Net professional income	13
Net commission income	14
Net farming income	15
Net fishing income	16
Minus (−)	
Union and professional dues	42
Education deduction	43
Tuition fees	44
Child care expenses	45
General expense allowance	46
Other expenses of employment	47
Other deductions	54
Transfers and social insurance	
Family allowance	7
Unemployment insurance benefits	8
Old age premiums	9
CPP or QPP benefits	10
Child tax credits	64
Payroll taxes	
CPP or QPP contributions	35
Unemployment insurance premiums	36
Income tax rate	
Basic federal tax	61
÷ Taxable income assessed	56
Total net tax payable	
Other pensions or superannuation	11

SOURCE: Revenue Canada, CANSIM, *Taxation Statistics, 1983 Edition*; reference to the item numbers in Table 4.

details on how each of the components are defined and what they include are available in the *Taxation Statistics* themselves.

The second general data sources are aggregate time series on interest rates and price level from CANSIM. The principal interest rate used is an annualized version of the rate on federal government bonds of 10 years' maturity or longer.[1] The general price level was represented by the annual Consumer Price Index (scaled to 100 in 1971). Thus in 1964, CPI took a value of 78.59, and it took a value of 236.99 by 1981, slightly over a threefold increase over the 1964-81 period.

Data Layout and Initial Data Generation

The basic data layout consists of a 10 × 18 matrix of data cells. Each cell contains an observation on each of the basic economic series. Each such observation is thus indexed by age group and time (year). If these two variables are viewed as axes in a diagram, then a given cohort can be thought of moving diagonally (45° to each axis) across the age-time plane. In three dimensions, the age-time plane represents the floor, and each of the variables in the 180 cells is measured in the height direction. Thus, for example, a slice of net earnings perpendicular to the time axis can be interpreted as an age-earnings cross section at a given year, and such a cross section can be expected to generally shift up over time. A given cohort of workers, then, can be thought of as travelling diagonally (to the age-time axis) across the top of a typically upwardly shifting earnings profile. Such a diagonal path travelled by a cohort will be referred to as a "trajectory."

To quantify the age and time "index" variables, two new variables were set up. One, called *TIME*, takes values 0 for 1964, 1 for 1965, . . . , 17 for 1981. The other, called *AGE*, indicates the typical age for each age-group interval and assumes the following representative values:

20 for age group under 25
27 " " " 25-29
32 " " " 30-34
37 " " " 35-39
42 " " " 40-44
47 " " " 45-49
52 " " " 50-54
57 " " " 55-59
62 " " " 60-64
68 " " " 65 and over.

In order to calculate real interest rates, an expected (annual) rate of inflation (*INFEXP*) was generated.

Box-Jenkins ARIMA methods were used on a quarterly CPI inflation-rate series over the 1949I-81IV period to predict five-year-ahead inflation-rate series that were then annualized. The particular ARIMA process employed in these calculations was (1,1,1)4(1,1,1) applied to the CPI log. Not surprisingly, the expected inflation-rate series is generally rising over the 1964-81 period.

The next step in the initial data set up is to transform all the income series into real per capita terms. Each observation of variables from the taxation data was divided by the CPI (base 1971) and by *NOBS*, the number of tax returns in each age group and each year data set. "Per capita" figures are thus in terms of dollars per tax-filer.[2] Sample means of some selected series are presented in Tables 4-2 and 4-3 to illustrate some of the general patterns by age and year. In Table 4-2, one can see that capital income and sheltered savings both increased very considerably (by 186 and 131 per cent, respectively) over the 1964-81 period, though both may appear to be relatively small. Neither, however, includes value of equity in housing or non-income-yielding inheritances since these are not reported on tax returns, and sheltered contributions refer only to those made by employees - employer contributions are viewed as deferred wages. Also, unincorporated business income is treated as earnings, although part is undoubtedly of a capital income nature. Capital gains, a component of capital income, include only those that are realized. Thus they do not fully reflect savings done by corporations on the owners' behalf (i.e., retained earnings). Real net earnings rose gradually until 1976 and then generally declined to a level not much different from that at the beginning of the series. Of all, transfers and social insurance rose most markedly - by 524 per cent over the period. It should be noted that one of the influences on these patterns of figures is the general trend over the period of an increasing proportion of income recipients who file income tax returns. The effect is to include increasing proportions of low-income recipients who often receive a large proportion of their income in the form of transfers and capital income. Total earnings per tax-filer would be expected to grow more slowly than per capita earnings in the economy as a whole.

In Table 4-3, the corresponding age patterns are indicated. Net earnings have a generally quadratic shape that peaks in the 40-44 year age interval. Capital income and sheltered saving strongly increase with age until the retirement age group, 65 and over, when capital income rises further while sheltered saving falls off. Transfers and social insurance remain at a relatively low level until retirement and then shoot up as well.

Generation of the Human Capital Stock Series

The first constructed capital stock series is that for human capital. This is estimated as the discounted present value of expected (real after-tax per capita) earnings over the rest of one's life. We are thus implicitly assuming rational expectations by individuals with respect to future earnings streams. The first step is to generate an expected earnings profile for each cell of the 10 x 18 table. "Earnings" for present purposes (*YEAT*) are defined as

(net earnings + miscellaneous income
+ transfers and social insurance
− payroll taxes)
x (1 - income tax rate),

where all income variables are in real per capita terms. Note, incidentally, that this series includes transfers and social insurance payments received during retirement. So "earnings" for present purposes is rather broadly interpreted to include all forms of anticipated future receipts.

Regressions were estimated for the *YEAT* log in terms of *TIME* and *AGE* across the 180 cells of the basic data matrix, and by weighted least squares to reflect the differences in the number of tax returns (or *NOBS*) in each cell (i.e., each observation was multiplied by the square root of *NOBS*). The results of two such equations are presented in Table 4-4. As can be seen, age-earnings cross sections are highly quadratic (with a peak age about 42), with the cross section generally shifting up over time (equation (1)) or shifting in concave fashion (peaking around 1977) over time (equation (2)). The fits of both equations are very good.

For purposes of projecting earnings profiles outside the estimation period, the simpler equation (1) was used to trace out an expected earnings trajectory (moving diagonally across the age-time plane) from a group's current age to age 72 for each cell in the basic data matrix.[3] The discounted present value of each of these predicted earnings streams was then calculated. The rate used to discount the stream was an after-tax real interest rate at the age at which the discounting begins:

$RL(1 - TRY) - INFEXP$,

where *RL* is the long-term (nominal) interest rate referred to above, *TRY* is the (average) income tax rate variable available in the basic data matrix, and *INFEXP* is the expected inflation-rate series that was previously generated.

Table 4-2

Selected Average Real Per Capita Income Components, by Year,* 1964-81

Year	Capital income	Sheltered saving	Net earnings	Transfers and social insurance
1964	371.7	113.7	4,969.6	57.2
1965	376.7	118.7	5,113.3	53.9
1966	360.0	110.1	5,092.1	60.1
1967	354.9	102.8	5,114.6	67.3
1968	388.2	108.9	5,206.9	75.6
1969	401.6	115.3	5,288.1	88.2
1970	430.2	125.5	5,386.9	102.5
1971	423.8	141.7	5,604.3	110.3
1972	472.8	181.6	5,572.4	254.6
1973	496.6	202.3	5,723.8	271.2
1974	581.8	235.4	5,850.2	395.1
1975	586.8	253.5	5,897.2	430.7
1976	632.6	301.1	6,105.4	423.5
1977	627.8	300.5	5,995.0	432.8
1978	718.5	268.2	5,210.9	418.9
1979	823.1	269.3	5,145.3	361.7
1980	962.7	278.9	5,158.8	369.2
1981	1,063.0	262.7	5,092.1	357.2

* In constant 1971 dollars.

Table 4-3

Selected Average Real Per Capita Income Components, by Age Group,* 1964-81

	Capital income	Sheltered saving	Net earnings	Transfers and social insurance
Age group:				
Under 25	38.2	41.0	3,108.5	108.9
25-29	68.8	136.1	5,378.9	145.2
30-34	121.9	183.1	6,354.7	152.0
35-39	208.4	213.8	6,844.1	170.6
40-44	320.8	234.8	6,959.1	173.8
45-49	463.2	261.0	6,853.0	154.8
50-54	634.7	283.7	6,538.0	134.7
55-59	848.3	290.0	5,992.1	133.2
60-64	1,135.3	245.9	4,877.3	158.6
65 and over	1,756.6	44.1	1,275.9	1,073.9

* In constant 1971 dollars.

The resulting estimated human capital stock series (*KH*) is summarized in Table 4-5, which presents averages by age group. As can be seen, the series shows a strong monotonic decrease with age in the value of human capital from over $240 thousand for the youngest group (in 1971 dollars) down to less than $10 thousand for the oldest age group. Averages by year are presented in the Table A-1 (see Appendix A). The series generally increases in somewhat jagged fashion up to 1974 or 1975 and then falls off somewhat.

Generation of the Unsheltered Capital Stock Series

The second constructed capital stock series is that for unsheltered capital. This is estimated by simply capitalizing up the flow of capital income to yield a capital stock:

$$KU = YKU/RL.$$

Table 4-4

After-Tax Real Per Capita Net Earnings Regressions

$$(1)\quad \ln(YEAT) = \underset{(93.0)}{5.729804} + \underset{(4.07)}{0.006485412}\,TIME + \underset{(44.6)}{0.1389142}\,AGE - \underset{(45.3)}{0.001647813}\,AGE^2$$

$\bar{R}^2 = 0.9214$ $\quad F(3, 176) = 687.6$ $\quad SSR = 2.04227$

$$(2)\quad \ln(YEAT) = \underset{(89.9)}{5.651464} + \underset{(4.74)}{0.02941024}\,TIME - \underset{(3.82)}{0.001267687}\,TIME^2 + \underset{(46.4)}{0.1393475}\,AGE - \underset{(47.1)}{0.001652999}\,AGE^2$$

$\bar{R}^2 = 0.9274$ $\quad F(4, 175) = 559.0$ $\quad SSR = 1.88545$

NOTE Figures in parentheses are absolute t-ratios.

Capital income consists both of interest on debt and dividends (and capital gains) on equity. In the case of interest, it is clear that, provided debt is not indexed, interest payments reflect the nominal return to wealth. That is, they incorporate any payment to compensate for the fall in the real value of debt. This means that in computing the value of wealth held as debt, it is appropriate to capitalize interest payments using the nominal interest rate. With equity, matters are not so simple. One could think of shares as indexed assets with share values rising at the rate of inflation and dividends reflecting a real return. If this were the case, it would be appropriate to capitalize dividends at the real interest rate to arrive at the value of shares. However, the empirical evidence of Modigliani and Cohn (1979) appears to indicate that stock markets actually capitalized dividends at the nominal interest rate. Therefore, we have opted to capitalize all capital income using the nominal interest rate.

The resulting capital stock series is summarized in Table 4-6 which again presents averages by age group. As is evident from the figures, unsheltered capital stocks are estimated to rise monotonically with age from less than $500 for the youngest group to about $25 thousand for the oldest group. Comparing the results in Tables 4-5 and 4-6, one can see that human and unsheltered capital stocks move in exactly opposite directions over the life cycle of workers. For young workers, human capital stocks are about 500 times larger than unsheltered capital, while for the oldest age group unsheltered capital accumulation is about three times larger than remaining human capital which is almost depleted. Year-to-year averages (see Table A-2) generally increase over time in uneven fashion, and are less than one-tenth the size of the averages for human capital.

Table 4-5

Estimated Average Real Per Capita Human Capital Stock, by Age Group,* 1964-81

Age group:	
Under 25	243,748
25-29	221,054
30-34	196,227
35-39	165,990
40-44	132,892
45-49	100,001
50-54	69,957
55-59	44,633
60-64	24,926
65 and over	8,548

* In constant 1971 dollars.

Table 4-6

Estimated Average Real Per Capita Unsheltered Capital Stock, by Age Group,* 1964-81

Age group:	
Under 25	482.8
25-29	864.1
30-34	1,540.2
35-39	2,666.1
40-44	4,135.2
45-49	6,009.7
50-54	8,324.3
55-59	11,260.0
60-64	15,209.0
65 and over	24,540.0

* In constant 1971 dollars.

Generation of the Sheltered Capital Stock Series

The third constructed capital stock series is that for sheltered capital. This is estimated as the accumulated present value of past sheltered savings or contributions. These consist of RPP, RRSP, and RHOSP contributions.

Once again, the first step is to generate a predicted trajectory of past (real per capita) sheltered savings (*SHSAV*). To do this, weighted regressions were estimated on *ln(SHSAV)* across 162 cells in the basic data matrix (i.e., without including the retired groups, which are assumed not to contribute any more). Regressions again included linear and quadratic functions of *TIME* and *AGE*. Regression results for two such equations are provided in Table 4-7. Again the fits are quite good with *AGE* having a marked concave quadratic effect; age-savings cross sections peak about age 49. Interaction terms between *AGE* and *TIME* were generally not significant and thus not included. Age-savings cross sections are also estimated to shift up rapidly over time - either at a constant rate of 7.4 per cent in equation (1) or at a rapid but declining rate in equation (2): 11.1 per cent in 1964 down to 2.9 per cent by 1981. The simpler equation (1) was used in the present stage of projecting outside the estimation period. The equation was used to trace out an estimated sheltered savings trajectory from the current age back in time to age 18 for each cell in our basic data matrix.

One difficulty with this procedure is that the figures in the *Taxation Statistics* volumes from which this equation was estimated refer to *gross* sheltered contributions. For accumulation purposes, however, relevant contribution figures are *net* of withdrawals and collapses. Using unpublished sources, Revenue Canada has estimated that, in 1982, RRSP withdrawals and collapses amounted to 15.26 per cent of sheltered savings contributions. Consequently, all the predicted sheltered savings trajectories have been scaled down by this proportion.[4]

The next issue is the treatment of interest rates in calculating the current value of a trajectory of past sheltered savings. Ideally, one ought to use a different interest rate for each year in a trajectory. But the resulting computational burden would be severe. Consequently, an average (nominal) interest rate is calculated over the years of each trajectory, and this constant rate is applied to the entire trajectory.

Each cell in the 10 × 18 data matrix, then, has a past sheltered savings trajectory calculated for it (back to age 18). The current cumulated present value of this stream of past sheltered (net real per capita) contributions is then calculated. For the oldest age group, contributions are assumed to continue only up to age 64, and the sheltered capital stock then rolls over at current interest rates until age 68 (the representative age of this group). It is then converted into an annuity and appears as pension income in the data series.

Results of these calculations are summarized in Table 4-8 by age group. Once again, the figures increase monotonically with age from less than $100 for the youngest group to almost $7 thousand for the oldest. Sheltered capital can thus be seen to follow a similar pattern to that of unsheltered capital stocks in Table 4-6. However, sheltered capital is only one-third to one-quarter the size of unsheltered capital. Year-to-year averages in sheltered capital holdings (see Table A-3) increase steadily over the entire period, but are less than 5 per cent of average human capital stocks.

Table 4-7

Real Per Capita Sheltered Savings Regressions

(1) $ln(SHSAV) = \underset{(2.67)}{0.4547570} + \underset{(19.4)}{0.07372491}\ TIME + \underset{(23.6)}{0.2231197}\ AGE - \underset{(18.7)}{0.002271096}\ AGE^2$

$\bar{R}^2 = 0.9206$ $F(3, 158) = 610.6$ $SSR = 9.49275$

(2) $ln(SHSAV) = \underset{(3.32)}{0.5816421} + \underset{(7.32)}{0.1106234}\ TIME - \underset{(2.52)}{0.002044556}\ TIME^2 + \underset{(24.1)}{0.2239009}\ AGE$
$- \underset{(19.1)}{0.0002280639}\ AGE^2$

$\bar{R}^2 = 0.9237$ $F(4, 157) = 475.1$ $SSR = 9.12345$

NOTE Figures in parentheses are absolute *t*-ratios.

Table 4-8

Estimated Average Real Per Capita Sheltered Capital Stock, by Age Group,* 1964-81

Age group:	
Under 25	99.5
25-29	524.1
30-34	1,035.2
35-39	1,740.4
40-44	2,609.6
45-49	3,552.0
50-54	4,436.3
55-59	5,131.8
60-64	5,550.9
65 and over	6,927.4

* In constant 1971 dollars.

Generation of the Consumption Series

The final series to be constructed is that for consumption. We do this in two separate ways. First, we calculate a series for cash-flow consumer expenditures. This is calculated as after-tax income minus savings, where unsheltered savings are generated from the change in stock of unsheltered assets (sheltered savings are observed directly). Consumer expenditures can be related to incomes and assets by the flow identity:

Consumption = after-tax cash-flow income
− net sheltered savings
− unsheltered savings
= (net earnings + capital income
+ miscellaneous income)
+ (transfers and social insurance
+ child tax credit
+ other pensions and superannuation)
− (income taxes + payroll taxes)
− (sheltered savings
+ unsheltered savings).

All the right-hand-side variables except the last one are available for each of the 180 cells of the basic data matrix of this study. If an estimate of unsheltered savings can be obtained, then consumer expenditures are generated from the above identity.

The estimation of unsheltered savings is not a straightforward matter. What taxation data reveal directly are the flows of returns to unsheltered savings, i.e., capital income (interest, dividends, and capital gains). Our procedure is to capitalize the flow of capital income into a wealth series and to infer from the movement of the wealth series over time how much savings was done. This is not altogether straightforward since calculated wealth changes over a taxpayer's life-cycle trajectory can occur for three distinct reasons. First, wealth changes can occur because of the acquisition of new assets through saving. Second, wealth changes can occur because of real interest-rate changes. Third, wealth changes can occur due to changes in the CPI. Our procedure is to attempt to purge observed wealth changes of those components arising from interest-rate and price level changes and be left with that due to savings in an unsheltered form.

The steps in the procedure are as follows. The estimated unsheltered capital stock series similar to that discussed above is used to predict the real value of unsheltered savings along a trajectory of a typical taxpayer.[5] These predicted real capital values are converted to nominal terms by multiplying by the CPI. The result is a series for predicted nominal wealth for a taxpayer of age t in year t which we can write as:

$$KUN(t,\ t) = YKUN(t,\ t)/R(t),$$

where N reflects the fact that these are in nominal terms. Changes in the nominal value of wealth from year to year can be derived as follows:

$$\Delta KUN = \Delta\ (\frac{YKUN}{R})$$

$$= \frac{\Delta YKUN}{R} + \frac{YKUN}{R}\ \frac{\Delta R}{R}$$

The first term represents nominal changes in wealth resulting from savings, while the last is that arising from interest changes. Expanding the first term, we obtain:

$$\frac{\Delta YKUN}{R} = \frac{YKUN(t,\ t) - YKUN(t\text{-}1,\ t\text{-}1)}{R(t\text{-}1)}$$

$$= \frac{R(t)}{R(t\text{-}1)}\ KUN(t,\ t) - KUN(t\text{-}1,\ t\text{-}1).$$

Values for KUN are those obtained from the estimated values for KU. This gives us current dollar unsheltered savings. To convert that into constant dollar unsheltered savings for the purpose of computing consumption, we deflate by the CPI:

$$SU(t) = [\frac{R(t)}{R(t\text{-}1)}\ KUN(t,\ t) - KUN(t\text{-}1,\ t\text{-}1)]/\text{CPI}.$$

Using $SU(t)$, a "raw" consumption series is generated for the 170 cells of the basic data matrix corresponding to the years 1965-81.

The above procedure is not without its difficulties and it would be worth pointing out some of them here. We have already mentioned that equity income is capitalized using the nominal interest rate which seems to accord with empirical evidence. In theory, however, one might argue that the real interest rate would be more appropriate. Next, the procedure used to purge the series on wealth changes of the component due to interest changes is valid only for long-term securities. For short-term assets (e.g., bank accounts), the appropriate measure of nominal savings is really $\Delta\ (YKUN/R)$ rather than $\Delta YKUN/R$. To the extent that capital income is on short-term assets, our savings series would be underestimated. We have done our computations with and without the interest-rate correction and find little difference in the results. Next, in the case of equity income, part of the increase in the flow of dividends to a taxpayer is due to past retention of dividends for reinvestment rather than the purchase of shares by a taxpayer. While one might legitimately view such retentions as being savings done on the taxpayer's behalf, such retentions are neither being included as savings in the year in which they are done nor as income to the taxpayer. Instead, some of the dividends received reflect past retained earnings. This is likely to make our estimate of unsheltered savings done by the taxpayer too high. Finally, some of what is reported as business income is undoubtedly of a capital nature whereas we have included it all as earnings. If so, changes in this income partly reflect a taxpayer's savings. Our estimates of unsheltered savings will be too low on that account. Since some of the above tend to cause our series to be underestimated and others to be overestimated, it is not clear on balance what the net effect will be.

The resulting estimated consumption series are summarized in the first column of Table 4-9 by age group, again in real terms. As can be seen, the series all move in fairly smooth fashion across age and time. Estimated consumer expenditures follow a general concave quadratic pattern that is lowest for the extreme age groups and peaks around 40 years of age. The series then generally decrease from this peak with a marked fall-off in retirement years.

The difficulty with these consumption data is that, since they are calculated on a cash-flow basis, they include expenditures on consumer durables rather than on the services of those durables. We have therefore also attempted to construct a series on consumer expenditures excluding the purchase of durables. In principle, the way to do this is to include the acquisition of equity in durables as savings rather than consumption. Unfortunately, the *Taxation Statistics* data we are using do not offer any information concerning the accumulation of durables and other personal property. For that we need annual wealth data by age group, which is not available in Canada. We do, however, have such data for 1977 from Statistics Canada's Survey of Income and Wealth. This source of data gives proportions in which households hold their wealth in the forms of financial and non-financial wealth over various segments of their life cycles (Statistics Canada, 1980). For this purpose, non-financial wealth includes housing, automobiles, non-housing real estate, and unincorporated businesses. We have calculated that, for 1977, the ratio of non-financial net worth to financial net worth (*KUN/KU*) over the life cycle is as follows:

Under 25	2.692
25-34	3.893
35-44	4.036
45-54	4.711
55-64	2.602
65 and over	1.582.

As can be seen by these figures, the proportion of wealth held as non-financial initially rises, then falls later in life. Persons accumulate equity in housing and other forms of non-financial wealth early in life and then convert it into a financial form later in life and into retirement. This phenomenon explains why our cash-flow consumer expenditures follow a similar life-cycle pattern and why we observe in our data a marked tendency for financial income to rise later in life. From the earlier 1970 data, we can detect a similar pattern of life-cycle wealth allocation. Since it is presented in a slightly different form, we are unable to use it along with these data. Therefore, all our calculations are done using the 1977 data above.

Table 4-9

Estimated Average Real Per Capita Consumption, by Age Group,* 1964-81

	Total consumer expenditures	Non-durable expenditures
Age group:		
Under 25	2,752	2,553
25-29	4,468	4,023
30-34	5,152	4,431
35-39	5,418	4,334
40-44	5,338	3,834
45-49	5,038	3,120
50-54	4,579	2,346
55-59	4,050	1,705
60-64	3,381	1,213
65 and over	2,093	838
Overall	4,227	2,840

* In constant 1971 dollars.

To correct our consumption series for the accumulation of non-financial wealth is a straightforward matter. First, we use the above ratios to fit a quadratic expression relating the ratio KUN/KU to age. The fitted equation allows us to predict the ratio of non-financial to financial wealth at each age, $KUN(t)/KU(t)$. These predicted values are then used to convert our earlier calculated unsheltered capital stock series $KU(t)$ into a series for the sum of unsheltered capital and non-financial wealth, $KUT(t)$, where:

$$KUT(t) = [1 + KUN(t)/KU(t)]KU(t).$$

This wealth series is then used in place of $KU(t)$ to generate wealth estimates for use in the consumption function and consumption estimates. The consumption series thus generated will be consumption expenditures on non-durable items alone. It is used as the dependent variable in one of our sets of estimates of consumption functions.

The second column of Table 4-9 indicates the pattern of consumer non-durable expenditures by age group aggregated over all years. As can be seen, these numbers are everywhere smaller than total expenditures and peak at a somewhat earlier age. Of course, part of the reason for this observed pattern, as well as that of the first column, concerns the effect of changes in the average level of consumption over time as well as age.

5 Regression Results and Evaluation

The objective of this chapter is to investigate formally the sensitivity of consumption and hence savings to interest rates, age and wealth by means of regression analysis in a life-cycle framework. The basic model is the formal life-cycle theory developed in Chapter 1 that included explicit introduction of tax rates into the analysis. That model makes rather strong assumptions about the rationality and foresight of household. Consequently, we also include in the analysis regressions based on much more naive models of life-cycle behaviour. We also focus our empirical work in this study on just consumption and savings behaviour. Labour-supply effects of interest-rate changes would constitute a further study of its own, and our data set does not allow inquiry into this question. The preceding chapter described the construction of the basic variables and data series to implement an empirical analysis of the life-cycle consumption-savings theory. We now seek to bring the two together to test the validity and usefulness of such an approach, and to provide actual estimates of life-cycle savings behaviour. These estimates will provide the basis for simulating the effects of various tax changes on savings and asset accumulation individually and in the aggregate.

The life-cycle consumption-savings estimates presented in this chapter represent a significant advance upon Summers' (1982) estimates for the United States in that the present data set has a cross-sectional age-cohort dimension that allows for explicit introduction of age effects into the estimated consumption function. Summers, in contrast, implements his theoretical model of life-cycle consumption with estimates from an aggregate data set that does not include an age or other demographic variable. Our estimates can be viewed as a much more realistic implementation and test of this type of model. We are thus especially interested in the impact of introducing an age variable into the empirical analysis of such a model. This is important in analysing the effects of tax changes since, as is now well known (e.g., Kotlikoff, 1984), most interesting tax changes have differential wealth impacts by age as well as interest-rate effects.

While Summers bases his consumption function estimates on only 29 observations of aggregate National Accounts data, the present study exploits a much richer data set of 180 observations pooled across 10 age groups for each of 18 years (1964-81). The present estimates also incorporate the shifting demographic weights of the changing age distribution of the population over this period. This will be exploited more fully in a later chapter on simulation. Finally, Canadian estimates represent a useful contribution to the life-cycle savings literature because interest rates for such a "small open economy" can be reasonably treated as exogenously determined on the world market. As a result, we need not "instrument them out" by some instrumental variables estimation procedure, as Summers does for the United States. The following Canadian estimates are thus cleaner of the variation associated with such proxying procedures.

It may be useful to link our empirical work with recent work on the permanent income hypothesis. As Hall (1978) points out, if the permanent income theory is interpreted as forward-looking rather than being based on past values of income, the life-cycle hypothesis and permanent income hypothesis can be viewed as alternative ways of expressing the same basic theory. In the latter case, consumption is viewed as determined by the flow of "permanent income" arising from or sustainable by this wealth. The general literature on the permanent income theory may be *usefully* viewed in such recent macro-economics texts as Barro (1984) and Hall and Taylor (1986). Following Hall (1978) or Flavin (1981, 1985), one can interpret permanent income, YP, as a constant annuity which (in the absence of bequests) just exhausts the stock of life-cycle wealth, K, at time of death:

$$YP + \frac{YP}{(1+R)} + \ldots + \frac{YP}{(1+R)^T} = K$$

evaluated at the discount interest rate R. Solving for YP:

$$YP = \Theta(R,T) \cdot T,$$

where the proportionality factor,[1] $\Theta(R,T) = R(1+R)^T/(1+R)^{T+1} - 1$. Thus in place of K in the empirical work of this study, one can use $(1/\Theta)YP$ and express the analysis in permanent income terms. If $\beta(R,T)$ is the marginal propensity to consume out of life-cycle wealth, then β/Θ is the corresponding propensity to consume out of permanent income. Consequently, all the results expressed in terms of the life-cycle formulation in the following chapters could also alternatively be expressed in terms of the permanent income formulation.

Variables that appear in the empirical analysis of this chapter are listed and defined in Table 5-1. Of particular importance for the empirical analysis is variable *T* which represents age effects in the regressions. Clearly, age effects are simply minus the coefficients on *T*. It should be pointed out that variable *A* is interpreted as non-human or material wealth or net worth. It is thus the net difference between gross value of assets and debts. Consequently, it would be expected to vary smoothly over the life cycle and not shift dramatically with the acquisition or disbursement of major assets. Note also that the (real after-tax) interest rate has been constructed as

$$R = RL(1 - TRY) - INFEXP,$$

where *RL* is a nominal rate, *INFEXP* represents inflationary expectations, and *TRY* is the tax rate which applies to nominal interest.[2] Thus capital income tax rate effects can be seen to operate through interest-rate effects.

The next section reports the basic regression results of the study. The following section examines some "naive" or non-forward-looking life-cycle regressions as an alternative specification for comparison with our own results. Regression results on consumption functions for separate age groups are presented in Appendix B. The pattern of coefficient changes across equations highlights the life-cycle pattern of interest-rate effects in a relatively unrestricted fashion. Some formal tests of the life-cycle model and the naive equation specifications are reported in Chapter 6. Various estimated effects and simulations, especially those involving interest-rate and tax changes, follow in Chapters 7 and 8.

Regression Results for the Basic Equations

The basic consumption function being estimated is equation 1.31 in Chapter 1. Per capita consumer expenditures at a point in time are viewed as being proportional to total life-cycle wealth, *K*, composed of both human and non-human components. The marginal propensity to consume wealth is a function of age and real interest rates. Specifically, it is expected to increase with age, while its response to interest-rate changes was shown to be indeterminate *a priori*. That is,

$$\frac{\delta MPC}{\delta T} < 0 \text{ and } \frac{\delta MPC}{\delta R} \gtrless 0.$$

Since the marginal propensity to consume wealth is a very complicated non-linear function of *R* and *T*, we have followed Summers (1982) by simply taking a linear function (plus interactions) and interpreted this as a first-order approximation to the theoretical *MPC* function.[3] Since this is an approximation, we also follow Summers in adding an intercept term to the equation to allow data to retain or reject its inclusion. Total life-cycle wealth, in the present study, consists of three separate components - human capital (*KH*), unsheltered stock of assets (*KU*), and sheltered assets (*KS*) - which are summed and entered simply as *K*.

Consumption function specifications in this section are viewed as structural form equations rather than reduced forms. That is, their derivatives represent direct or impact effects as opposed to full-model total effects where consumption and other macro-economic variables are all considered simultaneously determined. Alternatively, one could view the analysis of this chapter as sectoral in nature where one is focusing on the consumption sector alone. Full dynamic effects are considered later when simulations are undertaken.

Equations are estimated over the 1964-81 period (i.e., 180 observations). Estimation was done by linear least squares or by least squares where necessary. The first or basic regression equation estimated is of the form:

$$C = \alpha + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T) \cdot K + u, \qquad (5.1)$$

where *u* is an additive error term. The marginal propensity to consume is the expression in parentheses which also includes an interaction term between *R* and *T*. Regression results are presented in Table 5-2. Four sets of results are provided in the table. The first two columns refer to consumer expenditures on a cash-flow basis which include the purchase of durables. Most of our discussion will center on these equations. The last two columns refer to expenditures on non-durable consumption, the construction of which was discussed in Chapter 4. This series is, of course, smaller than consumer expenditures, so coefficients are correspondingly lower. The second and fourth equations were estimated by weighted least squares so as to reflect differences in the number of observations in each cell (i.e., each observation was multiplied by the square root of *NOBS*). The first and third equations were estimated in unweighted fashion. Figures in parentheses under each coefficient are absolute values of the coefficient *t*-ratios.[4]

The overall fits of the four versions of equation 5.1 appear to be reasonably good (about 70 per cent of variation in consumer expenditures explained) in light of the fact that they are estimated from a pooled data set involving both time-series and cross-sectional dimensions. The four versions are also quite similar in their coefficients so that the general pattern of effects appears to be fairly robust to these alternative versions of this specification. Consumer expenditures and non-

Table 5-1

Definition of Variables Used in Regression Analysis

C	-	Consumer expenditures (measured as either total expenditures or non-durable consumption)	
KH	-	Estimated stock of human capital	
KS	-	Estimated stock of sheltered capital	
KU	-	Estimated stock of unsheltered capital	
A	-	*KU* + *KS*	i.e.: Total non-human or material wealth
K	-	*KH* + *KU* + *KS*	i.e.: Total capital stock or wealth
R	-	Real after-tax interest rate	
TIME	-	*YEAR* - 1964	i.e.: Takes on values 0, 1, . . ., 18
T	-	72 - *AGE*	i.e.: Expected remaining lifetime
YK	-	After-tax (unsheltered) capital income	
YL	-	*YEAT*	i.e.: After-tax earnings (as defined in Chapter 4)
*YL*1	-	*YEAT*(-1)	i.e.: Estimated after-tax earnings lagged one year
*YL*2	-	*YEAT*(-2)	i.e.: Estimated after-tax earnings lagged two years.

NOTE All variables are in real per capita terms.

Table 5-2

$C = \alpha + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T) \cdot [KH + KU + KS]$

	Consumer expenditures		Non-durable consumption	
	Unweighted	Weighted	Unweighted	Weighted
α	14,584	-484.84	-2,079.9	-3,091
	(0.07)	(2.06)	(4.67)	(7.24)
β_0	0.07499	0.07979	0.07228	0.08463
	(18.62)	(22.47)	(9.35)	(12.55)
β_1	1.2638	1.3376	2.6339	2.5286
	(12.11)	(12.53)	(13.16)	(13.05)
β_2	-0.00124	-0.00130	-0.001033	-0.001211
	(17.89)	(21.61)	(7.78)	(11.12)
β_3	-0.01964	-0.01977	-0.04541	-0.03940
	(8.27)	(8.70)	(9.96)	(9.56)
$\bar{R}^2$	0.6857	0.7304	0.5985	0.6411
$F(4, 175)$	95.45	118.55	65.22	78.14

NOTE Figures in parentheses are absolute *t*-ratios.

durable consumption regressions vary mainly in their intercept term.

All coefficients with *a priori* expected signs also turn out to have their expected sign. β_1, the coefficient on *R* in the *MPC* expression, is positive so that, ignoring the small interaction term, interest rates have a positive effect on consumption via raising the *MPC*. That is, higher interest rates allow capital stocks to grow faster so that a given amount can be accumulated while saving less or consuming more. This is the same as found by Summers. The interaction term is negative indicating that the strength of this interest-rate effect on the *MPC* tends to increase with age. So, for example, in the second equation, at age 20, $\delta MPC/\delta R = 0.20$; at age 40, $\delta MPC/\delta R = 0.70$; and at age 72, $\delta MPC/\delta R = 1.34$. The interaction effect thus appears to be quite considerable. The coefficient on T itself turns out to be highly significant and negative, as expected, indicating that the *MPC* itself increases with age; i.e., older persons consume a larger proportion of their remaining capital than younger persons - one of the major implications of the life-cycle theory. Indeed, this effect is strengthened (by the interaction term) for higher values of R. That is, again for the second equation, at $R = 0.02$, $\delta MPC/\delta T = -0.0017$; at $R = 0$, $\delta MPC/\delta T = -0.0013$; and at $R = -0.02$, $\delta MPC/\delta T = -0.0009$. Coefficient β_0 also turns out small, positive, and highly significant, so that if both R and T were zero (i.e., at age 72), the *MPC* out of total wealth is about 7 or 8 per cent. Since age has a positive effect, younger persons on average have a lower *MPC* than this. Finally, only for non-durable consumption does the intercept of the equation also turn out highly significant; for consumer expenditures, it is less so.

It may be argued, however, that there has been structural change over time in the equation. The proportion of income recipients who were tax-filers has risen over time, and various tax changes have occurred over the period. For example, the child tax credit was introduced in 1978 and changes in the definition of taxable income occurred in 1972 (e.g., inclusion of capital gains, UI benefits, and fellowship income). Consequently, a time trend variable, *TIME*, has been introduced to capture such shifts, first in the intercept term of the equation:

$$C = (\alpha_0 + \alpha_1 TIME + \alpha_2 TIME^2) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T)K + u, \qquad (5.2)$$

and then in the *MPC* expression as well:

$$C = (\alpha_0 + \alpha_1 TIME + \alpha_2 TIME^2) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T + \beta_4 TIME)K + u. \qquad (5.3)$$

When linear and quadratic terms in *TIME* were tried, a quadratic appeared to fit best on the intercept and a simple linear term alone was significant in the *MPC* expression.

Regression results for these two equations are presented in Tables 5-3 and 5-4. The overall fits are indeed improved with R^2s rising 10 to 15 percentage points in the case of consumer expenditures, and all the log likelihood function values increasing. Improvement in the non-durable consumption equations is even more dramatic. Additional terms all turn out quite significant with the intercept shifting up in a positive concave fashion. In equation 5.2, the intercept shift peaks around 1970 for consumer expenditures; while for equation 5.3, it peaks a bit earlier, about 1968. The *MPC* shift term, however, is significantly positive indicating a very slight increase of less than 1 per cent per year relative to β_0. Results for non-durable consumption follow a similar pattern though with a more pronounced time trend. F-tests of the joint significance of *TIME* coefficients are provided in Table 5-5. The first row provides a test of the two intercept coefficients α_1 and α_2; the second row provides a test of the full set of *TIME* coefficients α_1, α_2, and β_4. As can be seen, all joint tests of no time-structural shifts are highly rejected by the data.

The general pattern of the rest of the regression coefficients remains the same as reported for the first equation. All the coefficients' signs remain the same as before, and some of the t-ratios even improve. The order of magnitude of *MPC* coefficients remains essentially unaffected with the introduction of additional shift terms. The interest-rate effect comes through persistently positive. As well, very strong age effects carry through unaffected, as does the negative interaction coefficient. The actual magnitude of the interest-rate effect is reduced slightly by the time trend, but the age coefficient is virtually unchanged.

So far in the discussion we have treated all three forms of capital stock as having equivalent dollar effects on consumption. However, one may wish to consider whether this is indeed empirically reasonable. All three forms of wealth stocks may potentially have different effects, or perhaps the two non-human forms of wealth may have equivalent effects though different from that for human capital. Accordingly, we have estimated a variety of equations in which coefficients of various forms of wealth have been allowed to differ. First, we estimated some equations with the following structural form:

$$C = \alpha(TIME) + MPC(R, T, TIME)(KH + \delta_1 KU + \delta_2 KS) + u. \qquad (5.4)$$

These equations tended to perform rather poorly, with coefficients δ_1 and δ_2 taking on economically implausible values. Similarly, when KU and KS were combined into a single financial wealth variable A, the results were quite unsatisfactory.

Instead of forcing the *MPC* out of financial wealth to be a linear proportion of the *MPC* out of human wealth, we ran some regressions in which coefficients in the *MPC* were themselves allowed to vary. In doing so, we aggregated financial wealth into a single variable A and estimated the following equations:

Table 5-3

$$C = (\alpha_0 + \alpha_1 TIME + \alpha_2 TIME^2) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R{\cdot}T){\cdot}[KH + KU + KS]$$

	Consumer expenditures		Non-durable consumption	
	Unweighted	Weighted	Unweighted	Weighted
α_0	227.20 (1.05)	−394.40 (1.67)	−864.07 (2.66)	−2,144.3 (6.06)
α_1	122.30 (3.94)	138.93 (4.11)	109.66 (2.34)	141.80 (2.80)
α_2	−13,652 (7.75)	−13,397 (7.46)	−24,036 (9.07)	−22,333 (8.30)
β_0	0.07760 (25.06)	0.08193 (28.25)	0.07855 (16.86)	0.08886 (20.45)
β_1	0.75747 (7.82)	0.92028 (9.53)	1.2809 (8.79)	1.4770 (10.21)
β_2	−0.001279 (24.05)	−0.001327 (28.35)	−0.001132 (14.14)	−0.001270 (18.11)
β_3	−0.01125 (5.53)	−0.01317 (6.82)	−0.02300 (7.52)	−0.02280 (7.89)
$\bar{R}^2$	0.8174	0.8385	0.8565	0.8535
$F(6, 173)$	129.05	149.74	172.0	168.012

NOTE See Table 5-2.

$$C = (\alpha_0 + \alpha_1 TIME + \alpha_2 TIME^2) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R{\cdot}T)KH + (\gamma_0 + \gamma_1 R + \gamma_2 T + \gamma_3 R{\cdot}T)A + u \quad (5.5)$$

and

$$C = (\alpha_0 + \alpha_1 TIME + \alpha_2 TIME^2) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R{\cdot}T + \beta_4 TIME)KH + (\gamma_0 + \gamma_1 R + \gamma_2 T + \gamma_3 R{\cdot}T + \gamma_4 TIME)A + u. \quad (5.6)$$

Regression results for these two equations are presented in Tables 5-6 and 5-7. These results review some interesting properties. The α coefficients follow a similar quadratic pattern as before, but the pattern of the *MPC* coefficients (β and γ) differs by type of wealth. For human wealth, β coefficients are quite similar as before. The interest-rate coefficient is significantly positive and between 0.6 and 0.9 for consumer expenditures, while the cohort T coefficient is negative as expected, again always significantly so. The interaction coefficient is also negative for consumer expenditures. For financial assets, the interest-rate coefficient is significant and largely positive in 5.5, but not significant in 5.6. The coefficient on T is, however, significantly positive and the interaction term negative. The marginal propensity to consume out of assets thus apparently falls with age. The fits of all these equations tend to be very good indeed. Of course, since human wealth KH tends to be much larger than asset wealth, its effect tends to dominate the outcome when KH and A are aggregated together, as in earlier regressions. What is remarkable is the continuing tendency for the after-tax real interest-rate coefficient to be positive despite changing specifications of the estimating equations.

The final concern in this section is to examine further the decision to include an intercept term (or time-shifting group of terms) in the regression equations. In all previous equations reviewed so far, intercept coefficients have generally turned out to be significant only when a time trend is included. But what about more formal joint tests on the full set of α coefficients? Accordingly, two further specifications of the consumption function were estimated:

Table 5-4

$$C = (\alpha_0 + \alpha_1 TIME + \alpha_2 TIME^2) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T + \beta_4 TIME) \cdot [KH + KU + KS]$$

	Consumer expenditures		Non-durable consumption	
	Unweighted	Weighted	Unweighted	Weighted
α_0	914.03 (3.83)	539.79 (1.97)	1,207.6 (4.76)	540.42 (2.07)
α_1	88.72 (3.00)	114.17 (3.66)	8.3684 (0.27)	69,414 (2.27)
α_2	– 17,262 (9.75)	– 18,413 (9.96)	– 34,926 (18.55)	– 37,001 (20.39)
β_0	0.07048 (22.23)	0.07306 (23.98)	0.05707 (16.92)	0.06294 (21.04)
β_1	0.54057 (5.48)	0.66480 (6.76)	0.62670 (5.97)	0.73002 (7.56)
β_2	– 0.00130 (26.24)	– 0.00132 (30.91)	– 0.00120 (22.68)	– 0.00126 (29.94)
β_3	– 0.004728 (2.10)	– 0.00703 (3.43)	– 0.00333 (1.39)	– 0.00486 (2.42)
β_4	0.00078 (5.34)	0.00076 (5.91)	0.00236 (15.14)	0.00221 (17.60)
$\bar{R}^2$	0.8435	0.8658	0.9384	0.9477
$F(7, 172)$	132.29	158.49	374.85	445.37

NOTE See Table 5-2.

Table 5-5

Tests of Time-Structural Shifts in Consumption

	Consumer expenditures		Non-durable consumption	
	Unweighted	Weighted	Unweighted	Weighted
(1) H_0: $\alpha_1 = \alpha_2 = 0$ (eq. 5.1)				
H_1: $\alpha_1, \alpha_2 = 0$ (eq. 5.2)	62.4*	57.9*	155.4*	125.5*
($F_{2, 120}(0.99) = 4.77$)				
(2) H_0: $\alpha_1 = \alpha_2 = \beta_4 = 0$ (eq. 5.1)				
H_1: $\alpha_1, \alpha_2, \beta_4 = 0$ (eq. 5.3)	57.7*	57.8*	316.6*	336.2*
($F_{3, 120}(0.99) = 3.95$)				

* Figures are significant at at least a 99 per cent level of confidence.

Table 5-6

$$C = (\alpha_0 + \alpha_1 TIME + \alpha_2 TIME^2) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R{\cdot}T)KH + (\gamma_0 + \gamma_1 R + \gamma_2 T + \gamma_3 R{\cdot}T)A$$

	Consumer expenditures		Non-durable consumption	
	Unweighted	Weighted	Unweighted	Weighted
α_0	858.38 (1.66)	1,299.2 (2.40)	−30,521 (0.4)	1,014.2 (1.20)
α_1	129.41 (5.77)	146.40 (6.07)	100.04 (2.80)	123.18 (3.26)
α_2	−13,885 (8.77)	−12,414 (8.32)	−18,911 (7.49)	−15,127 (6.46)
β_0	0.05643 (16.03)	0.05529 (15.06)	0.06676 (11.90)	0.06173 (10.72)
β_1	0.57312 (5.25)	0.77899 (7.33)	0.12989 (7.62)	0.42517 (9.71)
β_2	−0.000916 (19.71)	−0.000951 (21.64)	−0.000993 (13.40)	−0.001015 (14.72)
β_3	−0.00835 (2.55)	−0.01332 (4.23)	0.001289 (0.25)	−0.006234 (1.26)
γ_0	0.02118 (1.29)	−0.00451 (0.26)	0.02594 (0.99)	−0.02942 (1.09)
γ_1	1.7237 (7.06)	1.8370 (7.36)	4.5042 (11.58)	4.7927 (12.25)
γ_2	0.00416 (4.63)	0.00279 (3.17)	−0.000616 (0.43)	−0.003086 (2.23)
γ_3	−0.03582 (0.83)	−0.06868 (1.48)	0.01968 (0.28)	−0.03765 (0.52)
$\bar{R}^2$	0.9129	0.9226	0.9232	0.9230
$F(10, 169)$	177.05	201.46	203.09	202.56

NOTE See Table 5-2.

$$C = (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R{\cdot}T)K + u \qquad (5.7)$$

and

$$C = (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R{\cdot}T + \beta_4 TIME)K + u. \qquad (5.8)$$

Estimates of these two equations are provided in Tables 5-8 and 5-9. As can be seen from these tables, the overall fits have deteriorated very considerably on various summary criteria – comparing equation 5.7 with 5.2, and equation 5.8 with 5.3. The general pattern of coefficient signs in *MPC* expressions once again remains similar as before. The magnitudes of the coefficients tend to increase generally, and some quite considerably so – for example, the interest-rate coefficients β_1. The time trend coefficient in the *MPC* of equation 5.8 also changes sign. Nonetheless, the general pattern of β coefficients and their significance continues to hold.

Formal F-tests of the joint hypothesis that $\alpha_0 = \alpha_1 = \alpha_2 = 0$ are presented at the bottom of Tables 5-8 and 5-9. Compared to a critical F-value (at a 95 per cent level of confidence) of 2.68, test statistics are all very many times larger, thus very strongly rejecting the hypothesis of no intercept terms. Consequently, in our subsequent analysis of R and T effects on consumption and savings later in this chapter, equation specifications which include intercept terms are preferred.

Table 5-7

$$C = (\alpha_0 + \alpha_1 TIME + \alpha_2 TIME^2) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R{\bullet}T + \beta_4 TIME)KH + (\gamma_0 + \gamma_1 R + \gamma_2 T + \gamma_3 R{\bullet}T + \gamma_4 TIME)A$$

	Consumer expenditures		Non-durable consumption	
	Unweighted	Weighted	Unweighted	Weighted
α_0	1,134.0 (2.65)	1,013.3 (2.20)	379.11 (0.79)	159.67 (0.32)
α_1	192.33 (8.86)	175.82 (8.06)	177.88 (7.29)	166.42 (7.09)
α_2	-2.9065 (1.11)	-7.3113 (2.66)	-7.2865 (2.48)	-11,710 (3.95)
β_0	0.05439 (18.79)	0.05577 (17.99)	0.06088 (18.62)	0.06272 (18.80)
β_1	0.69300 (5.75)	0.87233 (7.05)	0.40571 (2.99)	0.63690 (4.78)
β_2	-0.000871 (21.56)	-0.000941 (23.77)	-0.000974 (21.43)	-0.001041 (24.43)
β_3	-0.013002 (4.64)	-0.01527 (5.53)	-0.004837 (1.54)	-0.008227 (2.77)
β_4	-0.000739 (3.48)	-0.000289 (1.42)	-0.000368 (1.54)	-0.000042 (0.19)
γ_0	0.07625 (5.16)	0.06969 (4.06)	0.13918 (8.37)	0.13563 (7.34)
γ_1	0.01607 (0.06)	0.11863 (0.40)	0.84518 (2.75)	0.96867 (3.03)
γ_2	0.00194 (2.32)	0.00220 (2.63)	-0.003462 (3.68)	-0.003114 (3.46)
γ_3	-0.01542 (0.43)	-0.04329 (1.10)	0.04524 (1.12)	0.009480 (0.22)
γ_4	0.01168 (6.97)	-0.008792 (5.12)	-0.01836 (9.74)	-0.01558 (8.43)
$\bar{R}^2$	0.9420	0.9455	0.9745	0.9745
$F(12, 167)$	225.95	241.41	532.57	531.55

NOTE See Table 5-2.

Regression Estimates of Summers' Specifications

The life-cycle approach to consumption functions implemented in the last section follows Summers (1981 and 1982). In the latter source, Summers offers his own estimates for the United States based on annual aggregate National Accounts data for the 1950-78 period. It would be interesting to compare our estimates with his, or more specifically to compare estimates from his specification and those of the last section obtained from the more disaggregative data set of this study.

In Summers' aggregate data source, age is not used as a variable; nor does he have aggregate data on human capital stock since this is also cohort-specific. Consequently, as discussed in Chapter 3, he specifies a consumption function of the form:

Table 5-8

$C = (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T)K$

	Consumer expenditures		Non-durable consumption	
	Unweighted	Weighted	Unweighted	Weighted
β_0	0.07523 (53.20)	0.07271 (50.87)	0.03851 (13.38)	0.03952 (13.53)
β_1	1.2663 (13.15)	1.2642 (12.45)	2.2798 (11.64)	2.0606 (9.93)
β_2	−0.001242 (36.84)	−0.001190 (37.85)	−0.000492 (7.18)	−0.000538 (8.37)
β_3	−0.01967 (8.41)	−0.1924 (8.45)	−0.04198 (8.82)	−0.03602 (7.74)
$F(3, 176)$	127.98	153.82	71.27	67.15
F-statistics for test of $\alpha_0 = \alpha_1 = \alpha_2 = 0$ (eq. 5.2 vs. eq. 5.7):				
	197.9	184.8	203.8	188.7
$(F_{3,120}(0.95) = 2.68)$				

NOTE See Table 5-2.

Table 5-9

$C = (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T + \beta_4 TIME)K$

	Consumer expenditures		Non-durable consumption	
	Unweighted	Weighted	Unweighted	Weighted
β_0	0.7955 (48.30)	0.7627 (48.10)	0.04834 (14.64)	0.04640 (14.24)
β_1	1.1316 (11.98)	1.1487 (11.46)	1.9734 (10.24)	1.8373 (8.92)
β_2	−0.001229 (38.26)	−0.001180 (39.25)	−0.000462 (7.18)	−0.000517 (8.37)
β_3	−0.01929 (8.69)	−0.01859 (8.55)	−0.04111 (9.24)	−0.03476 (7.78)
β_4	−0.000472 (4.52)	−0.000370 (4.37)	−0.001075 (5.13)	−0.000716 (4.11)
$F(4, 175)$	111.72	132.01	67.74	59.14
F-statistics for test of $\alpha_0 = \alpha_1 = \alpha_2 = 0$ (eq. 5.3 vs. eq. 5.8):				
	222.3	201.6	217.4	192.7
$(F_{3,120}(0.95) = 2.68)$				

NOTE See Table 5-2.

$$C = \alpha + (\beta_0 + \beta_1 R)[A + \frac{YL^e}{R + \delta}] + u,$$

where YL^e represents expected or permanent disposable labour income, and δ (assumed positive) is interpreted as a risk premium on human capital as opposed to non-human wealth. The fact that human capital stock is represented by an income flow divided by an interest rate reflects an implicit assumption that, in the aggregate, expected earnings are discounted infinitely into the future (rather than up until an expected time of death). Empirically, YL^e is proxied by "a three-period distributed lag on per capita disposable labour income, with the weights constrained to sum to one" (1982, p. 27). In our data set, however, we do have data on age (or rather T) so that we can include it in Summers' *MPC* expression both in level and interacted form. Consequently, if $YL1$ and $YL2$ represent after-tax earnings (i.e., *YEAT* as defined in Chapter 4) lagged one and two periods, respectively, one can specify Summers' consumption functions for our data set:

$$C = \alpha + (\beta_0 + \beta_1 R + \beta_2 T)$$
$$[A + \frac{(1-\gamma_1-\gamma_2)YL + \gamma_1 YL1 + \gamma_2 YL2}{R + \delta}] + u \qquad (5.9)$$

and

$$C = \alpha + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T)$$
$$[A + \frac{(1-\gamma_1-\gamma_2)YL + \gamma_1 YL1 + \gamma_2 YL2}{R + \delta}] + u. \qquad (5.10)$$

$YL1$ and $YL2$ have been generated from the quadratic earnings equation in Chapter 4, Table 4-4, equation (2), evaluated along an earnings trajectory where both *AGE* and *TIME* change together by one or two years, respectively.

Estimates of these two equations are provided in Tables 5-10 and 5-11. Summary statistics are generally inferior to those of equations 5.1 to 5.6 in the last section. Regression coefficients themselves indicate four principal results for the consumer-expenditure equations. First, little or no direct age effect appears to be present in the marginal propensity to consume as β_2 is essentially zero in magnitude and has insignificant t-ratios. Evidently, the age effect is picked up almost entirely in the wealth term in square brackets. Second, the interest rate appears with a persistently positive and highly significant coefficient in *MPC* expressions. Indeed, along with the intercept, it is the only significant coefficient. This positive effect on the *MPC* is similar in magnitude to that found in the last section, although the interaction term is insignificant. Third, however, the estimated weights on lagged earnings are economically unreasonable.[5] In particular, the sum of γ_1 and γ_2 exceeds unity in most cases, which would imply a negative coefficient on YL. In fact, these coefficients are all insignificant. Finally, δ coefficients turn out negative and are generally insignificant.

As an overall evaluation of Summers' specification, one finds that the equations fit poorly relative to equations 5.1 to 5.6, but indicate a positive interest-rate effect on the marginal propensity to consume that is comparable with that suggested by 5.1 to 5.6, and a considerably weaker age effect. Notice that since R appears in the denominator of expected earnings as a perpetual discount factor, the human wealth effect is bound to be large by construction. In subsequent analysis, we will not use Summers' specification at all since the results are so poor.

Regression Estimates of Naive Specifications

Life-cycle consumption function estimates of equations 5.1 to 5.8 are based upon some fairly strong assumptions about household behaviour. For example, households are assumed to know the future path of their earnings and tax liabilities and to take their current consumption decisions according to a rational plan of consumption for the remainder of their lives. Consumers may, in practice, be neither so rational nor so forward-looking. We would like to compare the results obtained from this forward-looking specification with those for "naive" consumption functions obtained by using more short-horizon variables in a largely ad hoc additive fashion, or from simple life-cycle specifications that do not include human capital or expected future earnings. Many examples of the latter are available in the early literature on life-cycle consumption functions reviewed, for example, in Evans (1967) or (1969). Unconstrained consumption functions based only on income and lagged consumption[6] estimated on cross-sectional data are considered in Leviatan (1965). Functions based on simply current earnings and assets are estimated from micro-data for the United States in Projector and Weiss (1968). National Accounts estimates of consumption functions involving these variables are also found in Ando and Brown (1968) and Ando and Goldfeld (1968).

Two particularly simple specifications are provided in equations 5.11 and 5.12:

$$C = \beta_0 + \beta_1 R + \beta_2 T + \beta_3 YL + \beta_4 YL1 + u \qquad (5.11)$$

and

$$C = \beta_0 + \beta_1 R + \beta_2 T + \beta_3 YL + \beta_4 YK + u. \qquad (5.12)$$

Table 5-10

$$C = \alpha + (\beta_0 + \beta_1 R + \beta_2 T)\,[A + (1 - \gamma_1 - \gamma_2)YL + \gamma_1 YL1 + \gamma_2 YL2]/R + \delta$$

	Consumer expenditures		Non-durable consumption	
	Unweighted	Weighted	Unweighted	Weighted
α	1,681.0 (5.32)	644.49 (2.22)	1,172.3 (1.52)	1,166.0 (1.63)
β_0	−0.0000888 (0.47)	−0.000149 (0.58)	−0.0000115 (0.15)	−0.000012 (0.14)
β_1	0.43101 (3.77)	0.72105 (6.70)	0.11624 (0.42)	0.03646 (0.14)
β_2	−0.81E-6 (0.52)	−0.76E-6 (0.52)	−0.27E-6 (0.18)	0.16E-7 (0.06)
γ_1	154.19 (1.68)	32.23 (0.93)	610.63 (0.33)	2,703.1 (0.13)
γ_2	−79.68 (1.69)	−17.40 (0.98)	−335.75 (0.34)	−1,455.6 (0.13)
δ	−0.000287 (0.88)	−0.000262 (0.91)	−0.00029 (1.01)	−0.00037 (1.09)
$\bar{R}^2$	0.8053	0.8558	0.5186	0.6345
$F(6, 173)$	119.22	171.06	31.06	50.04

NOTE See Table 5-2.

Corresponding regression results are presented in Tables 5-12 and 5-13.

As can be seen from these tables, the overall summary regression statistics for these naive equations are generally comparable with those in the first section. Turning to individual coefficients, one notes that the long-run propensity to consume out of earnings is around 0.8 for consumer expenditures and 0.4 for non-durables. The coefficients are consistently significant. The interest rate continues to have a positive and significant coefficient and to be of large magnitude. One should recall that in the full life-cycle model estimated earlier, the interest rate worked both directly through the propensity to consume wealth and indirectly through the evaluation of human wealth (the human wealth effect). The age coefficient β_2 tends to be negative but not always significant for consumer-expenditure equations (as expected), but flips signs for the non-durable consumption equation. Given that the age variable appears on its own and not as part of the propensity to consume, we have no strong *a priori* views concerning its sign. Surprising results concern the coefficients on capital income in 5.12. They turn out to be significantly negative. However, their magnitude is extremely small.

These specifications, however, may be viewed as incomplete or faulty in that they do not include asset stocks $A = KS + KU$. Simple specifications which do introduce assets in an unrestricted fashion are:

$$C = \beta_0 + \beta_1 R + \beta_2 T + \beta_3 YL + \beta_4 A + u \tag{5.13}$$

and

$$C = \beta_0 + \beta_1 R + \beta_2 T + \beta_3 YL + \beta_4 YL1 + \beta_5 A + u. \tag{5.14}$$

Their results are presented in Tables 5-14 and 5-15. Again the overall fits appear quite good on standard criteria. Surprisingly, assets come through as clearly significant and negative with a marginal propensity to consume of −0.06 to −0.12 for expenditures. The long-run marginal propensity to consume out of earnings is estimated at about 0.71 in Table 5-15 and at 0.6 in Table 5-14 for consumer expenditures, and much smaller for non-durables. Age effects are generally negative, though smaller than before; and interest-rate effects are positive, though varying considerably in magnitude and not always statistically significant.

Table 5-11

$$C = \alpha + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \bullet T)\,[A + (1 - \gamma_1 - \gamma_2) YL + \gamma_1 YL1 + \gamma_2 YL2] R + \delta$$

	Consumer expenditures		Non-durable consumption	
	Unweighted	Weighted	Unweighted	Weighted
α	1,624.3	1,015.9	1,254.8	1,818.1
	(5.23)	(3.35)	(1.38)	(2.11)
β_0	−0.000246	−0.000299	−0.0000077	−0.0000067
	(1.63)	(0.99)	(0.69)	(0.49)
β_1	0.88794	1.0088	0.02221	0.01490
	(6.33)	(8.34)	(0.69)	(0.49)
β_2	0.276E-5	0.285E-5	0.23E-7	0.93E-7
	(1.16)	(0.74)	(0.61)	(0.49)
β_3	−0.01091	−0.01059	−0.0000318	−0.000206
	(5.19)	(5.55)	(0.59)	(0.49)
γ_1	21,681	5,949	4,594.1	8,565.7
	(0.58)	(0.22)	(0.70)	(0.47)
γ_2	−15,004	−6,384	−2,475.2	−4,744.3
	(0.78)	(0.45)	(0.70)	(0.47)
δ	−0.000320	−0.000327	−0.000376	−0.000454
	(2.92)	(1.33)	(1.02)	(7.24)
$\bar{R}^2$	0.8440	0.8814	0.5209	0.6701
$F(7, 172)$	132.93	182.53	26.72	49.92

NOTE See Table 5-2.

Table 5-12

$$C = \beta_0 + \beta_1 R + \beta_2 T + \beta_3 YL + \beta_4 YL1$$

	Consumer expenditures		Non-durable consumption	
	Unweighted	Weighted	Unweighted	Weighted
β_0	1,514.8	993.57	1,565.2	541.38
	(6.55)	(4.47)	(3.15)	(1.14)
β_1	0.14252	0.10146	0.45503	0.33728
	(3.96)	(3.12)	(5.89)	(4.87)
β_2	−30,051	−23,036	−65,926	−42,990
	(3.94)	(3.50)	(4.03)	(3.07)
β_3	4.0417	4.2241	11,336	11,184
	(5.92)	(6.53)	(7.73)	(8.12)
β_4	−3.2736	−3.3970	−10,751	−10,528
	(4.82)	(5.25)	(7.38)	(7.65)
$\bar{R}^2$	0.7785	0.8287	0.6456	0.6861
$F(4, 175)$	153.76	211.72	79.71	95.61

NOTE See Table 5-2.

Table 5-13

$C = \beta_0 + \beta_1 R + \beta_2 T + \beta_3 YL + \beta_4 YK$

	Consumer expenditures		Non-durable consumption	
	Unweighted	Weighted	Unweighted	Weighted
β_0	1,209.2	1,038.0	1,854.3	1,336.8
	(7.40)	(6.65)	(4.24)	(3.11)
β_1	0.10873	7,737.2	0.34238	0.25159
	(4.48)	(3.70)	(5.28)	(4.37)
β_2	−3.6970	−4.3362	11,348	11,391
	(1.60)	(2.01)	(1.84)	(1.92)
β_3	0.75176	0.7935	0.3049	0.41339
	(28.22)	(36.15)	(4.28)	(6.84)
β_4	−0.000502	−0.000466	−0.001377	−0.001249
	(11.95)	(12.82)	(12.25)	(12.48)
$\bar{R}^2$	0.9050	0.9328	0.7644	0.7939
$F(4, 175)$	416.70	607.24	141.95	168.51

NOTE See Table 5-2.

Table 5-14

$C = \beta_0 + \beta_1 R + \beta_2 T + \beta_3 YL + \beta_4 A$

	Consumer expenditures		Non-durable consumption	
	Unweighted	Weighted	Unweighted	Weighted
β_0	2,296.6	3,413.3	6,187.8	8,823.6
	(4.09)	(6.82)	(4.19)	(16.72)
β_1	0.16794	7,904.8	0.44624	0.21587
	(4.85)	(2.88)	(4.91)	(3.00)
β_2	−27,423	−47,010	−73,633	−120.54
	(3.18)	(5.99)	(3.27)	(5.86)
β_3	0.73519	0.70917	0.17846	0.12553
	(16.38)	(19.98)	(1.51)	(1.35)
β_4	−0.06731	−0.10770	−0.22185	−0.31995
	(4.51)	(7.95)	(5.66)	(9.02)
$\bar{R}^2$	0.8455	0.9043	0.6299	0.7340
$F(4, 175)$	239.33	413.17	74.47	120,734

NOTE See Table 5-2.

Table 5-15

$C = \beta_0 + \beta_1 R + \beta_2 T + \beta_3 YL + \beta_4 YL1 + \beta_5 A$

	Consumer expenditures		Non-durable consumption	
	Unweighted	Weighted	Unweighted	Weighted
β_0	4,348.8	4,857.3	9,418.0	0.10866
	(7.10)	(8.33)	(7.53)	(9.57)
β_1	2,569.6	−2,143.9	0.13131	−194.43
	(0.62)	(0.64)	(1.56)	(0.14)
β_2	−71,443	−79,712	−180.62	−194.43
	(6.49)	(8.03)	(8.03)	(10.06)
β_3	3.5803	3.2165	10,057	8.4917
	(5.53)	(5.45)	(7.60)	(7.40)
β_4	−2.9796	−2.6063	−9.9359	−8.4151
	(4.65)	(4.47)	(7.59)	(7.41)
β_5	−0.08395	−0.1163	−0.2326	−0.3108
	(4.95)	(7.04)	(6.71)	(9.67)
$\bar{R}^2$	0.8058	0.8667	0.7185	0.7958
$F(5, 174)$	144.44	226.36	88.83	135.60

NOTE See Table 5-2.

Equations were also estimated with an $R{\cdot}T$ interaction term, but are not reported since this term never turned out significant in such an unrestricted specification, and the rest of the coefficients did not differ substantially from those just reported.

Early life-cycle consumption functions were also often estimated with a dependent variable as the ratio of consumption to labour income. Accordingly, we also estimate:

$$C/YL = \alpha_0 + \alpha_1 R + \alpha_2 T + \alpha_3 A + u \quad (5.15)$$

and

$$C/YL = \alpha_0 + \alpha_1 R + \alpha_2 T + \alpha_3 R{\cdot}T + \alpha_4 A + u. \quad (5.16)$$

Their results are presented in Tables 5-16 and 5-17. Clearly, summary regression statistics are not comparable between these two equations and the earlier ones, and the equations are not as unrestricted as equations 5.13 and 5.14. Here we are assuming the marginal and average propensities to be the same. Now, assets tend to have a negative effect on the *MPC*, often insignificant. In both specifications, the interest-rate effect turns out positive and quite significant. When the consumption function is written in ratio form, as it is here, the $R{\cdot}T$ interaction term does appear generally significant, and in this case negative (as also found in the estimates of the first section). Age, however, enters positively now - a result rather different in sign from what was found earlier.

The general findings from these naive and relatively unrestricted specifications are: (i) they fit comparably in terms of summary criteria to the life-cycle equations of the first section; (ii) unrestricted estimates of the interest-rate effect on consumption (other than through the human capital wealth term) are almost always positive, but vary dramatically in magnitude and are not at all reliably or robustly estimated; (iii) current earnings have a highly significant effect on consumption (when a human capital term is not included in the regression); (iv) unrestricted effects of age on the level of consumer expenditures are generally negative but are sensitive to the specific form of the equation; and (v) assets appear to have an unpredictable effect on consumption. Since some of these findings draw attention to the importance of the theoretical structure imposed on the life-cycle consumption functions of the first section in obtaining apparently more reliable or robust estimates, particularly of age and interest-rate effects, it behooves us to examine more carefully and formally test some of the key aspects of the life-cycle structure of the consumption functions estimated. This is undertaken in the next chapter.

Table 5-16

$C/YL = \alpha_0 + \alpha_1 R + \alpha_2 T + \alpha_3 A$

	Consumer expenditures		Non-durable consumption	
	Unweighted	Weighted	Unweighted	Weighted
α_0	0.9145	1.1675	0.98808	1.5911
	(7.54)	(10.36)	(3.35)	(5.90)
α_1	7.9630	5.2143	18,310	11,573
	(6.86)	(5.07)	(6.48)	(4.70)
α_2	0.000505	−0.003675	−0.00446	−0.01426
	(0.19)	(1.54)	(0.68)	(2.50)
α_3	−0.185E-5	−0.000014	−0.3176E-4	−0.6258E-4
	(0.43)	(3.53)	(3.05)	(6.56)
$\bar{R}^2$	0.2743	0.6575	0.4117	0.5721
$F(3, 176)$	22.17	112.63	41.06	78.44

NOTE See Table 5-2.

Table 5-17

$C/YL = \alpha_0 + \alpha_1 R + \alpha_2 T + \alpha_3 R{\cdot}T + \alpha_4 A$

	Consumer expenditures		Non-durable consumption	
	Unweighted	Weighted	Unweighted	Weighted
α_0	0.55189	0.79511	0.10777	0.72984
	(5.37)	(8.09)	(0.43)	(3.05)
α_1	25,165	23,166	60,067	53,092
	(13.03)	(11.58)	(12.76)	(10.88)
α_2	0.009815	0.00455	0.01814	0.004764
	(4.19)	(2.18)	(3.18)	(0.93)
α_3	−0.57761	−0.5030	−1,402	−1.1634
	(10.15)	(9.85)	(10.10)	(9.34)
α_4	0.8199E-5	−0.1667E-5	−0.7358E-5	−0.3388E-4
	(2.32)	(0.48)	(0.85)	(4.03)
$\bar{R}^2$	0.5431	0.7797	0.6283	0.7145
$F(4, 175)$	51.996	154.81	73.96	109.51

NOTE See Table 5-2.

6 Some Formal Tests of the Life-Cycle Consumption Theory

The last chapter highlighted several differences between the life-cycle consumption functions, and the naive, simplified, or relatively unrestricted specifications. Essentially, the two differed in their treatment of human capital stock and whether age and interest-rate effects operate through the marginal propensity-to-consume term. In the naive specifications, the human capital variable *KH* did not enter at all (the essential resource variables were assets and current earnings), and the interest-rate and age variables were entered as separate variables not interacting any of the resource variables so as to impact their *MPC*s. Life-cycle specifications, on the other hand, included *KH* as indeed the dominant component of lifetime wealth or resources available for consumption, and introduced *R* and *T* not as separate variables on their own in the equation but as arguments of the marginal propensity-to-consume function. In the first section of this chapter, we formally test the significance of the human capital variable beyond what is provided by a current earnings term along with assets. We thus wish to allow the data the opportunity to reject the inclusion of the human capital term and thus reject any (negative) interest-rate effects upon consumption operating via the discounted present value of expected future earnings embodied in the structure of the life-cycle equations of Chapter 5. In the next section, we investigate whether *R* and *T* variables enter the consumption function directly as suggested by the naive equations, or interacted with the *MPC* terms, as suggested by the life-cycle specifications. In the final section, we formally test for differences in the form of *MPC* expressions across the separate components of lifetime wealth. Again, the naive equations suggest that the *MPC*s need not be the same across the different lifetime wealth components, whereas the life-cycle specification suggests they should be the same.

Tests on Human Capital of Earnings Expectations

Consider first the introduction of a human capital term in a naive "unrestricted" regression where age and interest-rate variables are entered in separate additive fashion. Recall, however, that the human capital stock variable, *KH*, is calculated as a discounted present value of current and expected future earnings. Thus if both *YL* and *KH* are entered together in a regression, *YL* is in a sense being entered twice. The essence of the life-cycle theory of consumption is that expected future earnings are important in determining current consumer expenditures. Accordingly, instead of simply introducing *KH*, we enter the variable *KH-YL* as a measure of expected future earnings. Thus the "unrestricted" equation we consider is a generalization of that of Table 5-14:

$$C = \beta_0 + \beta_1 R + \beta_2 T + \beta_3 YL + \beta_4 (KH\text{-}YL) + \beta_5 A + u. \qquad (6.1)$$

Estimation results are presented in Table 6-1. Only "weighted" regression results are discussed in this chapter since the weighted and unweighted regression results in Chapter 5 gave quite similar results.

Two principal findings may be remarked upon from these results. First, the coefficient on future earnings expectations is indeed positive and statistically significantly different from zero for both consumption definitions. That is to say, human capital does indeed

Table 6-1

$$C = \beta_0 + \beta_1 R + \beta_2 T + \beta_3 YL + \beta_4 (KH\text{-}YL) + \beta_5 A$$

	Consumer expenditures	Non-durable consumption
β_0	1,936.3	4,867.4
	(4.03)	(3.89)
β_1	32,316	86,970
	(7.93)	(8.20)
β_2	−59,091	−152.90
	(8.38)	(8.33)
β_3	0.82533	0.43665
	(23.7)	(4.83)
β_4	0.006158	0.016493
	(7.41)	(7.63)
β_5	−0.06614	−0.20863
	(5.05)	(6.12)
$\bar{R}^2$	0.9272	0.8007
$F(5, 174)$	443.45	139.80

NOTE: Figures in parentheses are absolute *t*-ratios.

appear to significantly affect consumption beyond what is accounted for by simply current earnings. This is important because it provides a direct test of the significance of Summers' "human wealth effect" on which his large estimates of savings elasticities are based. Note, however, that the coefficient on future expected earnings is quite small compared to that on current labour income. Second, comparing Table 6-1 with Table 5-14 reveals that the addition of the term for future earnings expectations does change some of the earlier "unrestricted" estimates. All coefficients have the same sign as before. But the coefficient on interest rates has increased fourfold and that on current labour income has increased somewhat. The remaining coefficients are of the same order of magnitude as before with a highly significant positive age effect. Simple unrestricted estimates thus reveal a significant independent effect of human capital earnings expectations consistent with a life-cycle perspective.

One might expect, however, that in this "unrestricted" framework, marginal propensities to consume out of sheltered and unsheltered capital may well differ. Accordingly, equation 6.1 has been re-estimated with A broken up into its two components. The results are in Table 6-2. Once again, the coefficient on earnings expectations is positive and highly significant. The remaining coefficients retain their same signs as before. The negative sign on the former asset term can be seen to be attributable to sheltered assets, while unsheltered assets retain a positive coefficient that is considerably smaller than that on current earnings, but larger than that on expected future earnings.

Table 6-2

$$C = \beta_0 + \beta_1 R + \beta_2 T + \beta_3 YL + \beta_4 (KH\text{-}YL) + \beta_5 KU + \beta_6 KS$$

	Consumer expenditures	Non-durable consumption
β_0	1,606.3 (7.30)	4,000.8 (7.24)
β_1	10,368 (5.06)	29,329 (5.71)
β_2	−34,852 (10.4)	−89,244 (10.6)
β_3	0.93021 (56.7)	0.71210 (17.3)
β_4	0.001704 (4.09)	0.004796 (4.58)
β_5	0.04744 (6.38)	0.08968 (4.80)
β_6	−0.3783 (27.9)	−1.0285 (30.3)
$\bar{R}^2$	0.9849	0.9616
$F(6, 173)$	1,881.7	721.15

NOTE See Table 6-1.

Consider now the introduction of earnings expectations into a life-cycle specification that allows for different effects between assets and human capital:

$$C = \alpha + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T)$$
$$[YL + \delta_1 (KH\text{-}YL) + \delta_2 A] + u. \quad (6.2)$$

Their estimation results are presented in Table 6-3.

One notes that the bracketed MPC term is now interpreted as the MPC out of current labour income, and its coefficient pattern is no longer the same as found before (the coefficient on T is now positive). According to the simple life-cycle specification, the two δ coefficients on the KH-YL and A components of lifetime wealth should both be one. They turn out to be quite different from one, however. Earnings expectations still enter significantly, but with a small and negative coefficient. The coefficient on assets is also relatively small and positive. Individually, each of the δ coefficients is significantly different from unity. Jointly, they are also significantly different on the basis of F-tests between the figures in Tables 6-3 and 5-2 (with calculated F-statistics of 184.7 and 80.2).[1] It thus appears that, while earnings expectations are statistically significant so that there is a statistically significant human wealth effect, current earnings has a strong and distinct independent effect on consumption beyond what one would expect from it entering only as a component of human capital.

The principal findings of this section, then, are: (i) earnings expectations or human wealth do indeed have a positive and significant effect on consumer expenditures as suggested by the life-cycle theory and thus supporting the presence of a human wealth effect, but their (marginal) effects are quite small; and (ii) various resource components of lifetime wealth have marginal impacts that differ very considerably in size – in contrast to the simple life-cycle theory – with current earnings showing a much stronger (marginal) effect than the other components.

Table 6-3

$$C = \alpha + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T)[YL + \delta_1(KH\text{-}YL) + \delta_2 A]$$

	Consumer expenditures	Non-durable consumption
α	262.65	1,271.3
	(0.95)	(2.31)
β_0	0.55289	−0.34606
	(10.3)	(3.60)
β_1	17,701	30,054
	(10.9)	(7.02)
β_2	0.01147	0.023849
	(8.14)	(10.9)
β_3	−0.44562	−0.66409
	(7.06)	(4.77)
δ_1	−0.002067	−0.004601
	(2.89)	(2.68)
δ_2	0.01572	0.14041
	(1.17)	(4.37)
$\bar{R}^2$	0.9140	0.8137
$F(6, 173)$	306.58	125.94

NOTE See Table 6-1.

Table 6-4

$$C = (\alpha_0 + \alpha_1 R + \alpha_2 T + \alpha_3 R \cdot T) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T)K$$

	Consumer expenditures	Non-durable consumption
α_0	82.83	−2,521.0
	(0.47)	(6.92)
α_1	28,397	0.15931E-6
	(2.60)	(6.99)
α_2	195.30	167.45
	(12.3)	(5.05)
α_3	−2,467.6	−4,362.6
	(6.73)	(5.71)
β_0	0.03006	0.03607
	(6.37)	(3.67)
β_1	1.3352	0.92467
	(8.55)	(2.84)
β_2	−0.001080	−0.0009196
	(23.0)	(9.40)
β_3	−0.03138	−0.01860
	(8.89)	(2.53)
$\bar{R}^2$	0.8649	0.7623
$F(7, 172)$	157.27	78.80

NOTE See Table 6-1.

Tests of Direct or Interacted Effects of *R* and *T*

The second general issue of inquiry in this chapter is whether interest-rate and age effects operate through the marginal propensity to consume (as suggested by the life-cycle theory) or as separate variables on their own (as suggested by the simple naive specifications), not interacting any of the resource variables of the equations. We also introduce time trend shifts back into the equation as well.

Consider first the results of introducing interest-rate and age variables directly by themselves as well as interacted in the *MPC* expression, without time trend shifts in the equation:

$$C = (\alpha_0 + \alpha_1 R + \alpha_2 T + \alpha_3 R \cdot T) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T)K + u. \quad (6.3)$$

Their estimation results are presented in Table 6-4.

One can first test for whether R, T and $R \cdot T$ have a separate effect on consumption beyond their appearance in the *MPC* expression. That is, one can test H_0: $\alpha_1 = \alpha_2 = \alpha_3 = 0$ by comparing the sum of squared residuals with those for equations in Table 5-2. The calculated F-statistics for the weighted regressions are 57.0 and 29.2, which are highly significant.[2] R, T, and $R \cdot T$ do indeed appear to have a significant effect on consumption beyond what is specified in the simple life-cycle *MPC* expression. Note also that, while R and $R \cdot T$ retain the same signs between their intercept and *MPC* terms, the signs on T differ between the two terms. Thus age increases the *MPC* while lowering the intercept of the equation. The net effect is thus a compound of these two. The sign pattern of the coefficients in the *MPC* expression remains the same as in Table 5-2, although the magnitudes of some of the coefficients have changed, particularly for the non-durable consumption function.

Next, consider the tests and regression results when also controlling for time-structural shifts. Accordingly, we extend equation 6.3 to:

$$C = (\alpha_0 + \alpha_1 R + \alpha_2 T + \alpha_3 R{\cdot}T + \alpha_4 TIME + \alpha_5 TIME^2) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R{\cdot}T)K + u \quad (6.4)$$

and

$$C = (\alpha_0 + \alpha_1 R + \alpha_2 T + \alpha_3 R{\cdot}T + \alpha_4 TIME + \alpha_5 TIME^2) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R{\cdot}T + \beta_4 TIME)K + u. \quad (6.5)$$

Their regression results are presented in Tables 6-5 and 6-6.

Once again the tests yield very clear-cut results. One can test time-shift coefficients in the intercept alone by comparing the sum of squared residuals for the equations in Tables 6-5 and 6-4. The calculated F-statistics for H_0: $\alpha_4 = \alpha_5 = 0$ are 42.4 and 114.5. The F-statistics for H_0: $\alpha_4 = \alpha_5 = \beta_4 = 0$ analogously calculated for the equations in Tables 6-6 and 6-4 are 59.7 and 267.1. In all cases, the null hypotheses are highly significantly rejected,[3] so that time-shift coefficients should clearly be retained in both intercept and *MPC* expressions. Tests of the intercept terms R, T, and $R{\cdot}T$ can also be carried out for these equations as well.

Table 6-5

$$C = (\alpha_0 + \alpha_1 R + \alpha_2 T + \alpha_3 R{\cdot}T + \alpha_4 TIME + \alpha_5 TIME^2) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R{\cdot}T)K$$

	Consumer expenditures	Non-durable consumption
α_0	− 198.73 (1.06)	− 2,054.9 (6.59)
α_1	20,501 (2.23)	0.12030E-6 (7.83)
α_2	155.74 (10.9)	26,380 (1.10)
α_3	− 2,191.3 (7.24)	− 3,753.0 (7.44)
α_4	144.88 (5.52)	151.06 (3.45)
α_5	− 11,150 (8.14)	− 21,485 (9.41)
β_0	0.04156 (9.89)	0.07545 (10.8)
β_1	1.1745 (9.06)	0.44851 (2.08)
β_2	− 0.0011403 (29.1)	− 0.0010978 (16.8)
β_3	− 0.025556 (8.43)	0.0021942 (0.43)
$\bar{R}^2$	0.9099	0.8987
$F(9, 170)$	190.66	167.61

NOTE See Table 6-1.

Table 6-6

$$C = (\alpha_0 + \alpha_1 R + \alpha_2 T + \alpha_3 R{\cdot}T + \alpha_4 TIME + \alpha_5 TIME^2) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R{\cdot}T + \beta_4 TIME)K$$

	Consumer expenditures	Non-durable consumption
α_0	829.14 (4.03)	470.83 (1.83)
α_1	− 11,117 (1.26)	42,606 (3.86)
α_2	157.81 (12.8)	31,477 (2.05)
α_3	− 1,579.1 (5.84)	− 2,248.8 (6.66)
α_4	109.85 (4.80)	64,973 (2.27)
α_5	− 16,442 (12.2)	− 34,487 (20.5)
β_0	0.03315 (8.85)	0.05480 (11.7)
β_1	1.2317 (11.1)	0.58910 (4.24)
β_2	− 0.0011627 (34.6)	− 0.0011529 (27.4)
β_3	− 0.026047 (10.0)	0.000988 (0.30)
β_4	0.0008039 (7.95)	0.001975 (15.6)
$\bar{R}^2$	0.9344	0.9586
$F(10, 169)$	240.66	391.26

NOTE See Table 6-1.

In the case of Table 6-5, the calculated F-statistics for H_0: $\alpha_1 = \alpha_2 = \alpha_3 = 0$ are 44.8 and 25.3; in the case of Table 6-6, they are 58.9 and 14.8. Once again, this hypothesis is soundly rejected at conventional significance levels,[4] in contrast to the simple life-cycle specification that constrains age and interest-rate effects to operate solely through the *MPC* term.

Turning to the regression results themselves, one finds similar patterns of coefficients on the intercept and *MPC* expressions as in Table 6-4. The regression fits are considerably improved, particularly for the non-durable consumption equation. In the case of the consumer-expenditure equation, the only real changes are reductions (in absolute value) of the negative intercept coefficients on R and $R{\cdot}T$. In the case of the non-durable consumption equation, a number of the coefficients are reduced considerably (in absolute value).

The two principal findings of this section, then, are: (i) age and interest-rate changes definitely appear to affect consumption in ways other than through a joint *MPC* expression for life-cycle wealth; and (ii) time-structural shifts appear clearly significant in both intercept and marginal propensity-to-consume expressions.

Tests for Different *MPC* Effects across Wealth Components

We now investigate further the issue of how marginal propensity-to-consume expressions differ across various forms of life-cycle wealth. It has already been seen that different components of life-cycle wealth (*KH*, *YL*, and *A*) have impacts of quite different magnitudes on consumption, and that the structure of *MPC* interaction effects differ, particularly between *YL* and *KH*. Consequently, we wish to estimate a yet more unrestricted or more general model for consumption which allows for completely separate *MPC* expressions (with R and T interactions) for each of the major components of life-cycle wealth. This will allow one to formally test for differences in the structure of *MPC* expressions between wealth components. It will also, as an aside, allow one to test the significance of the *KH* component within the framework of quite general specifications.

Three general specifications which are considered here are:

$$\begin{aligned} C = {} & (\alpha_0 + \alpha_1 R + \alpha_2 T + \alpha_3 R{\cdot}T) \\ & + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R{\cdot}T) YL \\ & + (\gamma_0 + \gamma_1 R + \gamma_2 T + \gamma_3 R{\cdot}T) A \\ & + (\delta_0 + \delta_1 R + \delta_2 T + \delta_3 R{\cdot}T)[KH\text{-}YL] + u \qquad (6.6) \end{aligned}$$

and

$$\begin{aligned} C = {} & (\alpha_0 + \alpha_1 R + \alpha_2 T + \alpha_3 R{\cdot}T + \alpha_4 TIME + \alpha_5 TIME^2) \\ & + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R{\cdot}T) YL \\ & + (\gamma_0 + \gamma_1 R + \gamma_2 T + \gamma_3 R{\cdot}T) A \\ & + (\delta_0 + \delta_1 R + \delta_2 T + \delta_3 R{\cdot}T)[KH\text{-}YL] + u \qquad (6.7) \end{aligned}$$

and

$$\begin{aligned} C = {} & (\alpha_0 + \alpha_1 R + \alpha_2 T + \alpha_3 R{\cdot}T + \alpha_4 TIME + \alpha_5 TIME^2) \\ & + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R{\cdot}T + \beta_4 TIME) YL \\ & + (\gamma_0 + \gamma_1 R + \gamma_2 T + \gamma_3 R{\cdot}T + \gamma_4 TIME) A \\ & + (\delta_0 + \delta_1 R + \delta_2 T + \delta_3 R{\cdot}T + \delta_4 TIME) \\ & [KH\text{-}YL] + u. \qquad (6.8) \end{aligned}$$

Separate intercept terms in R and T are also allowed.

The first thing to consider in these general specifications is the statistical significance of including an earnings expectations component of wealth. Accordingly, we test the joint hypothesis H_0: $\delta_1 = 0$ for all the δ coefficients in an equation. The test is performed as a standard joint F-test for each specification, and resulting test statistics are provided in Table 6-7. Figures are given for each of the equations 6.6 to 6.8. As can be seen from the table, seven of the eight test statistics are significant at a 95 per cent level of confidence (and all at the 90 per cent level.) Once again, future earnings expectations or human capital do indeed appear to have a statistically significant effect on consumer expenditures.[5]

One can also formally test the simple life-cycle specifications that the coefficient structure of *MPC* terms is the same across different sources of life-cycle wealth.

Table 6-7

Tests on the Significance of Earnings Expectation Term

	Consumer expenditures	Non-durable consumption
Eq. 6.6 ($F(0.95) = 2.45$)	4.94	2.27
Eq. 6.7 ($F(0.95) = 2.45$)	71.2	88.5
Eq. 6.8 ($F(0.95) = 2.29$)	15.0	15.1

More formally, this hypothesis may be stated as H_0: $\beta_l = \gamma_l = \delta_l$ for all *MPC* coefficients in each of the equations 6.6 to 6.8. The *F*-test results for these tests are provided in Table 6-8 along with corresponding critical values. Quite clearly, the estimated statistics are an order of magnitude greater than the critical values at any standard level of confidence.[6] So the *MPC* coefficient structure is indeed highly significantly different among different lifetime wealth components. This is a clear rejection of the simple life-cycle specification that all wealth components affect consumption through a common marginal propensity to consume.

Equations 6.6 to 6.8 are the most general specifications estimated and presented for this study and clearly incorporate almost all earlier equations of this chapter and Chapter 4 as special cases. Estimation results for these equations are presented in Tables 6-9 to 6-11.

Turning to a brief evaluation of these equations, one notes first of all that summary regression statistics are all quite favourable with $\bar{R}^2$s, for example, in the range of 0.95–0.99. The age effect has a generally similar pattern across equations, particularly between equations 6.7 and 6.8 that adjust for time shifts. *MPC*s generally rise with age in the case of current earnings and expected earnings components (i.e., dominant negative coefficients on *T*), and generally decline with age in the case of assets (in the time-shift equations). The effect of interest-rate changes also has a generally similar pattern across equations. *MPC*s generally decrease with higher *R*s in the case of current earnings and expected earnings components (in the time-shift equations), and increase with *R* in the case of assets. Interest rates also have a general negative effect via the intercept term. One thus finds that the two human capital components, current earnings and expected earnings, share relatively similar age and interest-rate effects, particularly in the time-shift equations. Assets generally show an opposite pattern of age and interest rates on their *MPC*. The general finding of this section, then, is that of highly significantly different *MPC* coefficients among the various components of life-cycle wealth, but of closer similarity between those for the two human capital components than for assets.

More generally, this chapter has found the evidence is quite consistent with the life-cycle inclusion of human capital or expected future earnings in a consumption function and with a general similarity in *MPC* interaction effects between current and future earnings. However, the evidence does not at all support some of the stronger constraints of the simple life-cycle model that *MPC*s are all the same across lifetime wealth components or that age and interest-rate effects operate only through an MPC term. In particular, current earnings appear to have considerably stronger marginal impacts on consumption than do expected earnings or assets.

Table 6-8

Test Statistics of the Homogeneity of Marginal Propensities to Consume

(*F*-statistics for H_0: $\beta_l = \gamma_l = \delta_l$ for all *i*)

	Consumer expenditures	Non-durable consumption
Eq. 6.6 ($F(0.99) = 2.66$)	119.7	78.4
Eq. 6.7 ($F(0.99) = 2.66$)	308.3	151.6
Eq. 6.8 ($F(0.99) = 2.47$)	235.7	75.5

Table 6-9

$$C = (\alpha_0 + \alpha_1 R + \alpha_2 T + \alpha_3 R \cdot T) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T) YL + (\gamma_0 + \gamma_1 R + \gamma_2 T + \gamma_3 R \cdot T) A + (\delta_0 + \delta_1 R + \delta_2 T + \delta_3 R \cdot T) [KH\text{-}YL]$$

	Consumer expenditures	Non-durable consumption
α_0	812.62 (2.04)	1,749.7 (1.77)
α_1	– 0.11216E-6 (4.91)	– 0.34096E-6 (5.95)
α_2	31,259 (1.34)	42,747 (0.74)
α_3	1,393.6 (2.34)	4,974.2 (3.36)
β_0	1.1461 (10.2)	1.5080 (5.39)
β_1	14,968 (2.66)	51,177 (3.67)
β_2	– 0.007957 (2.51)	– 0.020595 (2.62)
β_3	– 0.12803 (0.81)	– 0.61591 (1.57)
γ_0	– 0.03032 (3.05)	– 0.11579 (4.68)
γ_1	5.2258 (9.74)	13,785 (10.3)
γ_2	– 0.0069215 (8.28)	– 0.018883 (9.09)
γ_3	– 0.19270 (3.21)	– 0.47428 (3.18)
δ_0	– 0.009243 (1.49)	0.01860 (1.20)
δ_1	0.13225 (0.69)	– 0.10274 (0.22)
δ_2	– 0.0002746 (3.91)	– 0.0004867 (2.79)
δ_3	– 0.003805 (0.97)	0.0008568 (0.09)
$\bar{R}^2$	0.9802	0.9507
$F(15, 164)$	542.52	211.06

NOTE See Table 6-1.

Table 6-10

$$C = (\alpha_0 + \alpha_1 R + \alpha_2 T + \alpha_3 R \cdot T + \alpha_4 TIME + \alpha_5 TIME^2) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T) YL + (\gamma_0 + \gamma_1 R + \gamma_2 T + \gamma_3 R \cdot T) A + (\delta_0 + \delta_1 R + \delta_2 T + \delta_3 R \cdot T) [KH\text{-}YL]$$

	Consumer expenditures	Non-durable consumption
α_0	574.19 (2.58)	1,452.1 (2.83)
α_1	– 13,100 (0.99)	– 87,233 (2.86)
α_2	– 366.07 (15.8)	– 961.95 (18.0)
α_3	3,537.4 (10.4)	10,134 (12.9)
α_4	– 43,117 (4.86)	– 148.87 (7.28)
α_5	– 6.6211 (11.4)	– 14,604 (10.9)
β_0	1.4827 (23.6)	2.3244 (16.0)
β_1	– 12,383 (3.62)	– 22,602 (2.87)
β_2	– 0.016398 (9.23)	– 0.040390 (9.86)
β_3	– 0.018836 (0.21)	– 0.18348 (0.87)
γ_0	– 0.01514 (2.79)	– 0.08096 (6.47)
γ_1	1.8262 (5.48)	5.3173 (6.92)
γ_2	0.0045037 (6.25)	0.010472 (6.30)
γ_3	0.094675 (2.49)	0.32284 (3.68)
δ_0	0.08257 (16.5)	0.20041 (17.4)
δ_1	– 0.21529 (1.95)	– 1.1615 (4.55)
δ_2	– 0.0001025 (2.59)	– 0.4493E-5 (0.05)
δ_3	0.030446 (11.1)	0.090475 (14.3)
$\bar{R}^2$	0.9944	0.9881
$F(17, 162)$	1,705.9	788.80

NOTE See Table 6-1.

Table 6-11

$$C = (\alpha_0 + \alpha_1 R + \alpha_2 T + \alpha_3 R \cdot T + \alpha_4 TIME + \alpha_5 TIME^2) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T + \beta_4 TIME) YL + (\gamma_0 + \gamma_1 R + \gamma_2 T + \gamma_3 R \cdot T + \gamma_4 TIME) A + (\delta_0 + \delta_1 R + \delta_2 T + \delta_3 R \cdot T + \delta_4 TIME) [KH\text{-}YL]$$

	Consumer expenditures	Non-durable consumption
α_0	−49,903	108.58
	(0.20)	(0.21)
α_1	13,579	−38,541
	(0.83)	(1.14)
α_2	−156.28	−363.81
	(4.41)	(4.95)
α_3	1,100.8	3,590.8
	(2.15)	(3.39)
α_4	4.2718	−54,182
	(0.26)	(1.59)
α_5	−4.9420	−12,740
	(4.55)	(5.66)
β_0	1.1178	1.2564
	(14.9)	(8.06)
β_1	−12,247	−17,596
	(3.65)	(2.53)
β_2	−0.0063425	−0.01177
	(3.01)	(2.69)
β_3	0.14686	0.20234
	(1.62)	(1.08)
β_4	−0.0030175	−0.0030019
	(1.15)	(0.55)
γ_0	0.03684	0.04909
	(3.61)	(2.33)
γ_1	0.93623	3.5413
	(2.06)	(3.76)
γ_2	0.0015389	0.0019913
	(1.83)	(1.14)
γ_3	0.083488	0.25179
	(2.37)	(3.45)
γ_4	−0.0030466	−0.0060184
	(3.24)	(3.09)
δ_0	0.04408	0.08807
	(6.43)	(6.20)
δ_1	−0.039189	−0.58917
	(0.39)	(2.80)
δ_2	−0.0001852	−0.0002309
	(4.78)	(2.88)
δ_3	0.012885	0.039814
	(3.78)	(5.65)
δ_4	0.7519E-4	0.0004962
	(0.86)	(2.76)
$\bar{R}^2$	0.9959	0.9928
$F(20, 159)$	1,909.4	1,098.1

NOTE See Table 6-1.

7 Short-Run Interest-Rate Sensitivity of Consumption and Savings

It is useful to recall that one of the objectives of this study is to obtain estimates of the interest-rate sensitivity of savings since capital income tax changes affect savings partly through the interest rate. So far, the discussion in this study has been devoted to the underlying life-cycle theory of consumption and savings and to the empirical estimates of implied consumption equations. In this chapter, we take some of the regression estimates of Chapters 5 and 6 and analyse their implications for the interest-rate sensitivity of consumption and savings. While the previous two chapters focused on the qualitative effects of variables such as age and interest rates, the present discussion focuses more narrowly on the actual magnitudes or quantitative values of real interest-rate effects. Recall also that the interest rate we are talking about is the real after-tax rate

$$R = RL(1 - TRY) - INFEXP,$$

where RL is the long-term nominal interest rate, TRY is the tax rate, and $INFEXP$ represents inflationary expectations. Thus tax-rate effects are seen to operate through interest-rate effects which are analysed in this chapter. Note also that the effects analysed in this chapter and the next all refer to the effects of assumed permanent changes in tax and interest rates. As pointed out at the beginning of Chapter 5, the lifetime wealth formulation of the life-cycle consumption model can be equivalently re-expressed as a permanent income formulation. Consequently, all the short-run interest-rate effects of this chapter and the long-run simulation effects of the next chapter refer to changes which are viewed as permanent rather than just transitory or temporary.

In the next section, various theoretical components of the interest-rate effect in the life-cycle model are reviewed. The components are then examined empirically in some detail in the following section using illustrative results from Table 5-3. Summary interest-rate effects on consumption based on the preferred equations of Chapter 5 are presented in the next section, and their corresponding effects on savings are provided in the following section. The chapter concludes with a brief review of major empirical findings. The interest-rate effects considered here are impact or short-run effects. They show the immediate impact of interest-rate changes on savings and consumption. Long-run effects are considered in the next chapter where some life-cycle simulations are presented.

Short-Run Interest-Rate Effects in a Life-Cycle Model

The basic theory of the life-cycle model of consumption and savings has already been discussed in some detail in Chapter 2. Here we simply review the calculations involved in computing empirical estimates of the interest-rate effects in terms of the empirical specifications employed in the regression analysis of the last two chapters. Calculations are illustrated in terms of the relatively simple life-cycle regression specification

$$C = \alpha + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R{\cdot}T)[KH + A], \qquad (7.1)$$

where, as before,

- C – consumer expenditures,
- R – the real after-tax interest rate,
- T – the number of remaining years of life (= 72-age),
- $R{\cdot}T$ – an interaction term between R and T,
- KH – the human capital stock component of life-cycle wealth, and
- A – the current asset component of life-cycle wealth.

Consumption and wealth components are all expressed in real per capita terms. For convenience, let the marginal propensity-to-consume expression be represented by

$$MPC = \beta_0 + \beta_1 R + \beta_2 T + \beta_3 R{\cdot}T.$$

Calculations based on more complicated expressions than 7.1 for the consumption function can be carried out in obvious analogous fashion.

The full marginal effect of interest-rate changes on consumption can be decomposed into two components:

$$\frac{\delta C}{\delta R} = \left(\frac{\delta MPC}{\delta R}\right)[KH + A] + MPC\left(\frac{\delta KH}{\delta R}\right). \qquad (7.2)$$

The first or "MPC effect" depends on the sign of $\delta MPC/\delta R$, the second or "KH effect" depends on the sign of $\delta KH/\delta R$. Since KH is simply the discounted present value of current and expected future earnings, the second derivative is clearly negative. The first derivative we have seen from the life-cycle theory can go either way. Empirically, this is almost always estimated to be positive - a result which is robust across alternative specifications. Thus,

$$\frac{\delta C}{\delta R} = \left(\frac{\delta MPC}{\delta R}\right) [KH + A] + MPC \left(\frac{\delta KH}{\delta R}\right)$$
$$\quad\;(+) \qquad\quad (+) \qquad\quad (+) \quad (-)$$

$$= MPC \text{ effect} + KH \text{ effect.}$$
$$\quad (+) \qquad\qquad (-)$$

Consequently, the full or net interest-rate effect is ambiguous. What is more, it typically turns out to be relatively small in magnitude compared to the size of its two components. Table 7-1 presents average values of the three effects based on equations 5.1 and 5.2 of Chapter 5, and calculated as a weighted average over the 180 observations of the data set of the study. As can be seen, the net effect or $\delta C/\delta R$ is very much a residual between two considerably larger components of opposite sign.

The expected pattern of each of these effects disaggregated across age groups, however, is fairly clear. Since total life-cycle wealth, $KH + A$, decreases with age while $\delta MPC/\delta R$ generally increases with age, the *MPC* effect generally has a single-peaked concave pattern illustrated in Figure 7-1. Similarly, as the *MPC* increases systematically with age whereas $\delta KH/\delta R$ decreases (in absolute value) with age (there being less human capital to operate on at higher ages), the *KH* effect also turns out to be single-peaked, though in a negative direction, as illustrated in Figure 7-2. A possible net outcome of these two profiles is a profile such as illustrated in Figure 7-3 where the net effect peaks at extreme ages and troughs at a middling young age. However, other patterns are possible. These will be illustrated empirically in the next section.

Table 7-1

Illustrative Calculations of the *MPC*, *KH*, and Net Effects*

Equation	*MPC* effect	*KH* effect	Net effect
		(1971 dollars)	
Table 5-2	901.29	−608.17	293.12
Table 5-3	649.72	−646.22	3.50

* Based on a 1 percentage point increase in *R*.

Figure 7-1

Illustrative *MPC* Effect, by Age Group

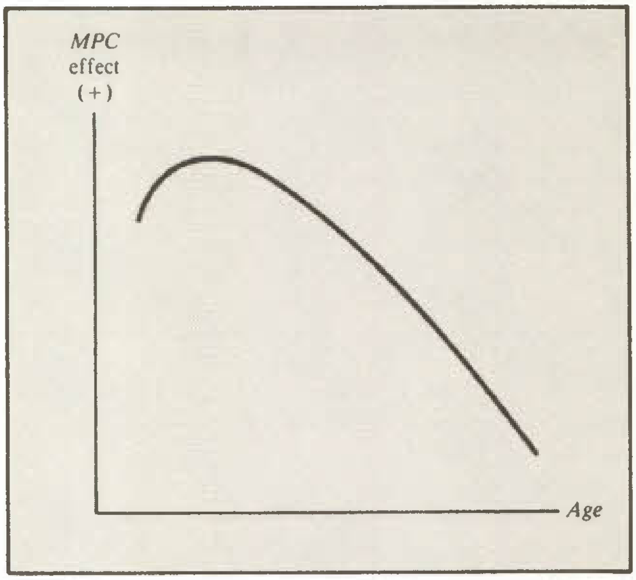


Figure 7-2

Illustrative *KH* Effect, by Age Group

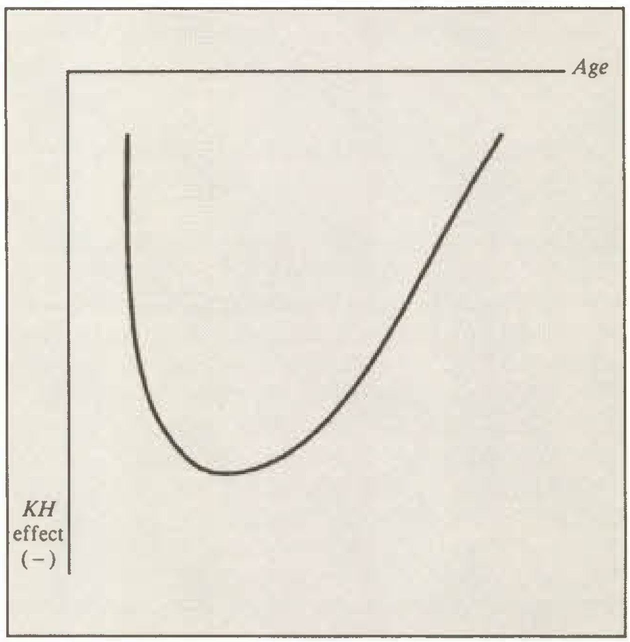


Figure 7-3

Illustrative Net Consumption Effect, by Age Group

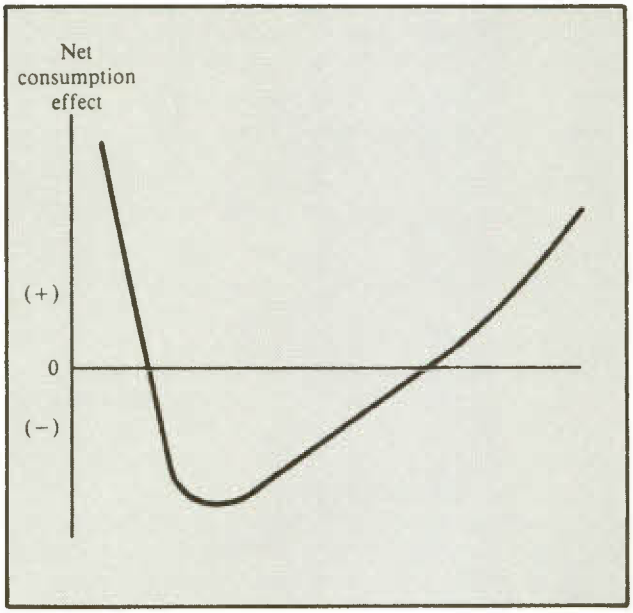
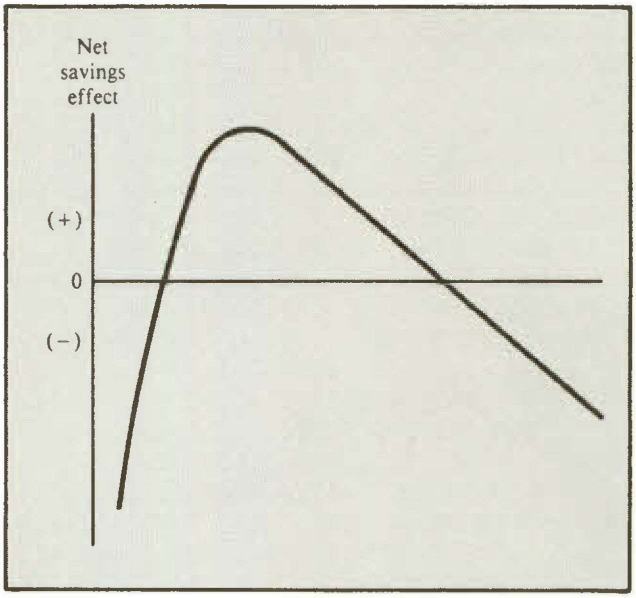


Figure 7-4

Illustrative Net Savings Effect, by Age Group



The effect of interest-rate changes on savings can be obtained simply by viewing savings as the alternative to consumption out of income. Since savings is defined by:

$$S = [\text{after-tax non-capital income} + R \cdot A] - C,$$

therefore,

$$\frac{\delta S}{\delta R} = A - \frac{\delta C^1}{\delta R}$$

$$= \underset{(+)}{\text{income effect}} - \underset{(?)}{\text{consumption effect}}. \quad (7.3)$$

Thus, if the net consumption effect is negative, the effect on savings is strictly positive. But if the consumption effect turns out positive, the effect on savings is once again indeterminate in sign. Disaggregating by age group, one would once again expect a systematic pattern. The negative of the net consumption effect is illustrated as the solid line in Figure 7-4. Add to this a vertical displacement corresponding to the positive income effect, A, which increases with age, and one obtains the dashed line. Consequently, except perhaps for the youngest age group, one would expect an effect on savings that would decrease (algebraically) with age.

These interest-rate effects on consumption and savings are now examined empirically on the basis of the regression estimates of the last chapter.

Illustrative Examination of Consumption and Savings Effects

Before considering the summary results of interest-rate effects on consumption and savings from the alternative regressions of the last two chapters, it is useful to examine in more detail the various components of these effects from some actual empirical results. One can then better understand the calculations and impact patterns involved that underlie the summary results of subsequent sections of this chapter. Regression results used in the following illustrative discussion are those of Table 5-3, corresponding to the specification:

$$C = (\alpha_0 + \alpha_1 TIME + \alpha_2 TIME^2)$$
$$+ (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T)K + u.$$

Calculations are done for the second column, consumer expenditures using a weighted regression. Marginal propensity-to-consume values by age group for this equation (evaluated at the mid-period 1971 values) are presented in Table D-1 (see Appendix D). They are seen to rise monotonically with age from 0.02 to 0.10. The table also presents implied *MPC*s out of permanent income as indicated in the introduction to Chapter 5. Excepting the two extreme age groups, implied *MPC*s out of permanent income do not differ greatly from one and follow an inverse U-shaped pattern across age groups.

Figures for the *MPC* effect $(\delta MPC/\delta R)[KH + A]$, are presented by age in the first column of Table 7-2 and expressed in percentage terms relative to C in the second column. Results for the *KH* effect, *MPC* $(\delta KH/\delta R)$, expressed in absolute and relative terms, are presented in Table 7-3. The latter involves calculating the marginal propensity to consume out of total lifetime "wealth," K, and these figures on the *MPC* by age group are provided in Table D-2. Calculations are performed by computing each of the two components (the *MPC* effect and the *KH* effect) for each age-year for all of our data set, and then calculating weighted averages by year for each age group (on the basis of the number of observations in each cell).[2] Figures in Tables 7-2 and 7-3 refer to the regression estimates in the second column of Table 5-3.

The estimated *MPC* effects in Table 7-2 are indeed all positive and follow the expected pattern in Figure 7-1. That is, they initially rise, peak in the third or fourth age group, and then monotonically decrease. The lowest effects occur at the extreme age groups. In relative terms, the *MPC* effect is estimated to vary from an 11 to a 23 per cent increase in consumption corresponding to a 1 percentage point increase in R.

The estimated *KH* effects in Table 7-3 all turn out negative and again appear of a similar pattern to Figure 7-2. In this case, the trough occurs in the second age group, with the most minor effects occurring at the oldest age groups. Expressed in relative terms, the *KH* effect is estimated to vary between a 1 and a 30 per cent decrease corresponding to a 1 percentage point increase in R. The relative effect monotonically rises from the youngest to the oldest age group.

The sum of the *MPC* effect and the *KH* effect is the net consumption effect, $\delta C/\delta R$, which is estimated by age group in Table 7-4. The figures are mixed, positive and negative, and rise virtually monotonically with age. Overall, the net consumption effect is positive. That is, figures start off large and negative and then increase to be large and positive. Over the younger age groups, the (negative) human capital effect dominates, whereas over the later age group, the (positive) *MPC* effect dominates. Clearly, the overall effect of interest-rate changes on aggregate consumption in the economy depends heavily on the demographics of the economy's population. As the age distribution of the population changes, so too will the aggregate interest elasticity of consumption and thus savings.

The net consumption effect in relative terms is also presented in Table 7-4. Clearly, the very youngest and older age groups experience the strongest effects in absolute terms. The largest negative effects are of the order of a 7 per cent decrease in consumption, while the largest positive effects are a 21 per cent increase in consumption for a 1 percentage point increase in R.

Table 7-2

The *MPC* Effect of a 1 Percentage Point Increase in *R*, by Age Group

	Effect on consumer expenditures (1971 dollars)	Percentage change in consumption
Age group:		
Under 25	618.28	22.58
25-29	793.68	17.75
30-34	847.19	16.60
35-39	823.60	15.35
40-44	756.03	14.26
45-49	666.55	13.32
50-54	560.65	12.40
55-59	454.70	11.56
60-64	371.28	11.60
65 and over	359.98	22.64
Overall	649.72	18.36

SOURCE Based on column 2 of Table 5-3.

Table 7-3

The *KH* Effect of a 1 Percentage Point Increase in *R*, by Age Group

	Effect on consumer expenditures (1971 dollars)	Percentage change in consumption
Age group:		
Under 25	−821.55	−29.53
25-29	−1,036.28	−23.18
30-34	−1,009.04	−19.77
35-39	−866.70	−16.15
40-44	−680.05	−12.83
45-49	−488.96	−9.77
50-54	−313.45	−6.93
55-59	−172.28	−4.38
60-64	−74.13	−2.32
65 and over	−12.64	−0.80
Overall	−646.22	−16.38

SOURCE See Table 7-2.

The corresponding effects on savings are provided in Table 7-5. As can be seen from the first column, the effect of higher interest rates is to increase savings for the first four age groups but to decrease them for the remainder. This shows the importance of the *KH* effect by age group which tends to be much larger for younger persons. The overall effect tends to be positive, but the variability of the savings effect by age is considerable. This is also reflected in the second column showing percentage changes.

Net Interest-Rate Effects on Consumption

In this section, the summary implications for interest-rate effects on consumer expenditures are worked out for several of the equations of Chapters 5 and 6. The last section reviewed various components of the interest-rate effect in some detail. So here we review only the net or final effects. We also focus mainly on the results of Chapter 5, as this may be thought of as containing the more basic or simpler regression equations of the study. One equation from Chapter 6 is chosen for illustration.

Since space prohibits analysing all the regression equations specified in Chapter 5, only a selection of what are judged to be the more successful equations are examined here. Major empirical findings, though, are found to be quite robust to the alternative specifications examined. In the discussion to follow, interest-rate effects in six equations are analysed:

eq. (1) - found in Table 5-3 (simple life-cycle equation with intercept time shifts)

eq. (2) - found in Table 5-4 (simple life-cycle equation with *MPC* and intercept time shifts)

eq. (3) - found in Table 5-6 (life-cycle equation with different *MPC* out of *KH* and *A*; no time shifts)

eq. (4) - found in Table 5-7 (life-cycle equation with different *MPC* out of *KH* and *A*, and time shifts)

eq. (5) - found in Table 5-14 (naive equation with *YL* and *A*)

eq. (6) - found in Table 6-11 (most general equation nesting others; different *MPC* out of *YL*, *KH-YL* and *A*, and time shifts).

For each of these equations, Table 7-4 was drawn up of the net interest-rate effects on consumption in level or (real) dollar terms corresponding to a 1 percentage point increase in *R*. Thus, for each equation specification, one obtains a single age-specific series of interest-rate effects in dollar terms. For the life-cycle equations (1) to (4), the same monotonically increasing pattern is

Table 7-4

The Net Consumption Effect of a 1 Percentage Point Increase in *R*, by Age Group

	Effect on consumer expenditures (1971 dollars)	Percentage change in consumption
Age group:		
Under 25	–203.27	–7.31
25-29	–242.60	–5.43
30-34	–161.84	–3.17
35-39	–43.10	–0.80
40-44	75.97	1.42
45-49	177.59	3.55
50-54	247.19	5.47
55-59	282.42	7.18
60-64	297.15	9.29
65 and over	347.34	21.85
Overall	3.50	1.98

SOURCE See Table 7-2.

Table 7-5

The Effect on Savings of a 1 Percentage Point Increase in *R*, by Age Group

	Effect on consumer expenditures (1971 dollars)	Percentage change in consumption
Age group:		
Under 25	209.59	133.13
25-29	258.41	74.77
30-34	191.52	34.67
35-39	91.67	11.72
40-44	–4.44	–0.43
45-49	–76.51	–5.59
50-54	–112.11	–6.49
55-59	–109.77	–5.30
60-64	–80.50	–3.41
65 and over	–31.75	–1.14
Overall	82.16	59.29

SOURCE See Table 7-2.

found, as described in Table 7-4. For the naive equation (5), the impacts of interest-rate changes are specified to be the same across all 10 age groups. Equation (6) combines the naive and the life-cycle specifications in the same equation. For it, interest-rate effects on consumption are positive and increase with age.

The net interest-rate effects on consumption are then converted into percentage or relative terms by dividing each cell entry by the mean consumption level for that cell and the results aggregated by age using the number of filers in each cell. The resulting percentage effects are provided in Table 7-6 and once again correspond to the results of a 1 percentage point increase in *R*. As can be seen, percentage changes rise virtually monotonically with age for the life-cycle and nested specifications, while for the naive equation (5) they fall and then rise until retirement. Similarly, weighted consumption elasticities for each age group are calculated and presented in Table 7-7. Notice that these elasticities are computed by aggregating consumption elasticities for each cell at the interest-rate variable applicable for the cell. Thus these elasticities by age have not been computed for a common interest rate. Consumption elasticities tend on average to be quite small, always less than 0.05. For the life-cycle equations, they are actually negative for lower age groups reflecting the relative importance of the human wealth effect for these groups. Thus the age profile of the population is important. An economy with an aging population would have an increasing aggregate interest elasticity of consumption.

It should be noted that consumption effects and elasticities tend to be higher for both the naive and nested specifications than for the life-cycle specifications. This is due to the fact that the latter interest-rate changes are forced to have a human wealth effect, which reduces consumption. For equations (5) and (6), the interest rate is allowed to enter independently and always shows a positive coefficient. Unfortunately, for equation (6), the coefficient on *R*, though large and positive, is not actually significant. Thus we might be cautious about these estimates of the effects of interest-rate changes for that equation.

Interest-Rate Effects on Savings

Turning from the interest-rate responses of consumption in the last section, we examine the implications for savings. From the dollar consumption effects and asset holdings by cell, a corresponding set of dollar savings effects are computed using equation (3). These are reported in Table 7-8 for the same six equations. Savings effects are given as percentage changes by age group corresponding to a 1 percentage point increase in the after-tax real interest rate. These savings effects are somewhat more mixed than the consumption effects. For the four life-cycle equations, the savings effect initially declines with age, reaches a trough, and then rises gradually. The trough occurs at varying ages from 40 to post-retirement. For the first three, the savings effect remains essentially negative for the older cohorts, while for equation (4), it becomes positive after age 50. This troughing reflects the combined effects of the larger human wealth effect for the younger groups and the higher asset wealth for the older groups.

Table 7-6

The Net Consumption Effect of a 1 Percentage Point Increase in *R*, by Age Group

(Expressed as per cent)

	Equation					
	(1)	(2)	(3)	(4)	(5)	(6)
Age group:						
Under 25	−7.31	−1.47	−5.69	−1.12	2.853	0.280
25-29	−5.43	−4.61	−3.83	−1.01	1.778	0.454
30-34	−3.17	−3.87	−2.08	0.03	1.563	0.799
35-39	−0.80	−2.17	−0.32	0.93	1.485	1.240
40-44	1.43	−0.37	1.37	1.72	1.506	1.750
45-49	3.55	1.36	3.10	2.31	1.601	2.361
50-54	5.47	3.03	5.01	2.56	1.785	3.089
55-59	7.18	4.62	7.38	2.42	2.107	4.114
60-64	9.25	6.46	11.37	2.13	2.891	7.632
65 and over	21.85	15.69	37.32	4.74	6.932	25.228
Overall	1.97	1.50	4.83	1.16	2.49	3.85

Results for the naive equation show a much different pattern. The savings effect increases monotonically with age, being negative early in life and turning positive later on at about age 45. This pattern can be explained entirely by the fact that asset holdings rise with age so that the income effect of interest-rate increases also rises with age.

The nested equation (6) combines the effects of the naive equation with those of the life-cycle specifications. The savings effect falls and then rises, but the trough is much earlier in life and, as with the naive equation, it is positive and rising after age 45.

These results are converted into interest elasticities of savings in Table 7-9. The same pattern of signs prevails here as would be expected. For life-cycle equations, the weighted average elasticities range from 0.125 for the second equation to 0.927 for the first one. The most sophisticated equations and those with the best fit - (3)

Table 7-7

The Elasticity of Consumer Expenditures with Respect to Interest Rates, by Age Group

	Equation					
	(1)	(2)	(3)	(4)	(5)	(6)
Age group:						
Under 25	−0.096	−0.019	−0.075	−0.015	0.039	0.016
25-29	−0.070	−0.059	−0.049	−0.013	0.023	0.011
30-34	−0.041	−0.050	−0.027	0.0003	0.020	0.013
35-39	−0.011	−0.029	−0.004	0.012	0.020	0.018
40-44	0.019	−0.005	0.018	0.023	0.020	0.024
45-49	0.047	0.018	0.041	0.031	0.022	0.031
50-54	0.073	0.040	0.067	0.034	0.024	0.041
55-59	0.095	0.061	0.097	0.032	0.028	0.054
60-64	0.121	0.084	0.148	0.028	0.038	0.100
65 and over	0.266	·0.191	0.453	0.058	0.066	0.238
Overall	0.015	0.019	0.046	0.008	0.031	0.046

Table 7-8

The Effect on Savings of a 1 Percentage Point Increase in *R*, by Age Group

(Expressed as per cent)

	Equation					
	(1)	(2)	(3)	(4)	(5)	(6)
Age group:						
Under 25	113.13	29.98	104.48	23.75	−62.03	1.96
25-29	77.77	64.16	54.14	17.58	−24.61	0.72
30-34	34.67	41.13	24.55	5.13	−12.80	−0.01
35-39	11.72	21.10	8.39	−0.16	−6.43	−1.04
40-44	−0.43	8.75	−0.10	−1.87	−2.31	−0.82
45-49	−5.59	2.42	−3.94	−1.07	0.67	0.16
50-54	−6.49	−0.12	−5.28	1.11	2.82	1.36
55-59	−5.30	−0.43	−5.67	3.74	4.68	2.95
60-64	−3.41	−0.42	−6.25	6.30	6.92	3.53
65 and over	−1.14	2.37	−9.96	8.62	13.65	3.22
Overall	59.29	14.93	39.21	25.25	−17.48	1.13

and (4) - show an interest elasticity of about 0.5 to 0.6. These are the equations which allow the *MPC* to vary between human and non-human wealth. Elasticities for the naive equation are considerably lower, being negative on average. The difference between these two is largely due to the human wealth effect of interest-rate changes. The nested equation shows a slightly negative value, differing little from zero.

The interest elasticities of Table 7-9 are computed by aggregating the elasticities for each cell. This may be objected to on the grounds that the interest rates at which the elasticities are calculated vary considerably over the cells. In some years they are actually negative. One may wish to calculate elasticities for a more uniform set of interest rates. Table 7-10 presents interest elasticities for a year in which the real after-tax interest rates were about 2.7 per cent, differing over the cells because of different tax rates. This was the year 1971. Though the elasticities show a similar pattern over age groups, they tend to be much larger in magnitude when evaluated at these higher interest rates. Overall elasticities tend to be of the order of 1.21 to 1.26 for the more elaborate life-cycle equations, but they remain negative for the naive and nested versions. The age pattern of savings elasticities for the life-cycle equations (3) and (4) are illustrated in Figure 7-5.

What is clear from Table 7-10 is the importance of age as a determinant of savings behaviour. Not too much importance should be attached to the overall elasticities since they are contingent on the age pattern of the population. In the case of the calculations shown, the first two age groups constitute over 35 per cent of the tax-filing population, and that causes the overall average elasticity to be large and positive for the life-cycle equations and negative for the other two.

The Impact Effect of Income Redistributions

As mentioned earlier, reforms of capital taxation can influence savings behaviour in two ways. The first is through changes in the after-tax real interest as analysed above. The second is through differential wealth effects arising because different taxes are collected at different times in the life cycle. Impact effects of tax reforms which reallocate purchasing power across age groups can be deduced from the figures given in Table D-1 for the marginal propensity to consume current earnings by age. Only the life-cycle and nested equations are included here since the naive equation has identical wealth effects by age.

To illustrate the orders of magnitude involved, we have constructed Table 7-11 which shows the effect on savings of redistributing $1,000 from the highest age group to each of the others. Naturally, the younger the person to whom the redistribution is done, the greater the increase in savings (i.e., fall in consumption). For the life-cycle equations, $1,000 transferred from the retired to the youngest group increases savings by $50 to $65. For the nested equation, in which current earnings are allowed to enter separately from future human wealth, the impacts on savings are considerably more. For instance, transferring $1,000 from the highest to the lowest age groups raises savings by $324.

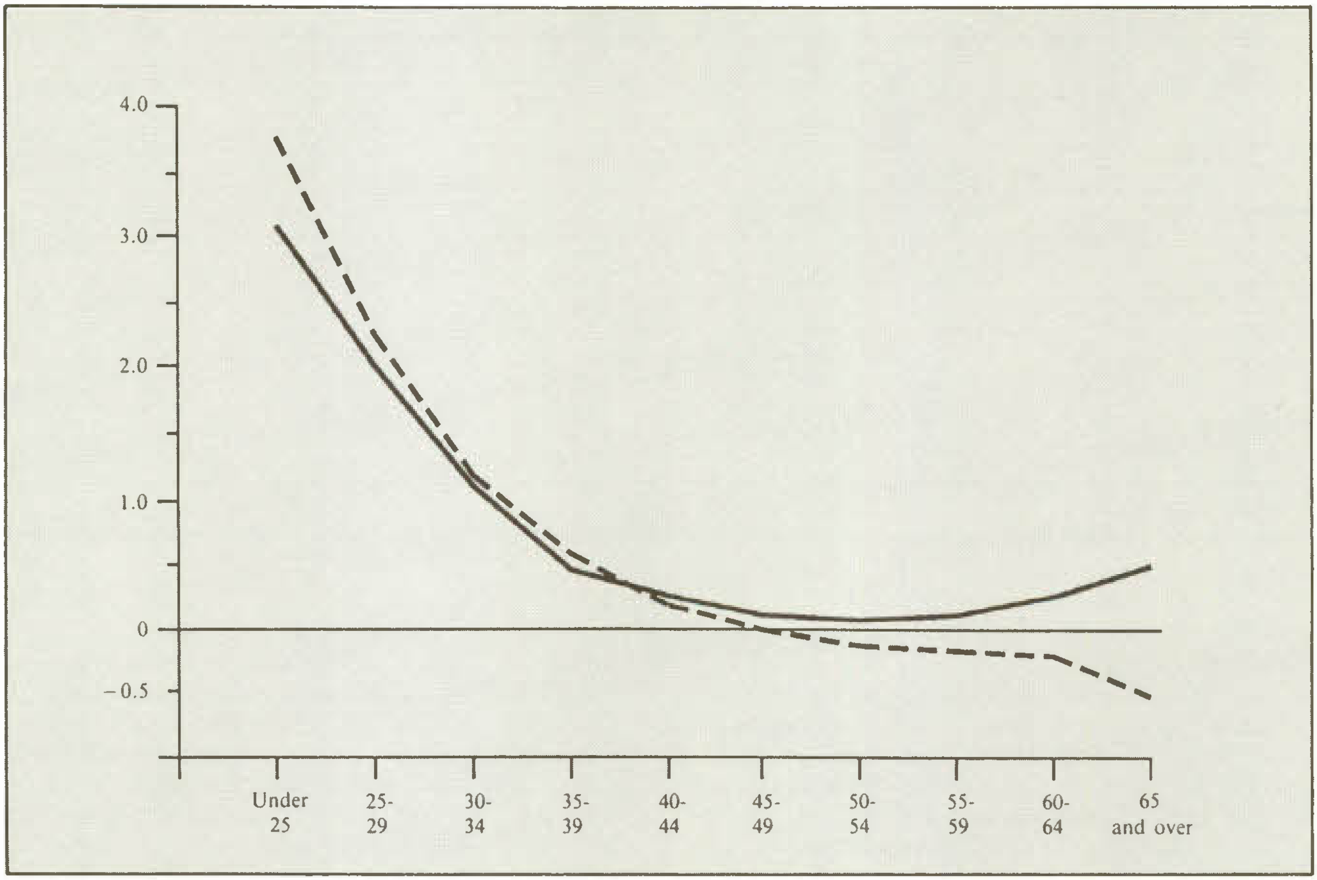
Table 7-9

The Elasticity of Savings with Respect to Interest Rates, by Age Group

	Equation					
	(1)	(2)	(3)	(4)	(5)	(6)
Age group:						
Under 25	1.757	0.396	1.379	0.313	−1.011	−0.215
25-29	0.961	0.825	0.696	0.226	−0.384	−0.065
30-34	0.445	0.528	0.315	0.066	−0.200	−0.034
35-39	0.156	0.280	0.112	−0.002	−0.105	−0.031
40-44	−0.006	0.118	−0.001	−0.025	−0.043	−0.018
45-49	−0.075	0.032	−0.053	−0.014	0.002	−0.001
50-54	−0.086	−0.002	−0.070	0.014	0.034	1.803
55-59	−0.070	−0.006	−0.075	0.049	0.063	4.265
60-64	−0.044	0.005	−0.081	0.082	0.099	5.569
65 and over	−0.014	0.029	−1.21	0.105	0.192	4.761
Overall	0.927	0.125	0.580	0.484	−0.288	−0.055

Figure 7-5

Short-Run Interest-Rate Elasticities of Savings, by Age Group



SOURCE: See Table 7-10.

Table 7-10

The Elasticity of Savings, by Age Group, 1971

	Per cent of population	R (per cent)	Equation (1)	(2)	(3)	(4)	(5)	(6)
Age group:								
Under 25	0.2365	3.12	6.868	3.086	3.757	3.090	-2.441	-0.716
25-29	0.1255	2.89	3.510	2.289	2.271	1.950	-0.982	0.145
30-34	0.0928	2.75	1.801	1.365	1.207	1.017	-0.539	0.212
35-39	0.0885	2.65	0.788	0.719	0.554	0.475	-0.284	0.114
40-44	0.0899	2.58	0.243	0.332	0.189	0.213	-0.129	0.092
45-49	0.0865	2.57	-0.029	0.117	-0.014	0.097	-0.037	0.111
50-54	0.0761	2.58	-0.145	0.013	-0.124	0.078	0.030	0.142
55-59	0.0650	2.57	-0.166	-0.012	-0.184	0.144	0.106	0.160
60-64	0.0502	2.59	-0.139	0.010	-0.250	0.243	0.189	0.162
65 and over	0.0891	2.72	-0.075	0.127	-0.577	0.481	0.450	0.080
Overall			2.285	1.259	1.265	1.210	-0.732	-0.067

Table 7-11

The Effect on Savings of Transferring $1,000 from those 65 and Over to each of the Other Age Groups

	Equation*				
	5-3	5-4	5-6	5-7	6-11
			(Dollars)		
Age group:					
Under 25	66.22	65.72	48.02	47.49	324.34
25-29	50.46	56.79	41.37	40.99	271.56
30-34	51.00	50.46	36.73	36.43	234.70
35-39	44.01	43.96	31.71	31.29	206.48
40-44	36.92	37.32	26.59	26.06	179.86
45-49	30.29	30.72	21.80	21.33	147.78
50-54	23.81	24.18	22.53	16.74	113.84
55-59	17.01	17.42	12.22	11.88	84.40
60-64	10.33	10.76	7.41	6.51	53.10

* By table number.

Conclusion

In this chapter, we have used some of the estimated consumption functions from earlier chapters to calculate the effect on consumption and savings of an increase in the after-tax real interest rate. Three features of those estimated equations are especially relevant. The first is that the coefficients on the interest-rate terms are uniformly positive. The second is that in the life-cycle specifications, interest-rate increases will indirectly reduce consumption through the human wealth effect. Finally, the age of a cohort is an important determinant of the life-cycle consumption and savings behaviour of households.

The results we obtain reflect these facts. The effect of interest-rate changes does vary systematically over households. Life-cycle specifications do tend to give higher savings elasticities than naive specifications. Indeed, for the latter, the elasticities seem to be negative overall. The order of magnitude of savings elasticities varies with the interest rate itself. Over the entire sample period, interest elasticities from life-cycle specifications tended to average about 0.5 for the preferred equations. That number compares with the figure of 0.4 reported by Boskin (1978) using aggregate data. It is considerably less than the figure of 2.0 favored by Summers (1981). However, if we restrict our calculations to years in which the after-tax real interest rate was about 2.7 per cent, the preferred elasticities rise to about 1.2. To repeat, this overall average is of limited interest because of the fact that it varies widely by age group.

The impact or short-run effects of this chapter capture only the instantaneous effects of capital income tax changes. To obtain longer-run effects, we must simulate the effects of tax changes over time. To that we now turn.

8 Simulated Long-Run Effects of Demographic and Tax Changes

Introduction

The effects calculated in the preceding chapter represent the impact or short-run effects of tax and interest-rate changes on consumption and savings. Perhaps of more relevance for tax reform issues is the long-run effect of tax-structure changes. The main purpose of this chapter is to report on simulations done on various age cohorts of the effect of two sorts of tax change. The first is the elimination of the existing tax on capital income and its replacement by a tax on consumer expenditures. The second alternative simulation is the replacement of the existing tax on capital income with increased taxes on labour income. Both sets of simulations are performed under the assumption that the government collects the same amount of tax revenue in each year from the economy as a whole.

From the literature on consumption taxation (e.g., Mintz, 1985), it is well known that there are two equivalent ways of levying a consumption tax. One is by the use of designated assets which allows firms to deduct savings contributed to registered assets much like the existing RRSP system, except without upper limits. This method is equivalent to taxing consumer expenditures as they occur. The second is the so-called prepayment method by which capital income is exempt from taxation. This method is equivalent to a tax on labour income alone. Our simulations can be interpreted as calculating the effect of tax reforms which move the system *towards* each of these two forms of consumption taxation.

A fuller treatment might investigate moving the system completely to one or the other sorts of consumption taxes. For example, moving to a completely designated-asset system would involve removing the tax on both capital and wage income and replacing it with a tax on consumer expenditures. We have not done that sort of simulation because it is not a particularly relevant policy alternative. Most suggestions for moving to a consumption tax would retain both designated assets and assets with prepaid taxes. Indeed, the systems advocated usually would give the taxpayer a choice as to which assets to hold in the designated form and which to hold as prepaid.

Tax change simulations we perform involve computing the path of consumption and net worth accumulation for various cohorts over the sample period under the existing and alternative tax structures, using some of the consumption functions we have estimated. The results of doing so when the alternative to the existing capital income tax is an increase in tax on consumer expenditures are presented later on. The subsequent section substitutes an increase in labour income taxes for the capital income tax. Before turning to those calculations, a much more straightforward simulation is reported – that of isolating the effects of demographic change alone on asset accumulation.

The Effect of Demographic Change on Asset Wealth Accumulation

As discussed earlier, our data have allowed us to calculate, for each of the 180 cells, the stock of both sheltered and unsheltered capital per capita. Aggregate holdings of capital by tax-filers in each year can be obtained by taking the weighted sum of asset holdings for each of the 10 age cohorts where weights are the number of tax-filers (*NOBS*) in the appropriate age-year cell. Obviously, aggregate asset demand for each year will depend upon the demographic composition of the tax-filing population.

In this section, we compare aggregate asset demands over each of the 18 years with what asset demands would have been had the age distribution of the population not changed over the 18 years. In particular, we assume the aggregate population of tax-filers in each year to be the same, but that in each year the age distribution to be the same as what it was in 1964. We then apply this new age distribution as weights in each year in averaging per capita asset demands to come up with an aggregate. Comparing these hypothetical annual aggregate demands for assets with the actual ones previously calculated will give some indication of the importance of demographic change *per se* as a determinant of changes in asset holdings.

In doing these calculations, we assume that per capita asset holdings remain identical and independent of the age distribution. This is a strong assumption and ignores both the general equilibrium impact of the age distribution on wage rates, interest rates, etc., and the fact that the age distribution of the population may bear a close relation with immigration characteristics. Since immigrants typically have different wealth holdings, this is not an innocuous assumption. Thus, our calculations should only be regarded as indicative rather than definitive.

Table 8-1 lists aggregate asset holdings for each of the 18 years as observed and calculated, holding the age structure of tax-filers constant. As might be expected, actual asset demands are higher under the existing age structure than they would have been had the age structure remained unchanged. That is, demographic changes caused asset demands to rise. This is presumably due to the bulge in population due to the baby boom working its way through the age structure.

As the data in Table 8-1 show, the magnitude of this demographic effect is not large. In the early 1970s, asset demands were over 5 per cent higher than what they otherwise might have been. However, as one approaches the 1980s, the proportionate rise in asset demands due to demographic considerations falls to less than 2 per cent. This evidence lends little support to the argument that rising savings rates can be attributed largely to demographic shifts in the population.

The Effect on Asset Wealth Accumulation of Replacing Capital Income Taxation with Consumption Taxation

Our empirical estimates of consumer expenditures incorporate three types of taxes: labour income taxes, capital income taxes and consumption taxes. This section and the next involve simulating the effects of eliminating capital income taxes and making up for lost revenues from one of the other taxes. In this section, it is the consumption tax that makes up for capital income tax revenues forgone. From an institutional tax-structure point of view, the tax reform undertaken in this section is exactly equivalent to removing the limits on RRSP donations. The proposed changes in tax assistance to pensions put forward in the November 1984 budget would have had roughly this effect if implemented.

The substitution of consumption taxation for capital income taxation so as to yield equal total revenues through time is a particularly straightforward exercise.

Table 8-1

The Effect of Changes in the Age Distribution of Tax-Filers on Aggregate Asset Demand, 1964-81

	Aggregate asset demand* ($ billions)		
Year	Actual population	Hypothetical population	Percentage change
1964	40.13	40.13	- -
1965	44.66	44.76	−0.22
1966	47.83	47.70	0.27
1967	51.68	50.84	1.63
1968	56.21	54.38	3.26
1969	60.35	57.93	4.01
1970	61.54	58.27	5.31
1971	59.71	56.37	5.59
1972	70.62	66.82	5.38
1973	87.00	82.67	4.98
1974	100.62	97.26	3.34
1975	104.56	100.65	3.74
1976	105.00	100.45	4.33
1977	109.22	103.91	4.86
1978	134.83	132.15	1.99
1979	162.60	158.29	2.65
1980	175.86	175.06	0.45
1981	188.45	186.08	1.26

* Sum of sheltered wealth (*KS*) and unsheltered wealth (*KU*) weighted by the number of persons per cell.

As we have seen in Chapter 1, if the consumer's lifetime utility takes the form of the discounted sum of future utilities, gross-of-tax consumer expenditures are independent of the tax rate on consumption taxes. Therefore, our simulation can concentrate entirely on the effects of removing the tax on capital income. Since removing the tax on capital income essentially involves a rise in the after-tax interest rate, simulation of this section essentially concentrates on the effect of this rise in capital returns.

The general procedure followed is to take a particular age cohort in 1964 and, using one of the estimated consumption functions, simulate the profile of asset accumulation for that household from 1964-81. In doing this simulation, one takes as given the existing pattern of after-tax labour earnings, sheltered savings, and interest rates. Then, for the same cohort, the profile of asset accumulation is simulated assuming the same consumption function, initial wealth, and profile of after-tax labour income, sheltered savings, and interest rates. The two asset accumulation profiles are then compared. Notice that this procedure assumes that changes in the after-tax interest rate affect only unsheltered savings. Since the return on sheltered savings is already tax free, removal of the tax on capital income should not affect this form of savings.

Details of the simulations are as follows. Consider a particular age cohort in 1964. For that age cohort, the trajectory of asset holdings over the 1964-81 period is constructed with the aid of two basic equations:

$$C_1 = \alpha (R_1, T_1) \cdot (KH_1 + KU_1 + KS_1) \qquad (8.1)$$

and

$$SU_1 = (\text{earnings})_1(1\text{-}t_w) + YKU_1(1\text{-}t_r) - SS_1 - C_1. \qquad (8.2)$$

The first equation is one of the estimated consumption functions showing how consumption in year *i* is related to various forms of wealth, the after-tax real interest rate, and age. The second equation is the identity relating unsheltered savings in year *i* to income less taxes, consumption, and sheltered savings. The variables KH_1, KS_1, $(\text{earnings})_1$ and SS_1 are all taken as exogenous and evaluated along an estimated trajectory for the taxpayer. For example, the value of KH_1 for various ages and years is determined from the following estimated equation for human wealth:

$$\ln KH = 11{,}267 + 0.039489\, TIME + 0.065431\, AGE - 0.0014555\, AGE^2. \qquad (8.3)$$

Similar equations were estimated for other exogenous variables, and values for these variables along a trajectory for the cohort are predicted by using the appropriate sequence of age and time values.

Simulation under the existing tax structure proceeds by predicting consumption in 1964 (C_0) using equation 8.1 and the observed initial values of all variables on the right-hand side. Using this predicted value $\hat{C}_0$, unsheltered savings, $S\hat{U}_0$, in 1964, are calculated using equation 8.2. This value of unsheltered savings is used to predict what the change in the unsheltered capital stock will be over the year. To do this, unsheltered savings and the original capital stock are first converted to nominal terms using the *CPI* for 1964:

$$NS\hat{U}_0 = S\hat{U}_0 \cdot CPI_0$$

$$NK\hat{U}_0 = KU_0 \cdot CPI_0.$$

The nominal unsheltered capital stock for the next year is then calculated:

$$NK\hat{U}_1 = NK\hat{U}_0 + NS\hat{U}_0.$$

This is then deflated to give the real capital stock:

$$K\hat{U}_1 = NK\hat{U}_1/CPI_1.$$

Consumption in the first period is then predicted using this value for unsheltered capital stock $K\hat{U}_1$. The after-tax capital income generated by this predicted capital stock is given by:

$$YK\hat{U}_1 = R_1 \cdot K\hat{U}_1.$$

This, along with $\hat{C}_1$, is used to calculate $S\hat{U}_1$. Next, $K\hat{U}_2$ is calculated as above, and the whole procedure is repeated for each year up until 1982. This gives us a set of simulated unsheltered asset demands for this particular cohort over the 1965-82 period under the existing tax system.

To simulate asset demands under the alternative tax structure, a similar procedure is followed except with the capital tax rate, t_r, set to zero. In practice, this requires two sorts of amendments. First, the values for the human capital stock KH_1 must be recomputed using the before-tax real interest rate as the discount factor. Thus a new exogenous trajectory for *KH* is obtained. Second, the interest rate used to calculate unsheltered capital income for the income identity 8.2 is now the before-tax real interest rate. Otherwise, the same iterative procedure applies.

This procedure can be carried out for any age cohort for any of the consumption functions. As in the previous chapter, a selection of alternative equation specifications from the relatively simple to the most complicated are used in the simulations. In the discussion to follow, the results of six different equations (similar in all but one to those of Chapter 7) are examined:

eq. (1) - found in Table 5-3 (simple life-cycle equation with intercept time shifts)

eq. (2) - found in Table 5-4 (simple life-cycle equation with *MPC* and intercept time shifts)

eq. (3) - found in Table 5-6 (life-cycle equation with different *MPC* out of *KH* and *A*; no time shifts)

eq. (4) - found in Table 5-7 (life-cycle equation with different *MPC* out of *KH* and *A*, and time shifts)

eq. (5) - found in Table 6-10 (general equation with different *MPC* out of *YL*, *KH-YL*, and *A*; no time shifts)

eq. (6) - found in Table 6-11 (most general equation nesting all the above; different *MPC* out of *YL*, *KH-YL* and *A*, and time shifts).

The first two equations are most consistent with the restrictions of a simple life-cycle theory, while the last two specifications are most consistent with the data.

In Tables 8-2, 8-3 and 8-4, we report the simulation results for three different age cohorts. The three representative age cohorts are those aged 20, 37, and 52 in 1964.

These tables report the change in asset demands for each year resulting from the replacement of the tax on capital income with a tax on consumer expenditures. In interpreting these results, it is useful to think of there being two main avenues through which the removal of the capital income tax operates. First, the rise in the after-tax interest rate reduces the life-cycle profile of human wealth. This would tend to reduce consumption and increase asset accumulation, the more so the lower the age since the fall in human wealth would be higher for younger persons. Second, the rise in after-tax interest rates increases the propensity to consume wealth in the estimated life-cycle versions of the model because interest-rate coefficients tend to be positive in size. The effect of the higher interest rate on the propensity to consume also rises with age owing to the negative sign on the interaction term *RT*.

The offsetting effects of these two influences can be discerned in Tables 8-2, 8-3 and 8-4. First, consider the

Table 8-2

Change in *KU* by Year Due to Substitution of t_c for t_r for Cohort Aged 20 in 1964, 1965-82

	Equation					
Year	(1)	(2)	(3)	(4)	(5)	(6)
1965	274	18	135	166	826	274
1966	571	63	284	537	1,237	528
1967	875	115	434	499	1,534	721
1968	1,210	214	594	663	1,801	916
1969	1,473	220	669	776	1,884	1,037
1970	1,780	272	761	898	2,098	1,187
1971	2,352	647	1,041	1,276	2,111	1,516
1972	2,952	1,105	1,326	1,622	2,167	1,905
1973	3,476	1,564	1,546	1,823	2,552	2,340
1974	3,676	1,792	1,533	1,739	3,606	2,656
1975	3,660	1,828	1,366	1,470	4,830	2,772
1976	3,713	1,922	1,239	1,232	6,120	2,887
1977	2,535	278	−55	414	5,647	2,496
1978	1,305	−1,330	−1,278	−462	5,650	2,188
1979	1,568	−814	−1,035	−553	6,655	2,521
1980	1,651	−369	−837	−723	8,073	2,804
1981	1,691	93	−730	−961	9,270	3,099
1982	1,599	451	−763	−1,355	10,659	3,376

Table 8-3

Change in *KU* by Year Due to Substitution of t_c for t_r for Cohort Aged 37 in 1964, 1965-82

	Equation					
Year	(1)	(2)	(3)	(4)	(5)	(6)
1965	68	−5	41	51	395	−48
1966	137	6	81	101	626	−41
1967	186	14	105	133	783	−18
1968	238	41	130	167	899	−31
1969	162	−78	42	134	878	38
1970	73	−193	−56	93	873	62
1971	110	−129	−40	536	803	154
1972	112	−74	−51	985	689	252
1973	82	−28	−93	972	663	371
1974	−5	−16	−184	832	859	497
1975	−231	−106	−381	594	1,060	580
1976	−516	−226	−625	374	1,221	658
1977	−2,257	−2,352	−2,220	−549	353	149
1978	−3,958	−4,389	−3,773	−1,481	−445	−358
1979	−4,132	−4,303	−3,923	−1,610	−488	−328
1980	−4,048	−3,934	−3,864	−1,538	−294	−212
1981	−4,217	−3,824	−4,046	−1,655	−433	−254
1982	−4,619	−3,912	−4,464	−1,852	−748	−397

Table 8-4

Change in *KU* by Year Due to Substitution of t_c for t_r for Cohort Aged 52 in 1964, 1965-82

	Equation					
Year	(1)	(2)	(3)	(4)	(5)	(6)
1965	−284	−224	−225	−134	−137	−109
1966	−546	−428	−441	−236	−277	−193
1967	−804	−625	−662	−323	−420	−263
1968	−1,046	−806	−883	−392	−558	−320
1969	−1,405	−1,135	−1,227	−513	−760	−413
1970	−1,783	−1,472	−1,608	−635	−970	−506
1971	−2,094	−1,689	−1,949	−213	−1,134	−564
1972	−2,406	−1,904	−2,316	217	−1,290	−625
1973	−2,658	−2,069	−2,652	152	−1,398	−672
1974	−2,773	−2,122	−2,891	83	−1,460	−695
1975	−2,946	−2,212	−3,226	−1	−1,570	−735
1976	−3,239	−2,387	−3,740	−89	−1,745	−807
1977	−5,051	−4,635	−5,703	−986	−2,629	−1,438
1978	−6,738	−6,719	−7,686	−1,907	−3,504	−2,074
1979	−6,848	−6,634	−8,360	−2,068	−3,649	−2,180
1980	−6,447	−6,056	−8,644	−1,858	−3,521	−2,041
1981	−6,446	−5,878	−9,314	−2,017	−3,617	−2,131
1982	−6,673	−5,908	−10,413	−2,279	−3,816	−2,298

simulation results for the cohort aged 20 in 1964 presented in Table 8-2. For this cohort, almost all simulated effects are positive, so that the tax change causes asset accumulation to rise for most if not all of the period. The rise occurs initially at an increasing rate until age 29-32 in 1973-76, continues to rise at a reduced rate for a while longer, and then either falls below what it would otherwise be - equations (3) and (4) - or continues rising further - equations (5) and (6). The change in life-cycle asset accumulation in the former case, such as in equation (4), can be shown schematically in Figure 8-1.

This pattern of changes is consistent with what one would expect on the basis of the above theoretical expectations. The rise in asset accumulation early in life results from the reduction in human wealth causing savings to rise despite the rise in the propensity to consume. An equivalent impact effect was obtained earlier in Chapter 7 where we found a positive interest elasticity of savings for younger cohorts. As one moves through the life cycle, the human wealth effect diminishes and the propensity-to-consume effect rises so that eventually, in the life-cycle formulations, asset accumulation falls below what it otherwise would have been. Relaxing the life-cycle restrictions of a uniform *MPC* across different components of wealth and particularly between current and expected future earnings, however, results in a greater simulated increase in asset holdings right through to age 38 in 1982, as the human wealth effect continues to dominate a set of mixed *MPC* effects.

Results for the older cohort aged 52 in 1964 are presented in Table 8-4. As can be seen, virtually all the figures in the table are negative, so that the tax change causes asset accumulation to fall for the remainder of the life cycle. For these older persons, the human wealth effect is much lower and the propensity to consume is much higher. When the cohort has reached age 70 in 1982, unsheltered asset holdings will have fallen by over $2,000. As before, the result of allowing separate *MPC* effects on different components of wealth is on net to attenuate the reduction in wealth accumulation. The more data-consistent specifications soften the more dramatic results of the restrictive life-cycle formulations.

Simulation results for the intermediate cohort aged 37 in 1964 are provided in Table 8-3. In this case, the figures are generally positive followed by negative; the tax change causes first greater asset accumulation with a peak difference occurring between ages 40-48 in the years 1968-76, and then reduced asset holdings with greatest reductions typically occurring in the oldest age 55 in 1982. These results can thus be seen as intermediate between those for the younger and older cohorts. The eventual reductions in asset holdings by 1982 are smaller in absolute value in Table 8-3 than in Table 8-4 for the older cohort, though the percentage declines are generally larger than in Table 8-4. Once again, the result of allowing different *MPC*s on various wealth components is to attenuate the stronger more marked declines in asset accumulation associated with the more restrictive life-cycle formulations.

The upshot of these simulations is that the longer-run effect of a switch from capital income taxation to consumption taxation on capital accumulation varies systematically with age cohorts and depends very much on the age structure of the population. The older the population, the more likely it is that aggregate asset accumulation actually falls.

The Effect on Asset Wealth Accumulation of Replacing Capital Income Taxation with Labour Income Taxation

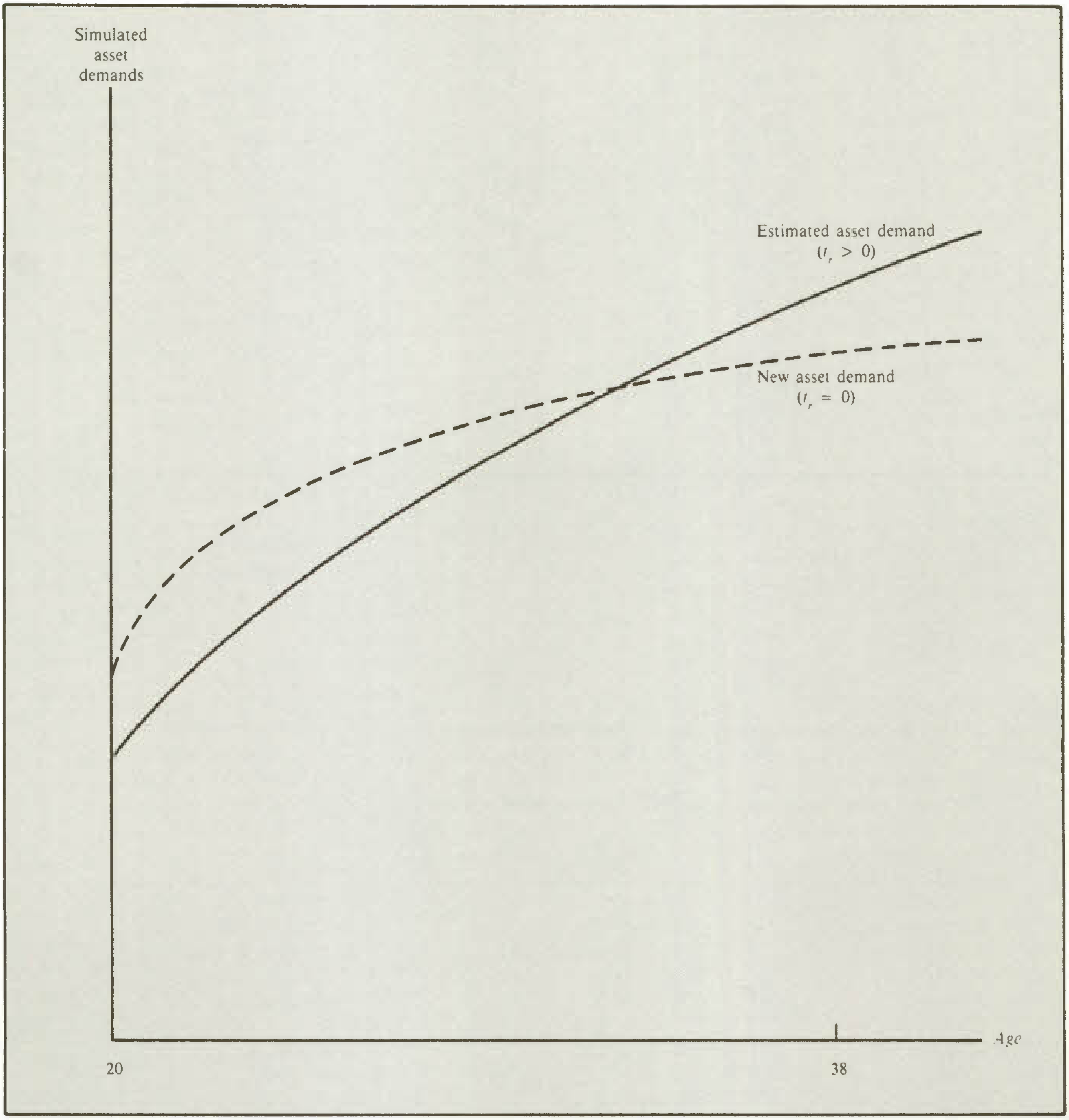
Simulation here proceeds in much the same manner as before. For a given cohort in 1964, the simulated path of capital demand along the life-cycle trajectory under the existing tax system is exactly as before. The simulation to be compared with that path is the one resulting from setting $t_r = 0$ and generating the same aggregate tax revenue each year by increasing t_w. This requires calculating the appropriate t_w, which holds tax revenue constant. Tax revenue previously collected from capital income in each year is just the annual sum of tax revenues collected from each cohort (*YKU•TRY*) weighted by the number of filers of each age. The tax on labour income which would yield the same tax revenue each year is obtained by dividing the tax on capital income each year by the total earnings (*NEARN*) for that year.

Using that new value for t_w and setting $t_r = 0$, the *KH* values for each cell are recomputed. To do this, the new values of after-tax earnings are used to estimate an age-earnings-time relation, and this is used to project earnings along a future trajectory for each cell. Simulation proceeds as before using this new value of human wealth in the consumption function, and amending the income identity 8.2 such that $t_r = 0$ and t_w is that calculated as outlined to yield the same revenue.

Results of these simulations are reported in Tables 8-5, 8-6 and 8-7 for the same three age cohorts and the same six consumption equations as in the previous section. These results can be viewed as incorporating both the change in the after-tax interest rate as in the previous section, plus the substitution of t_w for t_c. The effect on the capital stock from the setting of

Figure 8-1

Asset Accumulation Profiles under Existing and Alternative Tax Systems (t_r Replaced by t_c)



$t_r = 0$ is exactly as in the last section. In this section, it is now augmented by the rise in t_w. As discussed in Chapter 1, substitution of t_w for t_c essentially involves changing the time in the life cycle at which tax revenues are collected. Since labour income tends to occur earlier in the life cycle than does consumer expenditures, tax collections will be relatively earlier, and savings required to meet future tax liabilities would fall. Substitution of t_w for t_c should therefore cause asset accumulation to fall.

Table 8-5

Change in *KU* by Year Due to Substitution of t_w for t_r for Cohort Aged 20 in 1964, 1965-82

	Equation					
Year	(1)	(2)	(3)	(4)	(5)	(6)
1965	275	11	120	152	889	336
1966	566	42	249	304	1,336	632
1967	859	75	374	442	1,659	854
1968	1,174	147	503	576	1,943	1,070
1969	1,411	121	543	652	2,026	1,203
1970	1,681	131	590	728	2,237	1,361
1971	2,210	458	815	942	2,215	1,683
1972	2,759	863	1,040	1,152	2,224	2,053
1973	3,224	1,261	1,196	1,280	2,569	2,460
1974	3,354	1,421	1,131	1,148	3,622	2,758
1975	3,250	1,371	905	824	4,857	2,862
1976	3,188	1,351	695	494	6,148	2,964
1977	1,883	−419	−704	−464	5,877	2,524
1978	513	−2,165	−2,035	−1,490	5,720	2,164
1979	620	−1,803	−1,910	−1,753	6,628	2,439
1980	542	−1,515	−1,823	−2,093	7,970	2,666
1981	428	−1,204	−1,820	−2,500	9,090	2,899
1982	135	−1,044	−1,944	−3,130	10,390	3,101

Table 8-6

Change in *KU* by Year Due to Substitution of t_w for t_r for Cohort Aged 37 in 1964, 1965-82

	Equation					
Year	(1)	(2)	(3)	(4)	(5)	(6)
1965	−38	−105	−55	−45	305	−106
1966	−88	−208	−120	−100	464	−156
1967	−174	−330	−210	−179	548	−191
1968	−270	−445	−307	−265	591	−201
1969	−508	−725	−528	−433	494	−260
1970	−784	−1,019	−777	−630	405	−310
1971	−969	−1,172	−945	−786	246	−310
1972	−1,191	−1,337	−1,144	−982	52	−302
1973	−1,421	−1,488	−1,354	−1,207	−38	−260
1974	−1,642	−1,610	−1,545	−1,425	98	−185
1975	−2,006	−1,840	−1,841	−1,733	221	−159
1976	−2,493	−2,165	−2,242	−2,128	270	−169
1977	−4,466	−4,522	−4,033	−3,354	−594	−780
1978	−6,380	−6,774	−5,767	−4,590	−1,453	−1,385
1979	−6,762	−6,900	−6,100	−5,056	−1,607	−1,457
1980	−6,845	−6,700	−6,192	−5,286	−1,516	−1,435
1981	−7,130	−6,710	−6,489	−5,681	−1,737	−1,555
1982	−7,712	−6,981	−7,086	−6,299	−2,170	−1,812

Table 8-7

Change in *KU* by Year Due to Substitution of t_w for t_r for Cohort Aged 52 in 1964, 1965-82

Year	Equation (1)	(2)	(3)	(4)	(5)	(6)
1965	-491	-405	-386	-229	-309	-222
1966	-951	-787	-758	-559	-592	-404
1967	-1,398	-1,159	-1,133	-796	-863	-562
1968	-1,822	-1,511	-1,504	-1,011	-1,117	-699
1969	-2,359	-2,009	-1,998	-1,286	-1,423	-870
1970	-2,920	-2,523	-2,539	-1,577	-1,740	-1,043
1971	-3,433	-2,937	-3,060	-1,867	-2,000	-1,187
1972	-3,924	-3,327	-3,592	-2,165	-2,224	-1,322
1973	-4,301	-3,620	-4,053	-2,423	-2,378	-1,423
1974	-4,456	-3,721	-4,358	-2,546	-2,481	-1,476
1975	-4,664	-3,853	-4,769	-2,684	-2,656	-1,554
1976	-5,043	-4,119	-5,412	-2,938	-2,935	-1,692
1977	-6,947	-6,463	-7,497	-4,095	-3,907	-2,388
1978	-8,698	-8,616	-9,591	-5,276	-4,888	-3,084
1979	-8,858	-8,588	-10,371	-5,727	-5,097	-3,250
1980	-8,470	-8,027	-10,743	-5,783	-5,030	-3,162
1981	-8,441	-7,827	-11,467	-6,181	-5,163	-3,286
1982	-8,683	-7,872	-12,669	-6,828	-5,438	-3,516

In an economy moving through time, the effect on individual cohorts will differ in the short run from that in the long run. For those cohorts who are older when the tax substitution is introduced, a windfall gain is obtained as a result of removing their liability for future taxes. This causes a rise in their real consumption (and a reduction in asset demand) which is financed by subsequent generations. Substitution of t_w for t_c is equivalent to instituting a continuing intergenerational income redistribution from each generation to its predecessor. Aggregate asset demand should fall permanently.

The combination of the effects of the fall in t_r and the rise in t_w is borne out in the tables. The pattern of changes in asset accumulation over the life cycle are similar to that for the previous section, but they are uniformly smaller positive or larger negative than before. The reduction in asset accumulation, though, is less marked in the less restrictive equations (5) and (6). More generally, relaxing the life-cycle restriction of a uniform *MPC* across different components of wealth, and particularly between current and expected future earnings, results in higher simulated asset accumulations or an attenuation of the more marked declines associated with the more strict life-cycle specifications. Substitution of t_w for t_r is equivalent to a substitution of t_c for t_r, which gives the results of the previous section, and a substitution of t_w for t_c, which causes savings to fall. In quantitative terms, the youngest cohort still experiences a rise in asset demand to roughly the same age, but the magnitudes are smaller. However, for the other two cohorts, asset demands fall almost entirely throughout the entire life cycle.

Again, the effect on aggregate asset accumulation depends upon the demographic composition of the population. Unfortunately, we have been unable to provide a simulation to answer that question. Our calculations apply only for a representative cohort alive in 1964. To simulate aggregate asset demands over time, one has to account both for persons dying or emigrating over time and for new tax-filers coming in either through labour force participation or through immigration. Our data do not allow us to track such changes in the tax-filing population. However, such evidence as presented in this section indicates at the least that removing capital income from the tax base and adjusting labour income tax rates correspondingly need not lead to an increase in capital accumulation. Similarly, the previous section showed that even expanding the sheltering of savings without bound need not increase capital accumulation.

9 Efficiency, Equity and the Taxation of Saving

Introduction

In this chapter, we discuss the main efficiency and equity issues surrounding the taxation of the return to saving. These issues are discussed at a reasonably technical level and provide the background for Chapter 10 which examines the choice between consumption versus income base as a guide for tax reform. We first discuss the effect on economic efficiency of taxing the return to saving for a representative household with a fixed labour supply. We then derive an expression for measuring the efficiency cost in this framework, and provide calculations of the efficiency cost based on our estimates of household consumption functions described in previous chapters.

We then discuss a number of complications including variable labour supply, the fact that households in the economy are of different ages, as well as general equilibrium and open-economy issues. This is followed by a discussion of equity and the taxation of the return to saving. We look at both horizontal and vertical equity criteria as well as other fairness issues.

The major policy issue concerning taxation and savings is whether or not the return to saving should enter the personal tax base. This is equivalent to the question of whether the ideal personal tax base should be comprehensive income or consumption. Under a comprehensive income base, all capital income should be taxed on an accrual basis, although, in practice, this is rarely possible because of the difficulties of measuring imputed rent and capital gains on accruals. A consumption tax base can take different forms, but all are equivalent in present value terms to exempting capital income from the tax base. As discussed in the U.S. Treasury's *Blueprints for Basic Tax Reform* (1977) and surveyed in Boadway and Bruce (1985), savings can be treated in one of two ways under a consumption tax. One way is for the acquisition of an asset by saving to be deducted from the tax base as it occurs and the sale of the asset and cumulated interest to be included in the base when the dissaving takes place. Assets which are treated this way are referred to as *designated assets*. Accounts must be kept of the holding of such assets, as with RRSPs in the Canadian tax system. The second way is not to exempt savings when undertaken, but to exempt any capital income earned. As mentioned, the tax base under these two systems has the same present value. Practical application of such a system would be a combination of designated and non-designated savings. Some assets are best treated on a designated basis (e.g., assets in unincorporated business) while others are best treated on a non-designated basis (e.g., housing, cash balances).

Our discussion in this chapter centers on the question of whether capital income should be included in the tax base or not. It is organized under the categories of economic efficiency, equity and administrative simplicity.

Economic Efficiency

There are two main ways that the taxation of the return to saving affects economic efficiency. First, it distorts the intertemporal consumption decisions of the individual or "representative" household. Second, it alters the amount of capital accumulation in the economy by redistributing the burden of taxation among households and across generations.

Economic Efficiency and the Representative Household

It has long been argued that the taxation of the return to saving is inefficient because it involves "double" or "multiple" taxation of future consumption. That is, to the extent that such taxation lowers the after-tax real return to savers, it also lowers the relative price of current consumption in terms of future consumption. Thus, it is argued, the household is induced to consume more now and save less for the future. Because the actual rate at which society can transform current consumption into future consumption is given by the higher gross-of-tax real interest rate, this "distortion" of individual decisions imposes an efficiency cost or "excess burden."

This argument has been criticized on several grounds. First, it is argued that the actual effect on the level of current consumption of taxing the return to saving is ambiguous because of "income" effects. In fact, as we shall show, this argument is fallacious because it is the "compensated" effect of taxation on saving that determines the efficiency cost. Even if saving were increased by the income effects of taxation, the excess burden would still exist. Second, it is argued that if labour supply is not fixed, the income tax distorts both the intertemporal allocation of consumption and the labour-leisure choice. In such a second-best world of multiple distortions, circumstances can be found where the taxation of the return to saving may actually raise economic efficiency.

Before considering this second criticism, it is worthwhile analysing the efficiency cost of taxing the return to saving in an economy where the after-tax labour-income receipts of the household are fixed. In this case, the tax unambiguously reduces economic efficiency by reducing the level of lifetime utility that can be attained from the given stream of after-tax receipts. Obviously, it would be useful to have an income-equivalent measure of this efficiency cost, a topic to which we now turn.

Measuring the Efficiency Cost to the Representative Household

We begin by considering the efficiency cost when the tax on the return to saving is imposed for one period only (or equivalently, the household lives for only two periods). The household's post-tax budget constraint for the present period t and the next period $t+1$ is given by:

$$W_{t+1} = [1+r(1-t_r)]\,[W_t + L_t - C_t],$$

where W_t, C_t, and L_t are the wealth with which the individual opens period t, consumption in period t and after-tax labour-income receipts, respectively, r is the gross-of-tax real return to saving[1] (assumed exogenous), and t_r is the marginal tax rate on the return to saving. An income-equivalent measure of the efficiency cost or excess burden (*EB*) of this one-period taxation is given by:

$$EB = \hat{W}(r, u^0) - \hat{W}(r, u^1) - \text{taxes}, \qquad (9.1)$$

where $\hat{W}(r, u)$ is the minimum value of W_{t+1} + $[1+r(1-t_r)]C_t$ that is needed to attain the utility level u when the consumer faces an interest rate of r. u^0 and u^1 denote the level of lifetime utility obtained in the no-tax and tax situations, respectively. "Taxes" is equal to the value of taxes collected (i.e., $rt_r[W_t + L_t - C_t^1]$).

The logic of this expression is explained with the aid of Figure 9-1. The household faces budget line AA' (with absolute slope $[1+r(1-t_r)]$) in the post-tax situation; it "saves" $W_t + L_t - C_t^1$ thereby attaining lifetime utility level u^1. If no tax is levied, the household would face budget line AB (with absolute slope $1+r$) and achieve lifetime utility level u^0. The indifference curves represent levels of the additive lifetime utility function $U = u(C_t) + \gamma V^{t+1}(r, W_{t+1})$, where $u(\cdot)$ is the utility of current consumption, $\gamma/1-\gamma$ is the rate of time preference, and $V^{t+1}(r, W_{t+1})$ is an "indirect" utility function representing the maximum lifetime utility beginning in period $t+1$ that can be achieved if the household faces the before-tax interest rate r in period $t+1$ and thereafter, and begins period $t+1$ with wealth W_{t+1}.

Distance OB is equal to $\hat{W}(r, u^0)$, and distance OB'' is equal to $\hat{W}(r, u^1)$. Thus, distance BB'' is an income or wealth equivalent measure (in $t+1$ period units) of the total loss in utility as a result of the one-period tax imposition. Distance BB' is equal to tax revenues $(1+r) - [1+r(1-t_r)]\,(W_t + L_t - C_t^1)$ also measured in $t+1$ period units which is subtracted from BB'' to get $B'B''$ as the excess burden (*EB*) of the tax imposed on the saver.

We can add and subtract $\hat{W}[r(1-t_r), u^1]$ from equation 9.1 to get:

$$EB = \hat{W}[r(1-t_r), u^1] - \hat{W}(r, u^1) + rt_rC_t^1, \qquad (9.1a)$$

where $C_t^1 = C_t[1+r(1-t_r), u^1]$ is the level of consumption in period t in the presence of the tax, and we have substituted

$$\hat{W}(r, u^0) = (1+r)(W_t + L_t)$$

and

$$\hat{W}[r(1-t_r), u^1] = [1+r(1-t_r)](W_t + L_t)$$

from the household's budget constraint, and

$$\text{taxes} = rt_r(W_t + L_t + C_t^1).$$

By Hotelling's lemma,

$$\frac{\delta \hat{W}}{\delta r} = C_t[1+r(1-t_r), u^1].$$

$$\text{Also, } \frac{\delta r(1-t_r)}{\delta t_r} = -rC_t[1+r(1-\hat{t}_r), u^1]$$

$$= C_t^1 - r \int_{z=t_r}^{\hat{t}_r} \frac{\delta C_t}{\delta r}\, dz.$$

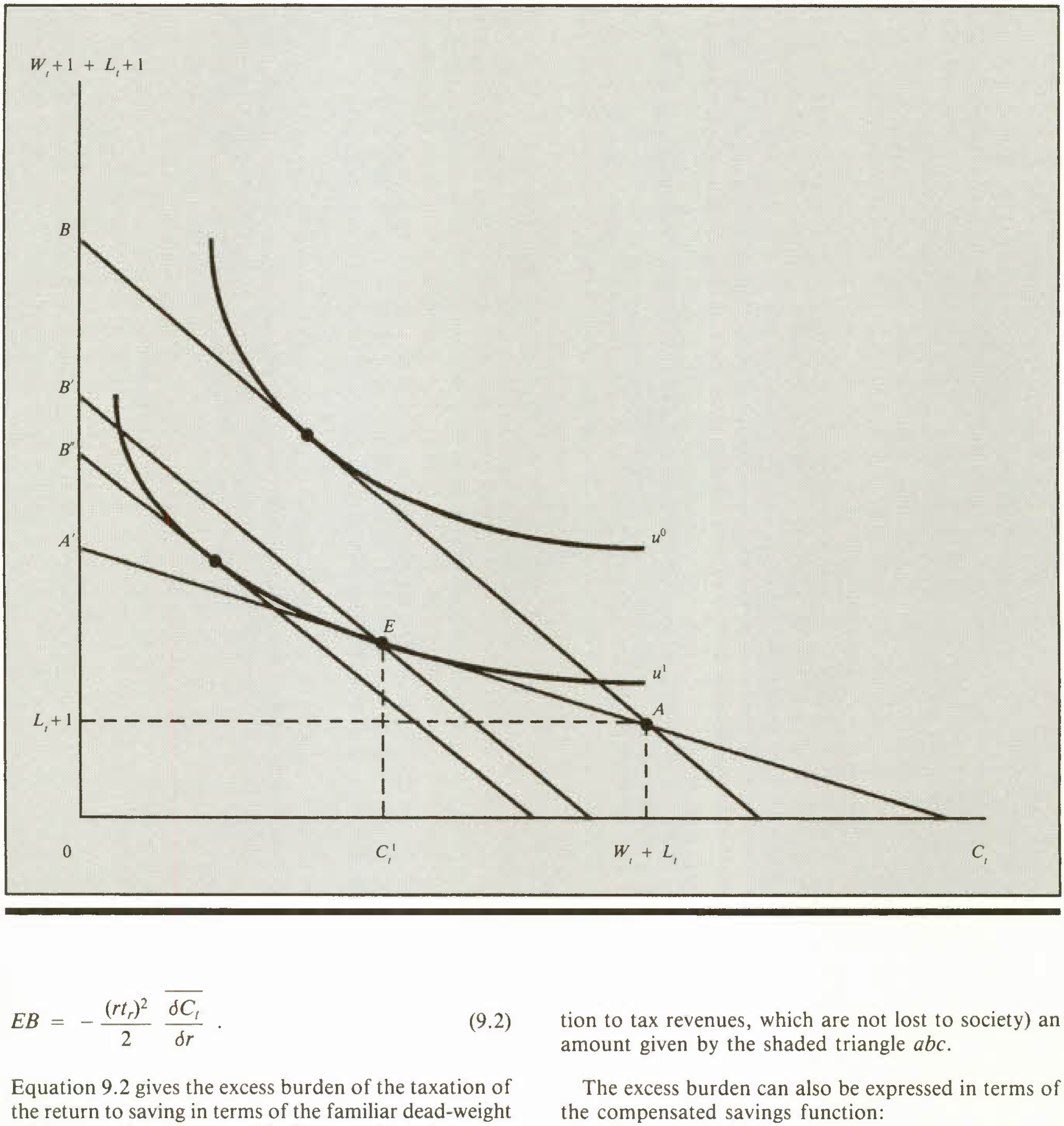
Making substitutions, we can express 9.1*a* as

$$EB = -r^2 \int_{\hat{t}_r=0}^{t_r} \int_{z=\hat{t}_r}^{t_r} \frac{\delta C}{\delta r}\, dz\, dt_r. \qquad (9.1b)$$

Using an intermediate value of $\delta C/\delta r$ and integrating yields:

Figure 9-1

Efficiency Costs of Taxing the Return to Saving



$$EB = -\frac{(rt_r)^2}{2}\ \overline{\frac{\delta C_t}{\delta r}}\ . \quad (9.2)$$

Equation 9.2 gives the excess burden of the taxation of the return to saving in terms of the familiar dead-weight triangle of Figure 9-2. In this figure, D is the *compensated* demand curve for period t consumption which is unambiguously negatively sloping. Taxing the return to saving at rate t_r means the household treats the relative price of current consumption (in terms of future consumption) as $1 + r(1 - t_r)$ rather than the true marginal social cost of $1 + r$. As a result, the household "over-consumes" in period t by $C_t^1 - C_t^0$ and loses (in addition to tax revenues, which are not lost to society) an amount given by the shaded triangle *abc*.

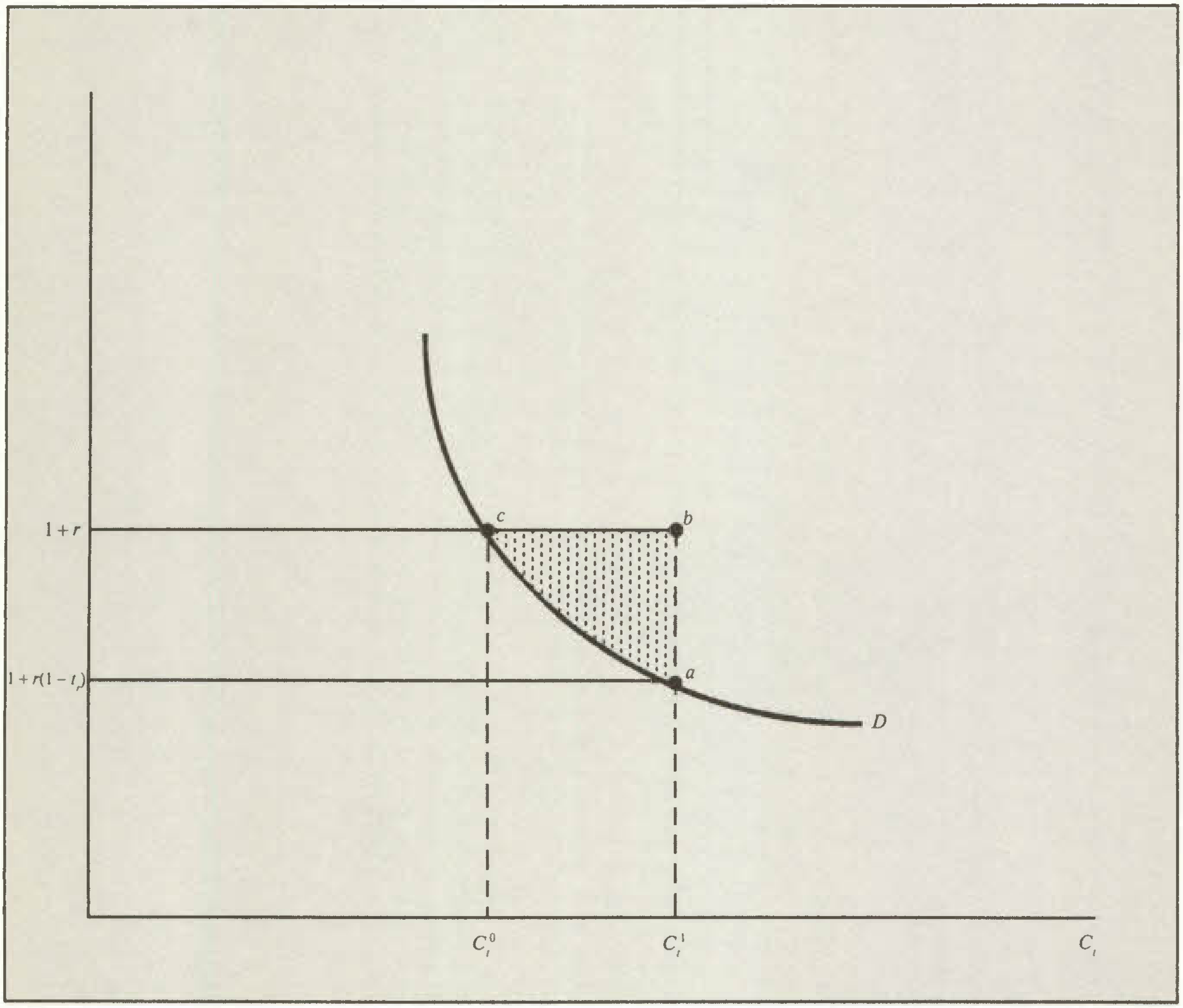
The excess burden can also be expressed in terms of the compensated savings function:

$$S_t[r(1 - t_r),\ u_t^1] = r_{t-1}W_{t-1} + L_t - C_t[r(1 - t_r),\ u^1].$$

Assuming that the tax is only imposed in the current period, r_{t-1} is exogenous so $\delta S_t/\delta r = -\delta C_t/\delta r$. Using estimates derived in Chapter 7, the compensated interest

Figure 9-2

Illustrative Dead-Weight Loss Triangle



elasticity of saving can be found and the one-period excess burden of taxing the return to saving in the economy as a whole can be calculated (if differences among households are ignored).

It is now recognized that this one-period excess-burden triangle measure, or a discounted sequence of such triangles, seriously mistates the loss to a household that behaves in accordance with the life-cycle theory. This is the case even if labour-income receipts are exogenous. The reason can be expressed in two ways. One, preferred by Summers (1981), is to identify the "human wealth effect" of a change in the after-tax real return to saving that occurs when the tax rate is changed in every period. As discussed in Chapter 1, the fall in $r(1-t_r)$ as t_r is increased in future periods causes the discounted value of future labour-income receipts (human capital) to rise causing the compensated current-period consumption to rise (or compensated saving to fall) by more than the pure substitution effect discussed above. Another way of seeing this is by considering the indirect utility function V^{t+1} (r, W_{t+1}) used in the above analysis. In the previous analysis, it was assumed that the household faced the interest rate r in future periods whether or not the tax was imposed in period t. If, however, we consider changing the tax rate in current and future periods, the indirect utility function is $V^{t+1}[r(1-t_r), W_{t+1}]$ in the presence of the tax, and

$V^{t+1}(r, W_{t+1})$ in its absence. $V^{t+1}(\cdot)$ is increasing in r, indicating that a given positive value of W_{t+1} yields a higher lifetime utility (from period $t+1$ and thereafter) if the after-tax return to saving is higher.

For this reason, the fall in the return to saving upon taxation causes consumption in period t to rise (saving to fall) above and beyond the one-period substitution effect discussed above. The lower return in future periods reduces the utility derived from W_{t+1} (but not C_t) inducing a further reduction in period t saving. As mentioned, this is just the human wealth effect viewed from a different perspective.

Measuring the efficiency cost of taxing the return to saving in a many-period context is a more difficult task. Other authors, notably Summers (1981) and Kotlikoff (1984), have tackled the problem by specifying a particular functional form for the lifetime utility function of the household and deriving the corresponding indirect utility function. We follow a less restrictive procedure by measuring the excess burden for a general (additive) lifetime utility function.

For simplicity, we derive our multi-period excess-burden measure in a continuous-time framework and then use a discrete time approximation. We assume the household maximizes

$$U = \int_{s=t}^{T} u(C_t)e^{-\delta(s-t)}ds \, ,$$

where δ is the rate of time preference. We use the last-period (T) values as numeric so the household's lifetime budget constraint is:

$$W_t = W_t e^{r(1-t_r)(T-t)} + \int_{s=t}^{T} e^{r(1-t_r)(T-s)} (L_s - C_s^1)ds. \tag{9.3}$$

Taxes collected over the household's lifetime have a value at time T to society of

$$\text{taxes} = \int_{s=t}^{T} rt_r W_s e^{r(T-s)}ds. \tag{9.4}$$

Using the equation of motion

$$\dot{W}_s = [1 + r(1-t_r)]W_s + L_s - C_s^1,$$

we can substitute for rt_rW_s in 9.4 and integrate to get

$$\text{taxes} = e^{r(T-t)}W_t - W_T + \int_{s=t}^{T} (L_s - C_s^1)e^{r(T-s)}ds. \tag{9.4a}$$

Using the consumer's budget constraint, we get:

$$\text{taxes} = W_t[e^{r(T-t)} - e^{r(1-t_r)(T-t)}] + \int_{s=t}^{T} (L_s - C_s^1) [e^{r(T-t)} - e^{r(1-t_r)(T-t)}]ds. \tag{9.5}$$

We now consider the "dual" to the consumer's lifetime utility maximization problem: maximize terminal wealth W^T subject to a given level of lifetime utility u given initial wealth W_t and the after-tax real interest rate $r(1-t_r)$. In order that our resulting wealth-metric utility indicator be increasing in lifetime utility, we redefine this problem as minimizing the negative of terminal wealth. Accordingly, we define $\hat{W}_T[R(1-t_r), u]$ as the minimum value of

$$-W_t e^{r(1-t_r)(T-t)} + \int_{s=t}^{T} e^{r(1-t_r)(T-s)} [C_s(r\text{-}t_r), u - L_s]ds$$

that is needed to obtain a prescribed level of lifetime utility u. By Hotelling's lemma,

$$\frac{\delta \hat{W}_T}{\delta[r(1-t_r)]} = -(T-t)W_t e^{r(1-t_r)(T-t)} + \int_{s=t}^{T} (T-s)(C_s - L_s)e^{r(1-t_r)(T-s)}ds.$$

Following logic that is analogous to that used in the two-period case discussed above, we define the income (or wealth) equivalent to the loss in lifetime utility resulting from imposing tax t_r at time t and all points of time thereafter as

$$\hat{W}^T(r, u^0) - \hat{W}^T(r, u^1) - \text{taxes},$$

where u^0 is lifetime utility in the no-tax case, and u^1 is lifetime utility when the return to saving is taxed at rate t_r at all points in time after t. We can add and subtract $\hat{W}^T[r(1-t_r), u^1]$, and because

$$\hat{W}^T[r(1-t_r), u^1] = \hat{W}^T(r, u^0) = 0$$

by definition of u^1 and u^0, we get:

$$EB = W^T[r(1-t_r), u^1] - \hat{W}^T(r, u^1) - \text{taxes}. \tag{9.6}$$

Using Hotelling's lemma, we have:

$$\hat{W}^T[r(1-t_r), u^1] - \hat{W}^T(r, u^1)$$

$$= \int_{\hat{t}_r=0}^{t_r} (T-t)W_t e^{r(1-\hat{t}_r)(T-t)}d\hat{t}_r$$

$$+ r \int_{s=t}^{T} \int_{\hat{t}_r=0}^{t_r} (T-s)(L_s - C_s)e^{r(1-\hat{t}_r)(T-s)}d\hat{t}_r ds.$$

Carrying out the integration gives:

$$\hat{W}^T[r(1-t_r), u^1] - \hat{W}^T(r, u^1)$$

$$= W_t[e^{r(T-t)} - e^{r(1-t_r)(T-t)}]$$

$$- \int_{s=t}^{T} (L_s - C_s^1)e^{r(1-t_r)(T-s)}ds$$

$$+ \int_{s=t}^{T} (L_s - C_s^0)e^{r(T-s)}ds$$

$$- r \int_{s=t}^{T} \int_{\hat{t}_r=0}^{t_r} e^{r(1-\hat{t}_r)(T-s)} \frac{\delta C_s}{\delta r} dt_r,$$

where $C_s^0 = C_s(r, u^1)$. Substituting this and equation 9.5 into 9.6 yields:

$$EB = \int_{s=t}^{T} [C_s^0 - C_s^1]e^{r(T-s)}ds$$

$$- r \int_{s=t}^{T} \int_{\hat{t}_r=0}^{t_r} e^{r(1-t_r)(T-s)} \frac{\delta C_s}{\delta r} dt_r ds. \quad (9.7)$$

By substituting $C_s^1 = C_s^0 - r \int_{\hat{t}_r=0}^{t_r} \frac{\delta C_s}{\delta r} dt_r$ and cancelling, we get:

$$EB = -r \int_{s=t}^{T} \int_{\hat{t}_r=0}^{t_r} \frac{\delta C_s}{\delta r}$$

$$[e^{r(T-s)} - e^{r(1-\hat{t}_r)(T-s)}]d\hat{t}_r ds.$$

The discrete-time analogue to this expression is:

$$EB = -r \sum_{s=t}^{T} \int_{\hat{t}_r=0}^{t_r} \frac{\delta C_s}{\delta r}$$

$$[(1+r)^{T-s} - [1+r(1-\hat{t}_r)]^{T-s}]\, dt_r. \quad (9.7a)$$

This can be approximated by substituting a constant (over t_r) average value of $\frac{\delta C_s}{\delta r}$ to get:

$$EB = \sum_{s=t}^{T} \frac{\delta C_s}{\delta r} [rt_r(T-s)(1+r)^{T-s}$$

$$- [1+r(1-t_r)]\,[(1+r)^{T-s}$$

$$- [1+r(1-t_r)]^{T-s}]/T-s+1. \quad (9.8)$$

Note that equation 9.8 reduces to 9.2 in the event that $T-s = 1$.

Although equation 9.8 is quite complicated, it can be evaluated with information on the age of the household, the before- and after-tax real return to saving facing the household, and estimates of the compensated intertemporal substitution term $\delta C_s/\delta r$ of the household at each age. Unlike the Summers and Kotlikoff approach, this expression does not require a specific parameterization of the individual lifetime utility function.

Illustrative Calculations of the Excess Burden

We calculate the excess burden of taxing the return to saving at the personal level using equation 9.8 and the coefficients of the life-cycle consumption function estimated in Chapter 5. First, it is necessary to derive the *compensated* substitution terms $\delta C_t/\delta r$ used in equation 9.8 for each age group. This is done using the "Slutsky equation" 9.9 below.

$$\frac{\delta C_t}{\delta r} = \left(\frac{\delta C_t}{\delta r}\right)^u - \frac{\delta C_t}{\delta W}$$

$$\cdot \left[\sum_{s=t}^{T} (s-t) \cdot \left(\frac{1}{1+r(1-t_r)}\right)^{s-t-1}\right]$$

$$\cdot (C_s - L_s) + (T-t)$$

$$\cdot BQ \left(\frac{1}{1+r(1-t_r)}\right)^{T-t-1}, \quad (9.9)$$

where $(\delta C_t/\delta r)^u$ is the uncompensated effect of a permanent change in the after-tax real interest rate on consumption by persons of age t, $\delta C_t/\delta W$ is the effect of an increase in lifetime wealth on consumption at age t, BQ is the end-of-life bequest, and the term in square brackets is the change in lifetime wealth needed to compensate for a small change in the after-tax real interest rate.

We used the estimate of $(\delta C_t/\delta r)^u$ and $\delta C_t/\delta W$ for each age group as estimated in equations from Tables 5-3 and 5-4 (see Tables 7-4, 7-6, and D-1). Per capita real consumption (C_t) over the life cycle and non-capital income (L_t) over the cycle were taken as period averages in Tables 4-3 and 4-9. Per capita real bequests were set equal to the financial wealth of persons aged 65 and over plus receipts less consumption for that group from Tables 4-3 and 4-9. Age of death (T) is set equal to 73, and the after-tax real interest rate is 2.7 per cent. The uncompensated and compensated values of $\delta C_t/\delta r$ for each age group are given in Table 9-1. The first two columns are the uncompensated and compensated values based on the regression from Table 5-3 and the next two columns are based on the regression from Table 5-4. As expected, the compensated values of $\delta C_t/\delta r$ are negative for all age groups.

Using the compensated substitution terms, the excess burden is now calculated for each age group. Those calculated on the basis of the equation of Table 5-3 are given in Table 9-2. In calculating these values, a statutory marginal tax rate of 30 per cent was assumed. The excess burden was then calculated for three alternative assumptions about the steady-state inflation rate of 0, 5, and 10 per cent, respectively. Assuming no indexation of interest income for tax purposes, these inflation rates correspond to effective marginal tax rates of 30, 55, and 67 per cent (of the gross return), respectively.[2] The excess burdens are expressed in present values.[3]

From Table 9-2, the lifetime excess burden is calculated on the basis of estimates from Table 5-3. The excess burden by age groups is shown both in constant 1971 dollars and as a percentage of all inclusive lifetime wealth (financial wealth plus human wealth) at the respective age. This table indicates that the excess burden of a 30 per cent tax on the return to saving is essentially negligible in a non-inflationary economy. The lifetime excess burden of the youngest age group (which is, of course, the largest of all age groups) is only $223 (1971) which is less than 0.1 per cent of that age group's lifetime wealth. The excess burden declines over age groups. Also shown in Table 9-2 is the weighted-average excess burden where the weights are equal to the fraction of the population in each age group for the sample. This amounts to only $146 (1971) or about 0.08 per cent of the weighted-average lifetime wealth.

We see, however, from Table 9-2 that the excess burden of taxing the return to saving may be quite large under a positive inflation rate without indexation even if the inflation rate is moderate. For example, the lifetime excess burden of the youngest age group amounts to $3,128 (1971) or about 1.3 per cent of that age group's lifetime wealth. The weighted-average excess burden is $1,888 (1971) or 1 per cent of the weighted-average lifetime wealth. When the steady-state inflation rate is 10 per cent, excess burdens become sizeable. In this case, the excess burden on the youngest age group is $15,340 (1971) or 5.6 per cent of lifetime wealth. The weighted average is $8,524 (1971) or 4.5 per cent of average lifetime wealth.

In Table 9-3, estimates are based on regression coefficients from Table 5-4. These coefficients yield a slightly lower but essentially similar pattern of excess burdens.

It is worth re-emphasizing the implicit assumptions underlying these estimates. The labour-supply decision is assumed exogenous, households are assumed to make lifetime utility maximizing consumption-savings decisions and face no capital market constraints. The lifetime utility function is assumed separable in deriving the life-cycle consumption function estimated but no

Table 9-1

Compensated and Uncompensated Substitution Effects of Interest-Rate Changes on Consumption, by Age Group

	(Table 5-3)		(Table 5-4)	
	$(\delta C_t/\delta r)^u$	$\delta C_t/\delta r$	$(\delta C_t/\delta r)^u$	$\delta C_t/\delta r$
Age group:				
Under 25	−203.3	−1,034.7	−40.9	−824.6
25-29	−242.6	−2,227.7	−206.0	−1,677.8
30-34	−161.8	−2,303.7	−197.6	−2,281.8
35-39	−43.1	−2,898.0	−116.9	−2,871.2
40-44	76.0	−3,492.5	−19.7	−3,446.0
45-49	177.6	−3,970.5	68.0	−3,934.2
50-54	247.2	−4,248.5	136.9	−4,223.6
55-59	282.4	−4,201.8	181.7	−4,179.3
60-64	297.1	−3,572.9	207.5	−3,565.2
65 and over	347.3	−2,201.4	249.4	−2,257.1

SOURCE Calculations by authors.

Table 9-2

Lifetime Excess Burden of a 30 Per Cent Tax on the Return to Saving, by Age Group

(Based on Table 5-3)

	Excess burden ($\pi = 0$)		Excess burden (π = 0.05)		Excess burden (π = 0.10)	
	1971 dollars	Per cent of LAW	1971 dollars	Per cent of LAW	1971 dollars	Per cent of LAW
Age group:						
Under 25	223.3	0.09	3,128.1	1.28	15,349.4	6.28
25-29	223.5	0.10	3,025.6	1.36	14,243.2	6.40
30-34	196.4	0.10	2,512.5	1.26	11,076.0	5.57
35-39	172.3	0.10	2,098.1	1.23	8,742.7	5.13
40-44	141.6	0.10	1,639.6	1.17	6,454.0	4.62
45-49	107.0	0.10	1,175.3	1.07	4,368.5	3.99
50-54	72.2	0.09	752.4	0.91	2,641.2	3.19
55-59	41.3	0.07	407.7	0.67	1,352.4	2.22
60-64	17.7	0.04	165.7	0.36	519.5	1.14
65 and over	4.2	0.01	36.9	0.09	109.2	0.27
Weighted average	146.2	0.08	1,888.0	1.04	8,523.7	4.50

SOURCE Authors' calculations based on coefficients estimated in Table 5-3. LAW = Lifetime All-inclusive Wealth.

Table 9-3

Lifetime Excess Burden of a 30 Per Cent Tax on the Return to Saving, by Age Group

(Based on Table 5-4)

	Excess burden ($\pi = 0$)		Excess burden (π = 0.05)		Excess burden (π = 0.10)	
	1971 dollars	Per cent of LAW	1971 dollars	Per cent of LAW	1971 dollars	Per cent of LAW
Age group:						
Under 25	205.2	0.08	2,834.4	1.16	13,694.4	5.60
25-29	209.2	0.09	2,801.4	1.26	13,029.5	5.86
30-34	194.7	0.10	2,489.5	1.25	10,972.2	5.52
35-39	170.8	0.10	2,079.1	1.22	8,661.3	5.08
40-44	140.4	0.10	1,624.9	1.16	6,393.7	4.58
45-49	106.3	0.10	1,167.8	1.07	4,339.6	3.96
50-54	71.9	0.09	749.2	0.91	2,629.6	3.18
55-59	41.2	0.07	406.8	0.67	1,348.9	2.21
60-64	17.8	0.04	166.3	0.36	521.0	1.14
65 and over	4.3	0.01	37.8	0.09	111.9	0.28
Weighted average	139.6	0.08	1,784.2	1.00	7,955.1	4.26

SOURCE Authors' calculations based on coefficients estimated in Table 5-4. LAW = Lifetime All-inclusive Wealth.

restrictions on preferences are made in deriving the excess-burden measures except the implicit ones made in using the mean value theorem. Importantly, estimates of the excess burden assume that lump-sum redistribution among age groups is feasible through debt policy. Specifically, long-run welfare gains that could be obtained through debt policy (by altering the steady-state capital-labour ratio as discussed in Boadway and Clark, 1986) are ignored. Implicit wealth taxes levied through the impact of a consumption tax on the older age groups are also ruled out. Resulting estimates indicate that the excess burden of taxing the return to saving is not as large as authors such as Summers (1981) have implied, unless the effective tax rate on these returns is increased by inflation without tax indexation.

The Efficiency Cost with Variable Labour Supply

It has been recognized at least since the time of Ramsey (1928) that the efficiency cost of taxing the return to saving may be positive, negative or zero if labour supply is variable. The issues concern the effect of taxing the rate of return to saving on the timing of labour supply over the life cycle, the level of the labour supply overall, the existence of tax distortions in the labour market itself, and changes in those labour taxes implied by changing the tax on the return to saving.

We consider first the case where the labour market is undistorted. The relative price of market consumption in terms of current consumption in the absence of a tax is $1/(1+r)$. If the wage rate is w, the relative price of current leisure is w, and the relative price of future leisure is $w/(1+r)$, both in terms of current consumption. The imposition of the savings tax raises the relative price of future consumption and leisure relative to current consumption and leisure to $1/[1+r(1-t_r)]$. The household is induced to take a given amount of leisure earlier in the life cycle assuming general substitutability. This aspect by itself leads the tax to have a larger compensated effect on saving than it did in the case of the fixed labour supply, and raises the efficiency cost of the tax. In addition, the savings tax could cause more or less leisure to be taken overall. Well-known marginal productivity considerations lead to leisure being concentrated in the latter part of the life cycle. As a result, the savings tax, by raising the relative price of future values, raises the relative price of overall leisure to consumption. This induces a likely fall in leisure (i.e., later retirement) and a further decline in saving due to the shorter period of retirement consumption.

When the labour market is distorted, say by a labour-income tax, efficiency effects of the savings tax must take into account changes in these labour taxes. The incentive to take a given amount of leisure earlier reduces the social present value of labour taxes collected because they are discounted at the gross-of-tax interest rate. However, the incentive to consume less leisure overall by retiring later increases the present value of labour taxes collected. In general, therefore, the present value of labour-income taxes may be increased or decreased by the savings tax.

The above assumes that revenues collected through the tax on the return to saving are spent on a public good or redistributed as a lump-sum payment. If, instead, revenues from the savings tax are used to reduce the labour-income tax rate, the direction of efficiency effects is even less clear. The reduction in the labour-income tax also alters the level and timing of consumption and leisure, and the overall effect on efficiency is ambiguous.

There are few unqualified theoretical results in this case. One important result developed by King (1980) is the application of the well-known Ramsey rule in this context. It implies that if the uniform taxation of labour income gives rise to an equi-proportionate decline in consumption in every period, the optimal tax on the return to saving is zero or equivalently, that the imposition of a savings tax imposes an efficiency cost. More generally, we would expect the labour-income tax to cause consumption to change by different proportions in different periods, and an empirical study is needed to determine the efficiency cost. Such a study would require estimates of various elasticities of substitution between labour supply in any period and consumption in the same and other periods. In the absence of such estimates, one must consider the efficiency costs calculated under the fixed labour-supply assumption as preliminary and illustrative.

Efficiency Costs in an Overlapping Generations Context

The analysis in the previous section was based on the individual household or an economy of identical households. However, an important consideration is that, at any point in time, the economy is populated with many households who are of different ages and therefore at different points in their life cycle. This simple fact precludes us from discussing efficiency solely in the context of a single-person economy even if we assume households are identical in all respects except age.

There are a number of economic efficiency issues that arise in an economy of "overlapping" generations. First, there is the problem of defining economic efficiency in such an economy. Second, there is the possible existence of inefficiency in such economies even if there are no market distortions. This raises the third and main issue – in such economies, tax policy (dealing with the type of taxes to be levied) and debt policy (which concerns the timing of the taxes) are interrelated.

It is necessary to first deal with the definition of *efficiency* in these overlapping generations models because the term has been used in an unconventional way by some authors. An economy is dynamically efficient if it is not possible to increase the lifetime utility of one generation (we assume there is a representative household for each generation) without decreasing the utility of another (see Starrett, 1972). This is, of course, the Pareto principle as widely used in welfare economics. This point is emphasized because King (1980), Summers (1981) and others have defined efficiency in terms of moving the economy to the "golden rule" level of capital per head. In fact, the most that can be said about Pareto efficiency in this regard is that an economy in which capital accumulation has proceeded past the golden rule and will continue there indefinitely – i.e., one where the real interest rate is forever less than the GNP growth rate – is inefficient in that the utility of every generation can be raised by reducing the capital-labour ratio in all future periods. However, no such statement can be made about economies that have accumulated less than the golden rule level of capital per head (i.e., where real interest rates exceed the GNP growth rate). Although achieving the golden rule level of capital per head would raise utility in the *steady state*, it would lower the utility of the transition generations and therefore cannot be evaluated using the Pareto criterion. We will restrict our use of the term efficiency to the Paretian sense. It should be noted that studies which have found sizeable "efficiency" gains by comparing steady states are not using the word "efficiency" in this generally accepted way. In that sense, the large welfare gains reported by Summers (1981) are not efficiency gains.

The second issue concerns efficiency (in the Paretian sense) in an undistorted overlapping generations model. It is well known from the work of Malinvaud (1953), Samuelson (1958), Diamond (1965), and Starrett (1972) that the overlapping generations economy may not be efficient even if there are no tax distortions and agents are competitive. It can be shown that an economy of selfish, finite-lived overlapping generations may accumulate capital in excess of the golden rule level. Moreover, Carmichael (1982) has shown that this inefficiency may exist even if there is intergenerational altruism and an "operative bequests/gift motive" – a situation in which government debt is neutral in the Ricardian-Barro sense. However, these latter inefficiencies appear to be confined to situations in which altruism runs from young to old generations (on net) which leads to an overaccumulation of capital relative to the golden rule.

This brings us to the third and major issue concerning debt policy and efficiency. Debt policy is defined here as a change in the timing but not the present value (to the government) of taxes levied and is accomplished by changing the level of government debt.[4] Providing conditions for Ricardian-Barro debt neutrality do not hold,[5] debt policy can alter the distribution of the tax burden across a given generation's lifetime or across generations. Also, it can directly alter economic efficiency. Tax policy also changes the distribution of the tax burden within and across generations and has effects on economic efficiency. Therefore, when undertaking an analysis of the efficiency effects of taxation, one must proceed with some explicit assumption about debt policy.

Most authors have proceeded on the assumption that debt policy is fixed and that any efficiency gains (losses) obtained through tax policy which *could* have been obtained (avoided) through debt policy are counted as part of tax policy. For example, Kotlikoff (1984) concentrates on "structural" tax changes which hold the time path of government receipts constant. Alternatively, one could proceed on the basis of accommodating debt policy. Here we assume that before the tax change, debt policy has already been designed to exploit all efficiency gains that are possible holding the tax structure constant. Upon changing the tax structure, debt policy can be adjusted so as to compensate generations which lose as a result of the tax change. This seems to be in accordance with efficiency analysis as it is carried out in other areas of economics. Moreover, it means we can ignore inefficiencies of the Malinvaud–Samuelson–Diamond type in analysing tax policy because efficiency gains of this dynamic type can be achieved through debt policy. Also, in the event that tax policy changes make some generations worse off, we can invoke the compensation principle and analyse potential Pareto improvements that can be realized through debt policy.

The upshot of this discussion is that the so-called "dynamic 'efficiency' gains" as measured by Summers (1981) and others based on changes in steady-state consumption can be attributed to something other than tax policy (i.e., a failure to exploit debt policy) and efficiency effects of policies that impinge on saving can be measured using the conventional excess-burden measures that apply to individuals as derived above.[6] The implication of this approach is that the relatively large efficiency gains that Summers (1981) has measured for consumption tax reforms and which can be attributed to an effective lump-sum tax on older generations should not be counted as the excess burden of existing taxation of the return to saving.

General Equilibrium and Open-Economy Efficiency Considerations

The efficiency analysis of the household was largely partial equilibrium in nature. For example, the before-tax interest rate facing households was assumed constant as was the real wage rate in the variable labour-supply case. In an open economy, changes in the equilibrium interest rate can largely be ignored because of a very elastic supply of foreign saving.[7] A similar case cannot be made for ignoring general equilibrium effects in labour markets, however, because labour is very immobile internationally. But in view of data limitations, we are forced to assume a fixed household labour supply anyway, so these general equilibrium considerations need not detain us here.

In the context of a small economy which is open to the world capital market, it is legitimate to treat the savings and investment sides of the economy separately, so we need only consider the partial equilibrium effects of changing taxes on saving. This is important in the open-economy context because it may be desirable to maintain direct taxation on investment (such as through the corporation income tax) if the foreign country adopts a foreign-tax credit policy. Non-discrimination provisions may well preclude the taxation of foreign but not domestic incomes at the corporate level (although this has been carried out in Canada to some degree through the foreign tax credit), and efficiency gains from abolishing domestic investment taxes may be swamped by transfer to the foreign treasury. However, it would still be efficient and feasible to eliminate personal taxes on savings.

This is illustrated in Figure 9-3 for a capital-importing economy where $S(S')$ is domestic supply[8] of loanable funds gross (net) of personal taxes, and $D(D')$ is domestic demand for such funds for investment purposes net (gross) of business taxes. S^w is the perfectly elastic supply of funds from abroad at the world interest rate i^*. It is assumed that foreign country taxes income to foreign-owned capital in the domestic economy at rate u^* without deferral and allows a full tax credit up to rate u^*.[9] As a result, any attempt to tax investments domestically at a rate below u^* would simply transfer revenues to the foreign treasury. Consequently, it would not be desirable to eliminate creditable domestic capital taxes such as the corporation income tax. It is, however, desirable to eliminate the personal taxation of domestic savings. By eliminating this tax, we gain the triangle *aeg* in Figure 9-3. Note that though we lose revenues paid by foreign capitalists of *abfe*, that area is not lost to the Canadian economy. It is true that foreign savings earns a gross return of $i^*/1\text{-}u^*$ in the domestic economy and only costs i^*, but the same thing applies to domestic savings. Domestic savings that replaces foreign savings earns a gross return of $i^*/1\text{-}u^*$ and costs the height of the net-of-tax supply curve S. The net gain is thus the usual efficiency triangle.

Summary of Efficiency Issues

The taxation of the return to saving lowers the after-tax real return to saving and raises the relative price of future consumption. This "distorts" the household's intertemporal allocation of resources. An excess burden is created because the household makes its consumption-savings decision on the basis of a real return that does not reflect the actual rate at which current consumption can be transformed into future consumption.

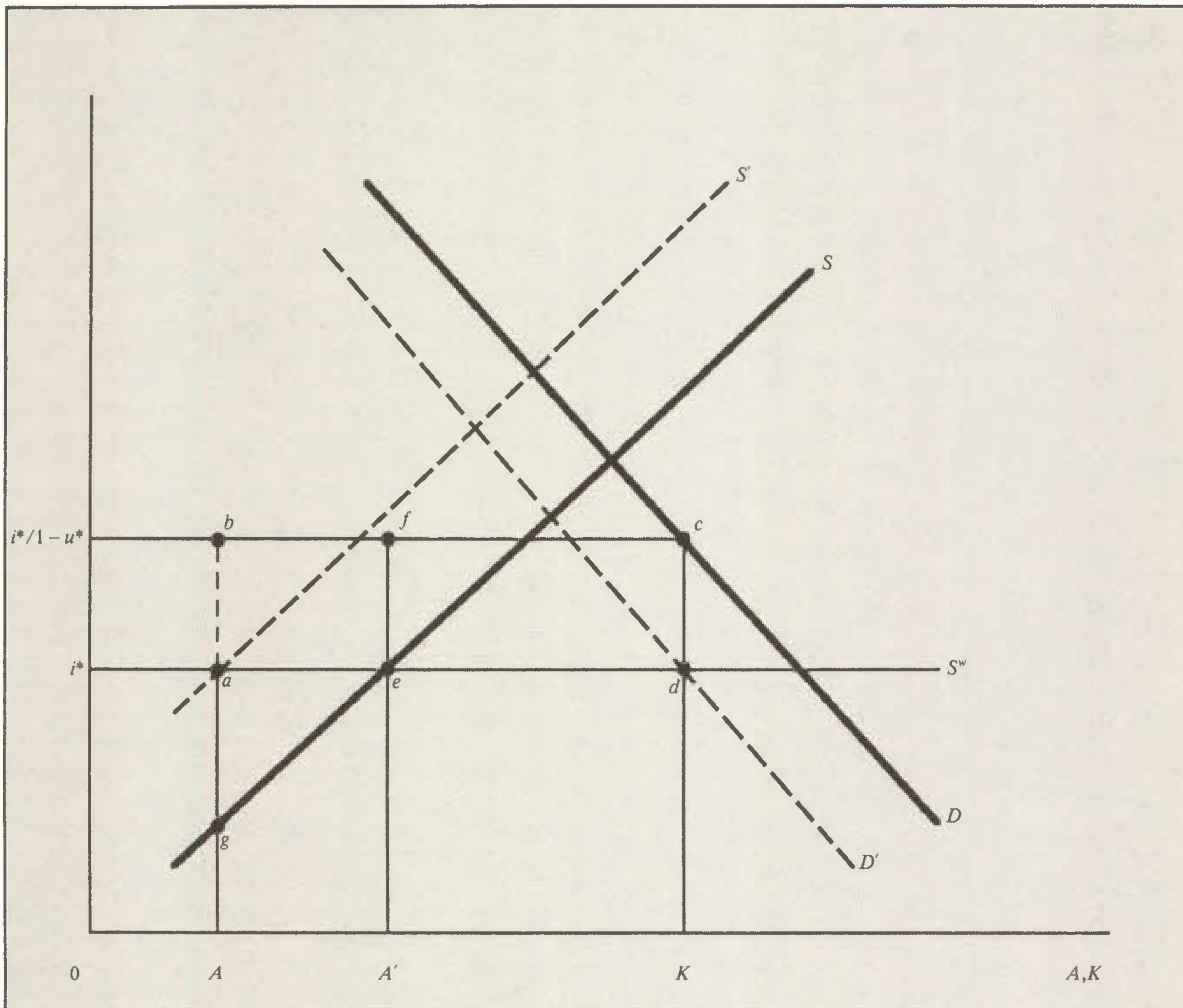
This excess burden can be measured using income-equivalent values. In the two-period case, excess burden is the familiar welfare-cost triangle found from the compensated savings function. In multi-period models, the measure is more complicated but can be calculated with age-specific compensated-savings curve slopes. These excess-burden measures are calculated on the assumption of a fixed labour supply. The possibility of a variable labour supply could raise or lower the excess burden. Without empirical evidence on the effect of wages and interest rates on labour supply, we are unable to determine whether our estimates over- or under-estimate the excess burden of the taxation of saving.

It is necessary to consider a multi-household economy in this context because the economy is populated with households of different ages. With disaggregated data, an aggregate measure of household excess burdens can be calculated. However, a further complication arises because of possible existence of non-tax intertemporal inefficiencies. Tax policy has additional efficiency effects by influencing the level of capital formation (or, in an open economy, the level of domestic wealth) in the presence of these inefficiencies.

Most authors have included these additional efficiency effects in their measures of the excess burden of the taxation of saving. Also, they have stretched the meaning of efficiency by considering changes in steady-state utility levels resulting from intergenerational transfers. A more conventional, and we believe meaningful, measure of the excess burden is obtained by assuming an accommodating debt policy rather than the fixed debt policy the above-mentioned authors assume. This allows the government to manipulate its debt so as to eliminate the non-tax intertemporal inefficiencies. Also, debt

Figure 9-3

Illustrative Demand and Supply of Capital



policy can be used to offset the intergenerational redistributive effects of tax policy so that the use of an aggregate excess burden can be justified on the basis of the compensation principle. In this case, efficiency effects of the taxation of saving are confined to intertemporal distortions of household choice. Specifically, "efficiency" gains obtained by lump-sum taxation of older households or by increasing capital formation when the real interest rate exceeds the population growth rate are ignored.

The open-economy assumption allows us to ignore general equilibrium considerations in capital markets and proceed with the analysis of the taxation of saving separately from the direct taxation of investment returns through business taxes. Importantly, this means that it is still efficient to eliminate the distortion caused by the taxation of saving even though foreign-tax credit arrangements preclude the elimination of direct taxes on investment. In removing personal taxes on the return to saving, taxes on foreign savings will be reduced, but this is not a loss to the economy. This is because the gross return on domestic savings which replaces foreign savings as a result of the tax change also exceeds the net return by the investment (corporate) tax. We are left with efficiency gains as calculated for the household sector.

In conclusion, the excess burden of the taxation of saving as calculated from the intertemporal distortion of household decisions is the best available measure of the efficiency cost of such taxation. Of course, with reliable labour market data, a better measure could be obtained by relaxing the fixed labour-supply assumption.

Equity and the Taxation of Saving

We discuss these issues in terms of the standard horizontal and vertical equity criteria.

Horizontal Equity

The idea that income should be taxed at the same rate in the hands of different individuals regardless of differences in the source of that income has a long history in public finance as exemplified in the work of Haig (1921) and Simons (1938) and in the Report of the Carter Commission in Canada (1966). At first, it would appear that exempting the return to saving or taxing it differentially from labour-income receipts would violate this simple and plausible equity criterion.[10] However, this conflict is in fact more apparent than real. It arises because of a myopic or short-run view as to what constitutes equal incomes. Specifically, people are designated as equals on the basis of equal annual incomes. If one takes a lifetime view and equates households on the basis of their lifetime opportunity to consume regardless of the timing of income receipts, the exemption or differential taxation of the return to saving may well be required by the criterion of horizontal equity rather than being in conflict with it.

Horizontal equity would require the exemption of the return to saving from taxation if the labour-supply decisions by households are exogenous. In this case, taxing the return to saving would impose a heavier burden on a household that receives its labour income early in its lifetime or that has a preference for consumption later in its lifetime, as compared to another household which has the same lifetime income but receives and spends its labour income more smoothly over its lifetime.

In the event that the labour-supply decision is not exogenous, requirements of horizontal equity are less clear. Taxing income of any form favors non-market goods (e.g., leisure) over market goods. To the extent that leisure at any point in time is less substitutable for current goods than future goods, the taxation of the return to saving may be required by horizontal equity. This would be the case because a leisure-lover who enjoys more leisure by retiring early would be taxed less heavily than a goods-lover who has the same lifetime consumption opportunities if the return to saving were exempt from taxation. Taxing the return to saving by imposing a relatively higher tax on future consumption would result in the leisure-lover and goods-lover being taxed more equally. However, in doing this, conditions of horizontal equity between two goods-lovers or two leisure-lovers may be violated.

Vertical Equity

It is generally accepted that the tax liability of a household should increase as the household's ability to pay increases, and at an increasing rate.[11] Just as the implementation of horizontal equity criteria requires an operative definition of "equals," the crucial issue in implementing vertical equity concerns the definition of "ability to pay." If ability to pay were defined in terms of current income receipts inclusive of returns to saving, then the exemption or differential taxation of the return to saving could violate vertical equity because a high-income household with a high proportion of capital income could end up paying taxes in any given year which are proportionally lower than a lower-income household which has a high proportion of non-capital income. Again, however, defining ability to pay in terms of lifetime income resolves this apparent conflict. It is possible to tax progressively the lifetime income of a household while exempting or taxing differentially the return to saving.

Taxing lifetime income on a progressive basis does introduce the problem of averaging however, because the appropriate tax rate for a household need not bear any relationship to current values of receipts. As a result, averaging is necessary, otherwise horizontal and vertical equity goals, as well as efficiency goals, may not be realized.[12] In fact, a large degree of averaging would be a by-product of a tax system that exempts the return to saving through a system of designated (deductible) and non-designated assets. This will be discussed further.

Monitoring and Reporting the Distribution of the Tax Burden

Although the exemption of the return to saving from taxation is, or can be, made consistent with both horizontal and vertical equity criteria when they are defined on a lifetime basis, this does raise the problem of monitoring and reporting equity in these terms and the problem of perceived inequities based on reported annual incomes and taxes paid. Even if a longer-term measure of income and taxes paid was reported (and this would entail a substantially more complicated system of statistical reporting than is presently in use), the problem would only be mitigated and not eliminated because the actual distribution of the tax burden could only be established on the basis of lifetime information that includes taxes paid in retirement on incomes earned earlier in the life cycle. Although such life-cycle incidence studies are not impossible, there is a serious question whether results of such studies could overcome the simple appeal of annually reported taxation statistics. Consequently, the fairness of the tax system would have to be judged on the basis of its structure rather than reported taxation statistics. This would only be possible if the tax structure were relatively simple since a plethora of exemptions, deferrals and deductions would make it difficult to make any *a priori* appraisal of the tax system.

Other Fairness Issues

Perhaps the most commonly encountered argument concerning the inequity of exempting the return to saving asserts that personal wealth yields utility above and beyond the future consumption that it makes possible. If this argument were true (i.e., financial wealth enters the utility function in each period directly), there would indeed be a case for taxing wealth directly or indirectly by taxing the return to wealth. There is no presumption that the return to saving should be taxed at the same rate as labour income, however.

The major difficulty with this argument is that it is based on a non-verifiable assumption. In order to apply the argument, it would be necessary to identify the channels through which wealth provides such utility services. Moreover, the appropriate policy would then be to tax such activities rather than wealth itself. For example, if it was argued that wealth increases utility by making possible the exercise of political power through contributions to political parties, then the appropriate policy would be to make political contributions taxable rather than taxing the return to wealth itself.

Other arguments concern bequests. It is now fairly clear that the issue of whether or not to have an inheritance tax is separate from whether or not to tax the return to saving. Only if inheritance taxes are desirable on equity grounds (say, to prevent increasing wealth inequality through some sort of Markov process) but unfeasible in their own right can one make a case for taxing the return to saving as an indirect measure. It is not obvious that the inheritance tax imposes administrative problems that are any more difficult than those involved in the taxation of the return to saving, as discussed in the next section.

To conclude, equity arguments against exempting the return to saving from taxation are based on a very short-run view of ability to pay or equal incomes (which is difficult to defend) or rather weak arguments concerning the substitutability of leisure for future consumption or the existence of mysterious non-consumption benefits from wealth. In contrast, rather strong horizontal and vertical equity arguments for exempting the return to saving can be made on the basis of lifetime measures of ability to pay and equality.

Conclusion

In this chapter we have introduced the main efficiency and equity issues surrounding the taxation of the return to saving. We say that if variations in the labour supply can be ignored, a consumption tax would be a "lump-sum" tax, whereas the income tax, by distorting the consumption-savings decision, would impose an efficiency cost. This efficiency cost can be calculated on the basis of our estimates of household consumption functions and could be quite small in the absence of inflation or in the event that the income tax were to fully index capital income for inflation.

When, however, the inflation distortion of the return to saving is considered, the effective marginal tax and the corresponding efficiency cost can be sizeable. These costs could be avoided in large part by indexing capital income or, in total, by adopting a consumption base of the personal tax.

We also discussed the main equity issues. It is argued that taxing the pure return to saving violates horizontal equity in the sense that taxpayers with some lifetime opportunity to consume would be taxed differently depending upon their desired timing of consumption. Also, it was argued that a personal consumption tax could achieve neutral equity because it can be made progressive. However, the appropriate criterion for vertical equity is lifetime ability to pay rather than accrual income.

10 Consumption versus Income as the Personal Tax Base

Introduction

In this chapter we consider the policy issues concerning the taxation of the return to saving in terms of the choice between income and consumption as the appropriate tax base. A pure consumption tax leaves the marginal return to saving completely untaxed, while the pure income tax taxes the return to saving at the same rate as other forms of income. If desired, these tax bases can be combined so that the return to saving is taxed at some rate between zero and the full income tax rate. However, we shall see that income and consumption base elements should be combined quite differently than they are under the current "hybrid" tax system in order to accomplish this.

The purpose of considering the pure tax bases is that an understanding of the pros and cons of these different tax bases is a valuable guide to understanding the issues surrounding the appropriate taxation of the return to saving. Indeed, it can be argued that the question of appropriate taxation of the return to saving is equivalent to the question of appropriate mix of income and consumption taxation. By considering how the existing personal income tax in Canada differs from the pure tax bases and identifying which reforms are required to move the existing system towards either of the two pure systems, we can develop a menu of tax reform options and a consistent framework for choosing among them. We shall argue that it is desirable to move the Canadian income tax system towards the consumption tax base or, at least, to reform the way in which we "mix" the two bases. While the existing income tax is a hybrid consumption and income tax base, it probably combines the worst features of the two systems rather than the best. This alone is sufficient cause to consider personal income tax reform in Canada.

In the next section we discuss the pure income tax base and then the types of changes that would have to be made in the existing personal tax system in order to achieve such a tax base. We also consider the appropriate role for the corporation income tax under a pure income tax system. Following this, we devote a section to the pure consumption tax base and changes that would have to be made in the present system for it to approximate such a tax base. We also consider the appropriate role for the corporate tax under such a system and see that it differs from that under an income tax. The next section evaluates the relative merits of the two pure systems. We then go on to describe how income and consumption tax elements could be combined in the case where partial taxation of the return to saving is desirable, followed by a brief section on international implications of tax reform. The second-to-last section considers the transition problem in tax reform, followed by our conclusions.

The Pure Income Tax System

The pure or "comprehensive" income tax base as a desirable objective dates back to the writings of Haig (1921) and Simons (1938) and, in the Canadian context, was most eloquently and vigourously advocated in the Report of the Carter Commission (1966). The comprehensive income tax base is defined to be equal to consumption plus the increment in net real wealth of the taxpayer over a defined interval of time. Equivalently, the tax base includes all forms of income as they accrue whether spent or saved. This is sometimes expressed as "a buck is a buck." It should be noted that consumption is defined to include all utility-generating activities whether or not they pass through the market. This means that the value of services derived from consumer durables and housing owned by the taxpayer as well as services provided within the household should be added to the tax base and taxed equally along with conventional pecuniary income. In the most extreme view, the value of leisure time consumed by the taxpayer should be included in the tax base. Needless to say, no one to our knowledge has actually suggested such a broad base in the context of actual tax reform but, *in principle*, the pure income base requires such inclusions. As in the case of the pure consumption tax base, the pure income base can only be approximated in practice.

Two general issues concerning the pure income tax base are the time interval over which income is measured and the definition of *real* versus nominal income. Income is a flow and can be measured only over an interval of time. An obvious question concerns the appropriate length for this interval which, in principle, could range from an instant to the lifetime of an individual or a family. It is fair to say that the implicit assumption made in choosing the pure income tax base is that the interval over which the flow of income is measured is the shortest interval that is administratively feasible. For all practical purposes, this means annual intervals. If a longer interval were chosen, the difference between the pure consumption tax base and the pure income tax base would fade, and indeed the two bases become essentially equivalent if the interval is sufficiently long, say the lifetime of the taxpayer.

One of the most important practical questions about the definition of the pure income base is how to measure capital income in real terms. In principle, the pure income base is defined as consumption plus net accretions to real wealth. Real wealth is the purchasing power of the taxpayer's dollar wealth in terms of the ability to consume goods and services. When the cost of living as measured by a price index rises, the purchasing power of the taxpayer's dollar wealth falls accordingly. The pure income tax base requires that such inflation-induced losses in real wealth be subtracted from dollar accretions in money wealth or, another way of saying the same thing, that capital income should be indexed for inflation. It should be noted that at zero or very low inflation rates such indexation is not necessary, which explains why advocates of the pure income base such as Haig and Simons and the Carter Report failed to address the problem adequately. Needless to say, the inflationary decade of the 1970s has made proponents of tax reform very aware of the difficulty, and it is now known that even "moderate" inflation rates can cause a serious divergence between money and real capital income. In our opinion, the difficulty in indexing capital income poses one of the most serious obstacles in the way of approximating the pure income base.

The above discussion only addresses the definition of the tax base under the pure or comprehensive income tax system. The choice of the tax rate structure is another issue and is separate from the choice of the base. The central concept in the choice of the tax rate structure is the so-called *progressivity principle* dictating that the tax burden should rise in greater proportion than the tax base across different taxpayers. Usually, this is accomplished by a graduated rate schedule with the marginal and average tax rate increasing as income increases. The existence of a graduated rate schedule raises the problem of fluctuating incomes. Under a graduated schedule, an individual with a fluctuating income will pay a larger share of that income as tax than an individual with a steady income equal to the average of the fluctuating income.

It is sometimes suggested that tax averaging is required under a pure income base when a graduated rate schedule is in place. In fact, the Carter Commission recommended lifetime averaging but, strictly speaking, the logic of the pure income base implies that this is not the case. As pointed out above, the essential difference between pure income and pure consumption tax bases is that the former defines income as a flow over a relatively short period of time. If one accepts that the appropriate measure of ability to pay is annual income, it is inconsistent to also promote tax averaging over a lengthier interval. If, in fact, one accepts that a longer-run measure of income such as permanent income is the appropriate measure of pure income for the tax base, one is actually advocating consumption taxation, as we will see below.

Reforming the Current System towards a Pure Income Tax

The types of changes in the current income tax system required to move it towards a pure income tax can be accurately described, for the most part, as broadening the tax base. This involves eliminating various exclusions, deductions, deferrals and preferential tax rates applying to certain types of income. Perhaps the one exception is the indexation of capital income. A pure income tax base would deduct from capital income the inflation-induced loss in the purchasing power of all money wealth, thus narrowing the tax base relative to the current system which allows only limited indexation of capital income. Problems with indexing capital income have been discussed at length elsewhere.[1] We believe it is accurate to describe the indexation problem as one of the most severe practical problems facing the implementation of the pure income tax base.

The base-broadening reforms required by the pure income base fall into three categories: those which are clear in principle and face only political resistance; those which are clear in principle but pose administrative problems; and those which are ambiguous in principle. The first category includes reforms such as the abolishment of all deductible forms of saving including RSPs, the elimination of deductions for medical expenses, charitable donations, CPP contributions, and UI premiums; the inclusion of receipts from all government transfer programs, all gifts and inheritances, all employer-paid fringe benefits, and certain returns on life insurance policies; and the elimination of averaging provisions offered by the current system to some types of taxpayers. Although some of these deviations from the pure income base could be defended on special grounds (e.g., the deduction of medical expenses), it is fair to say that the pure income base requires such reforms as a matter of principle. The second category includes the full taxation of all real capital gains upon accrual rather than realization, the indexation of interest income, and the taxation of income and costs that do not pass through the market. The third category involves the choice of the taxpaying unit in general, and the treatment of gifts and bequests within the household in particular.

The second category of reforms requires further discussion. Indexation of capital income and the taxation of capital gains and losses upon accrual have been discussed elsewhere, so we will focus on the issue of implicit income and costs particularly with respect to the treatment of human capital and consumer durables. While in principle the value of services provided within the household for the household along with the value of leisure should be included in the tax base, it is generally conceded that this would be administratively unfeasible and politically unwise. Rather, much of the controversy has focused on the treatment of consumer durables including owner-occupied housing and the treatment of human capital under the pure income tax base. The logic of the pure income base requires that income used to purchase an asset and the returns accruing to the asset itself in future periods both be subject to the tax. In the case of the purchase of a financial or income-generating asset, the application is straightforward - income used to purchase an asset (for example, funds placed into a savings account) and the return to the asset (interest paid on the savings account) are included in the taxpayer's taxable income at the time they accrue. The application of this principle to the case of assets, where the cost of acquisition and/or returns are implicit and do not pass through the market, poses a major difficulty. In the case of human capital, it is often the case that a large part of the costs of acquiring the asset (education or technical skills) comes in the form of forgone earnings. For example, a substantial part of the cost of a year's education in university is the earnings foregone by not being employed full-time during the year. In order to treat the acquisition of human capital in the same way that financial and income-generating physical capital are treated under the pure income tax, this part of the cost should be imputed to the income base and subject to tax. Returns to the human capital asset in the form of future labour income should be taxed also, as they presently are, but depreciation and interest costs of holding human capital should be deductible.

Consumer durables and owner-occupied housing pose a related problem. Here, the income used to acquire equity in such assets is subject to tax, but the returns to such assets which come in the form of a flow of services to the owner are not taxed. Again the logic of the pure income base requires that these returns be imputed to the owner's income as they accrue, even though they are not pecuniary in nature. Sometimes people suggest that this will involve a "double taxation" of returns to such assets since both the purchase of the asset and the flow of services from the asset are being taxed. This is true, but it should be noted that this is the logic of the pure income tax base. If one believes that there is double taxation involved in the act of imputing income foregone in the acquisition of human capital or the services provided by consumer durables to the tax base, then this double taxation criticism applies equally to the treatment of conventional saving and investment under a pure income base.

The above imputations, while required by the pure income base, are difficult to implement for both administrative and political reasons. Thus, most implementations of the income base will treat human capital and consumer durables/owner-occupied housing differently than other capital assets in a way that favors these assets. In fact, as we argue below, the income tax treats these assets in a way that would be appropriate under the pure consumption tax base. For this reason, along with the problem of indexing capital income, we believe the pure income base is administratively unfeasible or certainly difficult even to an approximation.

A few words need to be said about those issues concerning the pure income tax base which are ambiguous in principle. One such issue is the choice of the tax unit (i.e., individual, married couple, family, etc.). We have little to say on this subject except to point out that it is a more severe issue to resolve under the pure income base than under the pure consumption base to be discussed below because transfers among family members do not alter family consumption, although they do alter family income depending on the choice of the tax unit. As a practical matter, the issue concerns whether income splitting among family members should be subject to tax (in addition to the tax on the income transferred as it is earned by one family member). A related issue is the treatment of bequests. Although there is general agreement that the receipt of inheritances should be included in the tax base of the recipient, there is a question of whether the bequest should be subtracted from the tax base of the donor. In other words, should the bequest be treated as consumption by the donor or as a reduction in wealth? In some sense, this depends on whether the bequest was voluntary or not, which seems to be an undecidable issue from a practical standpoint. In any case, we shall see that the same question concerning bequests also arises under the consumption tax. Our point is that this question is not uniquely confined to the consumption tax as some critics of the consumption tax seem to think.

Taxation of the Firm under a Pure Income Tax

Although a detailed discussion of the relationship between taxes levied on the firm and taxes levied on the household is beyond the scope of this study, a few points should be noted. First, where the firm and the household are not clearly separate as taxpayers, as in the case of proprietorships and partnerships, the primary issue concerns the determination of the base. The pure income base requires that revenues of the firm be added to the tax base as they accrue, while current costs, including labour and materials, are deducted as they accrue. The main complications concern the treatment of capital costs. The pure income base in principle requires that the cost of capital be deducted in the form of the implicit user cost of the capital asset over the tax period (year). This requires that an amount equal to the real cost of finance (generally a weighted average of the real interest rate on debt and the real return on equity paid to persons outside the firm) be deducted along with a true economic depreciation deduction, equal to the true physical rate of depreciation, less the rate of change in the relative price of capital assets held, times the value of capital assets held measured in constant dollars.[2] Inventories should be accounted according to a constant dollar FIFO (first-in, first-out) method. All of the above are difficult to implement.

Where the firm and household are distinct as in the case of a corporation, the above issues apply with equal force to the corporation income tax. For simplicity, we adopt the view that the primary purpose of the corporate income tax is necessary to prevent the income tax from being deferred and preferentially taxed as capital gains by saving and investing it within a corporation as retained earnings.[3] This essentially requires corporate income being determined on an accrual basis, as described above. To prevent income from being taxed many times, a tax crediting arrangement is needed as income flows among or between corporations and resident households.

The Pure Consumption Tax System

The pure consumption tax base differs from the pure income tax base in that net changes in real wealth over the interval of measurement are not part of the tax base. Income earned but used to augment real wealth is not taxed, while consumption, whether financed out of income or accumulated past savings, is part of the tax base. Like the pure income base, the pure consumption base should, ideally, include consumption of goods produced and consumed within the household, including leisure. But also like the pure income tax, such inclusions are impractical so the ideal consumption base can only be approximated.

The flow of real consumption can be taxed directly or indirectly. Indirect taxation of consumption is accomplished through a sales or value-added tax levied on a destination basis which excludes producer durables. Direct taxation involves taxing the consumption stream of the individual taxpayer. This is accomplished by subtracting the change in real net wealth from the pure income base of the taxpayer. In most cases, this is going to require that additions and reductions in wealth be monitored. This is accomplished by having the acquired assets "registered" with the taxpayer's identity. The cost of acquiring registered assets is deductible from the tax base in the year incurred, while withdrawals of principal and accrued interest of registered assets are added to the tax base. In other words, a consumption tax base can essentially be achieved by extending the RPP and RRSP provisions which currently exist in the present system.

Since the direct consumption tax base is equal to the difference between the pure income tax base and the net change in the real wealth of the taxpayer, it would appear that the tax authorities will be enmeshed in the same complex of problems that the pure income base involves. In fact, this is not the case. To begin with, there is no need to index capital income. The change in real net wealth is equal to the change in nominal net wealth minus the loss in the purchasing power of the outstanding stock of wealth due to inflation. This loss in the purchasing power is exactly the inflation adjustment that should be subtracted when calculating the pure income base. Since the change in real net wealth is subtracted from the tax base, the inflation adjustment term would exactly cancel that required for indexing the capital component of income so it can be ignored. Thus, real capital income adjusted for inflation less the change in real wealth is equal to capital income not adjusted for inflation less the change in net nominal (dollar) wealth. No inflation adjustment of capital income is required. For this reason, capital gains and losses do not have to be indexed for inflation. Moreover, capital gains need only be taxed at the time they are realized for the purpose of consumption. In other words, there is no need for the administrative complexities associated with the indexation of capital income or the taxation of capital gains upon accrual that a pure income tax would require.

It can further be noted that the deduction of costs incurred in acquiring assets and the addition of amounts withdrawn from wealth as required by the direct consumption tax base is automatically satisfied in the case of human capital without the need to register the asset. The implicit cost of acquiring human capital which occurs in the form of foregone earnings is automatically deducted simply by not imputing such costs to taxable income, as would be required by the pure income tax. Pecuniary costs such as tuition fees and the like should also be deductible under the pure consumption tax, as they are to some extent under the existing "income" tax.[4] Returns to human capital - assuming they are pecuniary - are added to the tax base since all earnings attributable to labour are so added. Of course, non-pecuniary returns to human capital should be imputed to the pure consumption tax base as they should be to the pure income tax base, but this is equally impractical in either case.

This direct method of imposing a pure consumption tax would, at first appearance, run into the same difficulty as does the pure income tax, with respect to the treatment of consumer durables. Remember that the return to consumer durables is in kind and should be imputed to the pure income base. Similarly, the pure consumption tax base would require that returns to consumer durables be imputed to the pure consumption base, while the costs of acquiring the consumer durable should be deductible. Under certain circumstances, however, there is an equivalence between the present value of the services of a consumer durable and the cost of acquiring the asset. Strictly speaking, this would be true for the marginal (i.e., last) dollar spent on the consumer durable when future services of the consumer durable and prices of those services are known with certainty. In this case, an equivalent way of taxing such assets under the pure consumption tax base would be to exclude the value of consumption services from the base as they accrue, but add the cost of asset to the base at the time it is acquired; that is, do not let the cost of acquiring consumer durables be deductible because returns to consumer durables are not taxed as they accrue. Bradford (1982) calls this the "prepayment" method of levying the consumption tax. It is also sometimes referred to as the exemption method since transactions in the asset are essentially ignored; neither the expenditures on such assets are deducted (so they need not be monitored) nor are the returns to the assets added to the tax base. Alternatively, the tax could be called an expenditure tax because all consumer expenditures are taxed whether they are on durables or non-durables. Remarkably, the present treatment of consumer durables is essentially that which is required by the pure consumption tax but not the pure income tax.[5]

The prepayment method of levying a consumption tax could be useful wherever an asset pays a return in kind, for example non-interest bearing cash balances. Thus, funds placed in a chequing account or held as cash should not be deductible from the tax base. It should be stressed, however, that the prepayment method could not be widely used as an alternative method of levying the consumption tax. A consumption tax is *not* equivalent to a tax on labour income, which is what one would have if widespread use of the prepayment or exemption method were allowed. The consumption tax is equivalent to a tax on labour income plus economic rents and profits received (plus inheritances and transfers as discussed further below). In other words, the only difference on the receipt side between a pure consumption tax and a pure income tax is that the pure consumption tax allows a deduction for the cost of foregoing a dollar of consumption as measured by the pure interest rate. The return to assets held as wealth includes economic rents and profits as well as pure profits. The prepayment method does not capture these elements of an asset's return and therefore should be used sparingly and only where it provides a clear administrative advantage, such as in the case of consumer durables. Election of the prepayment method should not be made generally available, or else economic profits and rents would escape taxation.

Another reason for permitting an asset to be treated on a prepaid or exemption basis is to permit the taxpayer to engage in self-averaging of his consumption tax base over time. This would not be necessary in the case of a proportional consumption tax. But in a consumption tax system, as in a pure income tax system, it is likely that some degree of progression in the tax burden is desirable for reasons of vertical equity. This progression can be accomplished by imposing a graduated rate structure which introduces the problem of averaging. Since consumption varies less over the lifetime of the taxpayer than does income, this problem is less severe than under the pure income tax[6] but is present, nevertheless, as long as there are variations in the desired level of consumption over time. Moreover, the lumpiness in expenditures on consumer durables also contributes to variations in the tax base over time making averaging desirable.[7]

Self-averaging can be introduced into a consumption tax system by allowing for some financial asset to be treated on an exemption basis. In this case, the taxpayer can manipulate his holdings of registered assets so as to attain a relatively smooth tax base over time. In periods where consumption is higher than the lifetime average, the taxpayer would add to registered assets, thereby reducing his tax liability, and would withdraw during periods where consumption is below the lifetime average level. The difference would be placed in a tax-exempt asset. In order to prevent tax avoidance, it would be necessary that the tax-exempt asset pay the risk-free interest rate. Obviously, deposits in chartered bank savings accounts that pay a floating rate of interest would be the type of asset that is appropriate for this role.

Finally, it should be noted that there is a set of unresolved problems such as the tax unit choice and the question of how bequests should be treated under the consumption tax base. These problems are exactly the same in the case of the pure income tax system, however. For example, both the pure income and consumption tax bases would include inheritances in the tax base. The pure consumption tax would allow deductions for inheritances received that are added to registered assets, and would only bring them into the heir's tax base when they are withdrawn for consumption. The issue of whether the bequest should enter the tax base of the donor is ambiguous in both cases. It is a matter of whether the bequest is treated as consumption (in which case it would be included under both bases), or whether it is treated as a reduction in wealth (in which case it would be excluded under both bases). There are important efficiency and ethical implications to the choice between these two alternatives. The important conclusion is that the choice is independent of whether one favors a consumption or income tax base.

Reforming the Current System towards a Pure Consumption Tax

It is perhaps surprising that in a very real sense there are fewer reforms required to change the existing personal tax system into a pure consumption tax base than required to change the existing system into a pure income tax. Many of the required reforms towards the consumption tax base are the same as those required towards the income base; namely, those changes that bring certain components of income, which are also components of current consumption, fully into the tax base. These reforms include the elimination of deductions for medical expenses, charitable donations and UI premiums, and the inclusion of receipts from all government transfer programs and the full value of employer-paid benefits which are of the current consumption variety into the tax base. Also, capital gains on "registered assets" should be fully taxed but upon realization and withdrawal rather than upon accrual, as required by the pure income tax base. As in the case of the income tax, some of these exemptions and deductions may be justified on a special equity basis (notably the deduction for medical expenses) but are legitimately part of the consumption (and income) tax base. Also, the value of goods and services produced by labour's services within the household for the use of the household, including leisure, is part of both tax bases in principle but is administratively unfeasible to include in both cases. The fact that such non-market goods cannot in practice be brought into either tax base is an important contributing factor to the ambiguity surrounding the superiority of the consumption tax base, as we shall see below.

The major difference between reforms required by consumption and income tax bases concerns those features of the current system which permit the deferral of taxes. These include deductions for employer contributions into RRPs and RDPSPs, and deductions for employee contributions into RRPs, RRSPs and the CPP. The pure income tax base requires the elimination of such deductions in principle, while the pure consumption tax requires not only the retention of such deductions but the removal of the limitations on contributions that exist under the present system and on the use of the proceeds on withdrawal. In this regard, the pure consumption and income tax bases suggest reforms in the opposite direction.

The other area in which income and consumption taxation suggests reforms in the opposite direction to each other is the exemption of certain forms of capital income, as under the investment income deduction. The pure income tax base would not allow any form of capital income to accrue tax-free. In implementing a consumption tax with a progressive rate structure, it would be useful to have some asset which pays a return in the form of pure interest be treated on an exemption basis. That is, the acquisition and disposal of such an asset including accrued interest has no tax consequences. It was argued above that access to such an asset on a limited scope would permit self-averaging of the consumption tax base without eroding it.

A very attractive feature of the pure consumption tax base as a guide to reform is that many of the difficult reforms required by the pure income base are not required. The most important of these is indexation of capital income and the treatment of human capital and consumer durables including owner-occupied housing. As discussed above, a pure income tax which taxes all capital income upon accrual requires that such capital income be indexed to remove the inflationary component. Under the pure consumption tax, this would not be necessary for the most part because the tax base is essentially coincident with cash flow. Nominal saving in the form of registered assets would be deductible, while nominal withdrawals from such wealth would be taxable. At most, it would be necessary to index the rate structure in the event that it is progressive.

Before considering consumer durables, it is useful to discuss the two-asset (registered and exempt/prepaid) method through which a consumption tax can be implemented. In particular, it should be noted that each of the above assets should have its counterpart liability. For registered assets, the counterpart will be an innovation – registered loans. The registered loan will be treated symmetrically with registered savings vehicles. The proceeds of a registered loan would be added to the taxpayer's base, while interest and amortization of the loan would be deductible. Of course, a taxpayer with a positive stock of registered assets could achieve the same effect by reducing his holdings. The existence of registered loans would simply extend this possibility to taxpayers without registered assets. The counterpart to an exempt/prepaid asset is an exempt/prepaid loan. Such a loan would have no tax consequences with the proceeds exempt from taxation, and the interest and amortization payments not deductible. In fact, this counterpart already exists – personal loans and mortgage loans on owner-occupied housing are treated in exactly this way in Canada.

We now turn to the appropriate treatment of housing and consumer durables under the consumption tax base which turns out to be exactly the same as under the existing system. As mentioned, the consumption tax would treat consumer durables on a prepaid basis with the costs of acquiring such assets non-deductible and the value of services from such assets not included in the tax base. It is sometimes thought that this would pose administrative problems because a household that makes a major purchase in a particular year (say of a house or car) would incur a large tax burden in that year possibly causing liquidity problems in addition to averaging problems in the event of a progressive rate structure. However, the consumption base requires only that the acquisition of equity in such assets be included in the tax base. Suppose, for example, that a taxpayer purchases a house for $100,000 and assumes a $90,000 mortgage. The $10,000 acquisition of equity is included in the tax base (that is, it would not be deductible from income earned to make the acquisition that year, or, if the $10,000 were withdrawn from registered assets, it would be added to the tax base), but the $90,000 mortgage would also be treated on an exemption basis so the proceeds would not be included in the tax base in the year of acquisition. Correspondingly, in the future, interest and amortization payments on the mortgage would not be deductible. In this way, the consumption tax on the durable would be "prepaid," but according to the time profile of the taxpayer's acquisition of equity in the durable and not at the time he takes physical possession of the asset. This is exactly the way such assets are taxed under the existing tax system.

Since housing and other consumer durables would be taxed on the prepaid method, it is true that the economic rents and capital gains on such assets would escape taxation. For example, an individual who enjoys a present value of consumption benefits from his house far in excess of the price he paid for his house (perhaps because of some fortuitous event unforseen at the time the house was purchased) would not be fully taxed on consumption, and conversely for an individual who paid for his house an amount in excess of the present value of his consumption benefits. Also, any real capital gains on the house between the time an individual purchases a house and when he sells it would not be captured under the prepaid system. It should be noted that neither are these returns being captured under the existing system.

As discussed in an earlier section, the appropriate tax treatment of human capital under the pure consumption tax is the same as it receives under the existing system. Essentially, the acquisition of human capital is treated under the existing system equivalently with registered assets. The costs of acquiring human capital whether forgone earnings or tuition are not included in the tax base: the former is not imputed to income and the latter is deductible. Returns to human capital to the extent that they are pecuniary are added to the tax base as wages and salaries and, unless saved as registered assets, taxed as consumed. Non-pecuniary returns to human capital escape taxation in this way, of course, but that is as much a fault of the existing system as it is with the consumption tax.

Taxation of the Firm under a Pure Consumption Tax

Taxation of the firm under a pure consumption tax could, if desired, be the same as under the pure income tax. Under the pure income tax, as seen above, the tax base of the firm, whether or not incorporated, should be the real income accruing to equity holders. In a relatively simple case, this would be revenues less current costs less the real interest on debt and the true economic depreciation of the firm's capital stock. The latter is equal to the true physical depreciation rate less the inflation rate times the constant dollar historic value of the firm's undepreciated capital stock. Inventory cost would be calculated on a constant dollar FIFO basis. This real equity income would then be added to the tax base of the firm's owners in the same way that their labour income is added. These households could deduct their registered savings from this real income as before. Integration between personal and corporate tax bases could be achieved through a tax credit device.

The big advantage of consumption taxation is that a simpler way of taxing at the level of the firm is possible. Under the consumption tax base, but not the income tax base, an equivalent way of taxing at the level of the firm is to tax it on a cash-flow basis. As under the income tax, revenues of the firm are added to its tax base while current costs are deducted, but as these items are received and paid out rather than upon accrual. The main difference concerns the treatment of capital. Under the cash-flow tax, the firm gets to deduct capital costs as they are incurred rather than in the form of real interest and true economic depreciation. Investments in machines, property, inventory, etc., are deducted at the time they are purchased and no interest or depreciation deductions are permitted. All revenues which these capital assets earn are added to the tax base. In other words, capital assets of the firm are treated in exactly the same way as registered assets of the household. It would not be possible to treat assets of the firm on an exempt basis because pure rents and profits earned on the investments would escape taxation. Moreover, the firm (and the household) could avoid taxes by arranging to pay our labour income as tax-exempt dividends or interest.

The main problem with taxing firms on a cash-flow basis is the possibility that firms making large investments would have negative tax liabilities which would have to be refunded. For various reasons, governments are loathed to allow such refundability. However, it turns out that there is a modified cash-flow treatment of the firm which is equivalent but does not require the same degree of refundability. This modified cash-flow system is not too different from the way capital costs are actually treated under the existing corporation income tax.[8]

The design of the corporation tax under the consumption tax should essentially follow these precepts. Again we assume that the purpose of the corporation tax is that of an adjunct to the personal tax rather than a separate tax in its own right. If not, the choice of income versus consumption at the personal level holds no implications about the appropriate design of the corporate tax. One major purpose for taxing corporations under the income tax becomes irrelevant under the consumption tax, and that is the prevention of tax deferrals. Under the consumption tax, it is only appropriate to tax income when it is consumed so the need to prevent deferral by saving the income within the corporation does not exist. The corporation tax can still be used to prevent tax avoidance through off-shore shell corporations, to tax income accruing to foreign-held capital and to tax differentially economic rents and profits. A detailed discussion of these issues is beyond the scope of the present study, although the taxation of foreign capital is discussed further.

The Pros and Cons of Consumption versus Income Taxation

The relative merits of consumption versus income taxation concern the efficiency, equity and administrative properties of the two tax bases. A longer discussion of the first two issues is found in Chapter 9, and highlights will only be reviewed in this section. It is clear that, based on a lifetime utility maximizing theory of household behaviour, the pure consumption tax base is superior to the pure income tax base on both efficiency and equity grounds. These "pure" tax bases are those defined in principle and include, for example, the value of goods and services produced and consumed within the household, including leisure. In this case, a proportional consumption tax or a progressive one that allows for full averaging over the life cycle would be a lump-sum tax levied on an individual in accordance with his lifetime utility of ability to pay. In contrast, the pure income tax, as discussed, would raise the relative price of future to current consumption, inducing a substitution effect which would reduce economic efficiency. In Chapter 9 we saw that, based on estimates of savings equations for the Canadian economy, the efficiency cost of the pure income tax relative to the pure consumption tax could be quite low in the case where the inflation rate is zero.[9] In addition, however, the income tax, by taxing future consumption more heavily than current consumption, would not be horizontally equitable. Two households with the same lifetime utility possibilities in the absence of an income tax would be taxed differently if they chose different consumption streams over time with the household preferring more consumption in the future being taxed more heavily.

When we move away from the pure forms of the above taxes, a number of considerations arise. From a practical standpoint, neither base can be expected to include goods and services produced and consumed within the household such as leisure, so both consumption and income taxes will favor the consumption of such goods. In such a "second-best" economy, it cannot be shown that consumption tax is superior to income tax in terms of efficiency or equity. The penalty that the income tax imposes on future consumption could offset the subsidy that both tax systems impose on leisure and other non-marketable commodities, depending on the cross substitution effect between future consumption and current non-market goods and services.

While such practical considerations may seem to suggest that an agnostic view of the choice between consumption and income taxes is appropriate until better evidence is found, we do not think this is the case. If one is going to make judgments on the basis of practical forms of the tax bases, then one should include the fact that practical income taxes will discriminate between different types of capital. For example, consumer durables including owner-occupied housing, human capital and some other types of capital that either have implicit benefits or costs are likely to be treated on a consumption tax basis under an income tax system, and thereby favored relative to other assets. This means that the income tax will impose further efficiency and equity costs by misallocating saving regardless of efficiency and equity effects it has through its influence on the level of saving. Furthermore, it seems likely that the indexation of capital income, as required by an income tax, would involve considerable administrative costs and would likely be done on a very limited scale, if at all. In the absence of such indexation, the effective marginal tax rate on the return to saving can become very large even at moderate inflation rates (e.g., less than 10 per cent per annum). The corresponding efficiency cost of the distortion imposed by the income tax on the level of saving (ignoring second-best considerations which become less relevant)[10] becomes larger as a result and, as shown in Chapter 9, may exceed 5 per cent of lifetime income for younger generations.

We believe it is fair to say that the strongest opposition to the consumption tax is based on the view that it is less equitable than the income tax. This argument is subject to a number of fallacies. First, it is sometimes not recognized that a personal consumption tax of the direct type we have been describing can be progressive. A progressive tax on current consumption may be distortionary if consumption varies over time[11] so there is a need for averaging. The two-asset system we have described above allows for a lot of self-averaging by the taxpayer and eliminates this problem for all practical purposes. A second fallacy is to argue that even a progressive consumption tax rate may be regressive because taxpayers with high income and low or moderate consumption may pay a smaller proportion of their income in taxes. The answer to this is that the averaged personal consumption tax is still progressive, but it is progressive in terms of lifetime income and consumption rather than in terms of the annual income. Consumption tax advocates argue that this is the more appropriate definition of progressivity because lifetime consumption is a better indicator of a household's ability to pay than current income.

Another frequently heard criticism of the consumption tax base is the assertion that it is equivalent to taxing income to labour alone. If so, this equivalence to a wage tax would make the equity shortcomings of the consumption tax transparent. Actually, the idea that the consumption tax is equivalent to a wage tax is a misunderstanding based on some expositions of the consumption tax which, for the purpose of illustration, assume that there are only two types of income – labour income and pure real interest. In this case, the consumption tax would be equivalent to a tax on labour income. More generally, however, the consumption tax is equivalent to a tax on labour income plus profits and economic rents (that is, capital income above and beyond pure real interest), plus all inheritances and transfers. Thus non-interest forms of capital income, which are instrumental in creating and perpetuating fortunes, do not escape taxation under a consumption tax and indeed may be taxed more heavily than under the existing system, which exempts and taxes preferentially such incomes in the form of capital gains. In other words, the only component of the pure income base that is not taxed under the consumption base is pure real interest which is exactly the compensation required by a household for deferring its consumption for a period of time. The consumption tax advocate denies that this real interest is income because a household would be just indifferent between consuming a dollar now or a dollar plus real interest in the future.

Combining the Income and Consumption Tax Bases

As emphasized in this chapter, the existing Canadian income tax system contains both income and consumption tax components. The main consumption tax components are the treatment of consumer durables (including owner-occupied housing), human capital and pensions, and other limited forms of tax-deductible saving. The main income component is the taxation of saving beyond the deductible limits and the absence of a pure interest, tax-exempt asset. In this sense, the Canadian tax system can be said to be a mixture of income and consumption bases.[12] Some observers argue that this mixture might be a good idea in view of ambiguities about the superiority of one base over the other. In this section, we argue that the way in which consumption and income elements are mixed under the current system is inappropriate even if a mixed system is desirable.

A mixed system of consumption and income taxation would involve the partial taxation of the return to a marginal dollar saved. This is equivalent to a system in which a consumption tax is levied on consumption and an income tax is levied on income with the return to saving being subject only to the latter, while other forms of income including labour income would be taxed at the sum of consumption and income tax rates. Under the existing system, the tax on the return to the marginal dollar saved is the full income tax rate or zero, depending on whether the saver has exhausted the tax-deductible forms of saving or not. For those savers who have exhausted all tax-deductible forms of saving, consumption tax provisions are of the form of lump-sum tax relief. They lower the taxpayer's tax bill and correspondingly the tax base of the government while retaining the full distortion of the consumption-savings decision. The inefficiency of the income tax is retained while the tax base is reduced, thus necessitating higher tax rates and further inefficiencies.

In this section, we suggest that, in the event that a mixed system is desired, a superior way of combining the two systems is to allow tax-deductible saving in unlimited amounts but at a partial tax rate. In the absence of consumer durables and human capital, this would be equivalent to a combined personal income and consumption tax system. Consider the simplified income identity 10.1 below where C denotes consumption, Y denotes non-capital income, W denotes wealth so iW denotes nominal capital income, π denotes the inflation rate, T denotes total taxes, and ΔW denotes the change in nominal wealth.

$$C = Y + iW - \pi W - (\Delta W - \pi W) - T. \quad (10.1)$$

The income tax component at rate T_1 is

$$T_1 = \pi_1 (Y + iW - \pi W),$$

while the consumption tax component at rate T_2 is

$$T_2 = T_2 C = T_2 (Y + iW - \Delta W).$$

The combined tax is

$$T = (T_1 + T_2)(Y + iW) - T_2 \Delta W - T_1 \pi W.$$

This states that income from non-capital sources plus nominal income accruing on tax-deductible assets is brought into the tax base at the full (combined) rate, while the acquisition and disposal of "registered" assets is at a partial rate. Also, indexation of capital income on these registered assets is permitted but only at a partial rate (in this case, the income tax part).

Obviously, this type of mixed system is going to have some administrative complexities, all of which are attributable to the income part of the mixed base, namely, the indexation and inclusion of capital income into the tax base upon accrual rather than upon realization. Both of these features would seem to be necessary in any properly mixed system. Ignoring the problem of indexation which has been discussed exhaustively by other authors, the main reforms towards this system would be the removal of limits on tax-deductible saving, allowing such deductions only at part rate and the inclusion of nominal income earned by tax-deferred wealth in the tax base as it accrues. Of course, to the extent that such earnings are reinvested, they would only be taxed at the income rate T_1 upon accrual since they would be deductible at T_2. When earnings are removed from a registered account, they would be taxed again at T_2. Finally, a corresponding pure interest asset for averaging purposes could be defined, which is not deductible on acquisition, but earnings on that asset are only taxed at the partial rate T_l.

A final point to note is that unless the implicit income on consumer durables and owner-occupied housing and the implicit costs of acquiring human capital were brought into the income part of the tax base, the combined system implemented by allowing saving to be deductible at a partial rate will favor those assets. This is because such assets are already being treated fully on the consumption tax system and the marginal tax on their return is zero, whereas a mixed system would impose a positive marginal tax on the return on other forms of saving.

International Aspects of the Choice between Tax Bases

In this section, we briefly discuss the international issues concerning the choice between consumption and income taxes, taking into account the highly open nature of the Canadian capital market and the fact that Canada is a large net capital importer in stock terms. The income tax is a source-based (or origin-based) tax, and most international tax arrangements with the capital-exporting countries (the "destination" countries) recognize this by, in some way, giving the country where the capital is located (the "source" country) priority in the taxation of income to capital located within its borders. For example, some of Canada's tax treaty partners such as the United States accomplish this by allowing foreign tax credits for certain taxes paid in Canada against taxes owing in the destination country, while others accomplish it by exempting capital income in the destination country which has already been taxed in the source country. In contrast, most consumption taxes, which are usually in the form of indirect consumption taxes such as the value-added tax, are levied on a destination basis which gives priority to the country in which products end up rather than where they were produced. For a debtor country like Canada with a large merchandise account surplus financing a large service account deficit (mostly dividends and interest), the source base is considerably larger than the destination base.

One certainty in moving towards a direct or personal consumption tax base is that it is not clear how such taxes would be treated under international arrangements. There does not seem to be any difficulty at the personal level. Here the primary concern will be to prevent tax avoidance by individuals with large amounts of registered assets who subsequently leave Canada. The simplest way to prevent this is to impose a withholding tax at the maximum personal rate on such withdrawals which would be credited when the individual files a tax return in Canada declaring world income.

The main international problem is the case of non-resident taxpayers who own capital in Canada, which for the most part are multinational corporations. Should Canada treat such a taxpayer on a consumption or cash-flow tax basis when his own country taxes him on an income basis? It would not seem to be in the interest of a source country to do this because it would lose the tax revenue on the difference between the income and consumption part of the base, but at the same time benefits of the consumption tax would not be reaped because the foreign country would tax this difference. If, however, the source country were to discriminate between residents and non-residents and tax its own residents on a consumption basis while taxing non-resident income on an income basis, it would invite the destination country to retaliate, perhaps by removing the foreign tax credit. Non-discriminatory treatment of taxpayers is an entrenched convention in international tax arrangements.

As stated, the place where all of this would be most important would be in the tax treatment of corporations. We discussed earlier how the design of the corporation income tax would differ between the income and consumption tax bases. Specifically, under a consumption tax, there would be no domestic reason for the corporate tax to prevent tax deferral so it could be levied on a cash-flow rather than an accrual basis. In either case, the corporate tax would allow tax credits at the personal level and the main discriminatory feature would be the denial of such tax credits to foreign taxpayers. This discriminatory feature is already present in the Canadian tax system as the dividend tax credit is only made available on dividends to Canadian residents from Canadian corporations. The United States in particular has voiced disapproval of this arrangement, although it has not retaliated by limiting the foreign tax credit. One could rightly be concerned that any extension of such dividend tax credits that a consumption tax might require may jeopardize the foreign tax credit to Canada's detriment. Of course, the income tax in principle also requires full integration of the corporation income tax through complete tax credits, so the consumption tax is not unique in this regard.

The main difference that the consumption tax principle would introduce at the corporate tax level is the full write-off of investment expenditures. It should be noted in this regard that, in effect, the U.S. tax system already allows full write-off to subsidiaries of American firms in Canada to the extent that investment is financed out of retained earnings. The United States only subjects the corporate income of U.S. subsidiaries to taxation upon the repatriation of those earnings to the United States. Thus a U.S. subsidiary can effectively write off investment against U.S. corporate taxes and thereby defer them by reinvesting its earnings. In fact, most foreign investment in Canada is done through retained earnings which means that, for the most part, the United States is taxing its subsidiaries on a cash-flow basis. Therefore, levying the Canadian corporate tax on a cash-flow basis should not be viewed as discriminatory by the United States and nor would it transfer revenues to the United States if the foreign tax credit remains in force. For these reasons, it does not appear to be the case that reforming the Canadian tax system in accordance with the consumption tax principle should have any detrimental effects at the international level.

Implementation and Transition

We have discussed the choice between consumption and income taxation, or equivalently the taxation of the pure return to saving, in terms of the abstract concepts of economic efficiency and horizontal and vertical equity. Of course, there are other criteria that tax reforms must meet in terms of administrative simplicity and effects that the tax reform itself will have in terms of windfall distributional effects. We briefly consider each in turn.

Administrative Issues

Obviously, economists have limited specialized knowledge of this area and a complete discussion of these issues would require input from other tax professionals. As we see it, however, perhaps the strongest feature in favor of the consumption tax is its administrative simplicity. The major reforms required in the implementation of a consumption tax would be the removal of limits on tax-deductible saving to residents under the personal tax, the introduction of the registered loan counterpart to tax-deductible saving instruments, and the exemption from taxation of the return on short-term risk-free debt instruments. These reforms may well be coupled with conventional base-broadening reforms that bring into the tax base components of current consumption that are preferentially taxed under the existing system. Also, reforms of the corporation income tax towards a cash-flow or modified cash-flow type tax would be complementary to the consumption tax reforms undertaken at the personal level. This cash-flow corporate tax would be considerably simpler than one which taxes income to equity capital as it accrues, as would be required by the corporate tax which complements a pure income tax at the personal level. Also, complicated devices to index capital income such as the Indexed Security Investment Plan could be abolished, and capital gains could continue to be taxed upon realization. The treatment of consumer durables and human capital would also remain essentially as it is.

As indicated in an earlier discussion, we believe that reforms necessary to move the tax towards a comprehensive income tax pose much greater administrative problems. Such reforms include the full indexation of the capital income component of personal income, the imputation of implicit income to consumer durables and owner-occupied housing, implicit costs of acquiring human capital, and the full taxation of real capital gains upon accrual rather than realization. It is fair to say that because these reforms pose such administrative problems, actual reforms towards a pure income tax in Canada would probably be limited to the elimination of tax-deferred saving.

Transitional Issues

The main transitional issues arise because any change in the taxation of capital income will cause asset price revaluations. Also, because households in the country are in different parts of their life cycles, they will be affected differently at the time of a reform involving the taxation of capital income. Windfall capital gains and losses associated with changing tax rates impinging on capital income are to some degree endemic to this type of tax reform, and unless policy-makers are going to tolerate such effects, there is little point in discussing capital tax reform at all. However, there are reasons to believe that these windfall gains and losses will not be as large or widespread in the case of consumption tax reforms as one might expect.

The price of an asset is determined by present and future after-tax earnings on the asset and the interest rate at which future earnings are discounted. When interest earnings are taxed, this interest rate would be the after-tax interest rate. For example, in the case of a perpetuity, the price would be the after-tax earnings divided by the after-tax interest rate. If all forms of capital income were taxed at the same marginal rate, the tax rate would cancel in the numerator and denominator so the price of the asset would be unaffected by the tax if the before-tax interest rate is given. This principle generalizes to all forms of assets, thus the removal of a general tax on capital income, as would occur if one changed the tax system from a pure income tax to a pure consumption tax, would leave asset prices unchanged provided the before-tax interest rate was not affected by the reform. The assumption that the before-tax interest rate is unaffected by domestic tax reform policies is very reasonable for a relatively small economy with a very open capital market, which is an accurate description of the Canadian capital market environment.

In fact, the existing tax system is not a pure income tax which subjects all forms of capital income to a uniform tax. As discussed in detail above, various types of assets are preferentially taxed under the existing system including human capital, consumer durables, owner-occupied housing, some forms of life insurance, money balances and funds in deductible pension plans and savings accounts. Earnings on such assets are not subject to tax, while the interest rate at which they are capitalized would be the after-tax rate.[13] Clearly, the prices of these preferentially taxed assets, where they exist, will be higher than assets which offer the same gross return but are not tax-deductible. Reforms towards the consumption tax would remove the tax on all assets. As demonstrated above, this would leave the price of taxed assets unchanged; however, the price of assets which are tax-deductible under the existing system will fall because their earnings would now be capitalized using the higher before-tax interest rate. This change in the asset price causes a windfall loss to an individual holding such an asset.

To begin with, we can ignore human capital and money balances. Human capital cannot be bought and sold so asset price revaluations and the corresponding windfalls do not occur. Similarly, the "price" of money can never deviate from unity as it is the unit of account. Also, near-moneys, interest bearing assets of very short maturity, will not be affected as the return these assets pay can vary almost instantaneously. Thus the only types of assets where price revaluations are important are marketable assets, which are tax-deductible under the existing system and which have a variable asset price. This would seem to be restricted to owner-occupied housing and long-term bonds and equities which can be held in the tax-deductible funds; the latter includes mortgages, guaranteed investment certificates of Canadian financial institutions, and equities of Canadian corporations. The market price of these assets can be expected to fall causing windfall losses to those holding assets, and windfall gains to those who issued corresponding liabilities. Note that in some cases the windfalls cancel – e.g., the value of someone's house may fall but the cost of buying back his mortgage would also fall. All things considered, the extent of transitional windfalls due to asset price revaluations would be quite narrow. This is mainly a consequence of the fact that the before-tax interest rate in Canada is largely exogenous because of the open capital market.

The other transitional windfall occurs across age groups. If government debt policy is fixed (i.e., the timing of tax revenues is held constant), the removal of taxes from the return to saving must be compensated by changes in the tax rate. This increase in the tax rate will place a higher burden on those who are older and who are or will be dissaving. The magnitude of this effect will depend on the loss of tax revenues that removing tax-deductible saving limits would imply. As discussed in Chapter 3, over half of aggregate domestic saving is already sheltered so, at most, the tax base would decline by the component of unsheltered saving plus any new saving that is induced. This, however, could be offset by broadening the base to include components of current consumption that are preferentially taxed or excluded under the existing system.

Also, while the tax base is reduced in the short run, it will increase in the long run as dissaving is brought into the base. Similarly, losses in corporate tax revenue caused by the immediate write-off of investment expenditures would be recouped in the future because firms would not have depreciation and interest deductions. That is, the loss in current revenue from consumption tax reforms will be made up, at least in part, by higher tax revenues in the future. Thus windfall effects across age groups could be partly mitigated by a change in government debt policy. This would involve larger current deficits and smaller future deficits. Whether this is desirable or politically feasible in view of current deficit levels is debatable.

Even without compensating debt policies, the windfall effect across age cohorts would not be as great as sometimes asserted and could be mitigated by other tax changes. It is sometimes argued that a consumption tax would really hurt older generations, particularly the retired because they are dissaving. The point is that the personal consumption tax would not be implemented through a tax on consumption but on income less saving. To the extent that older generations had saved under the existing system, only the dissaving of registered assets and pension benefits would be struck by the higher tax rate. Retirement consumption financed through the disposal of non-registered assets and houses, etc., would not be hit with the consumption tax. Also, windfall losses on older generations could be avoided by raising lost tax revenues through wage taxes. In this case, the extra tax revenues would be paid by age groups who gain the most from consumption tax reforms, i.e., the working/saving age cohorts.

Conclusion

In this chapter we have compared the pure income and pure consumption tax bases as a guide to reforms of personal and corporate tax systems in Canada. It was argued that the pure consumption tax is superior to the pure income tax on both equity and efficiency grounds. In particular, the pure consumption tax is superior because lifetime ability to consume is a better criterion for vertical equity, because households with equal lifetime consumption opportunities would be treated the same under the consumption tax but not the income tax, and because a pure consumption tax would not distort the consumption-savings decision and thereby impose an efficiency loss. Unfortunately, when one considers the more realistic forms these two types of taxes would take, in particular the fact that both types of taxes would exclude consumption produced within the household for the household including leisure, the argument in favor of the consumption tax is far less clear. We do argue, however, that an approximate consumption tax base would be easier to implement than an approximate income tax base. The latter would require taxation upon accrual, the imputation of implicit income and costs as in the case of consumer durables (including housing) and human capital, respectively, and the indexation of capital incomes for spurious components introduced by the presence of inflation. The approximate consumption tax base involves none of these difficulties. We believe that in the absence of such provisions, the income tax would not be particularly desirable in terms of efficiency or equity criteria. With inflation, the effective income tax rate on the return to saving can become very high and impose a large efficiency cost as well as grossly violating horizontal and vertical equity by taxing much more severely those with a preference for future consumption or with an income profile that pays the bulk of their lifetime incomes in the early part of their life cycles. And by taxing consumer durables/housing and human capital on a consumption tax basis, the approximate income tax would distort the allocation of saving among different uses.

We have also examined other dimensions of the choice between reforms based on the income tax principle and reforms based on the consumption tax principle, including the role of the corporation income tax, international implications of tax reforms and problems associated with windfall gains and losses created by the transition. In all cases, we have argued that many of the problems associated with consumption tax reforms are exaggerated, more severe for reforms based on the income tax principle and, where they do exist, they can be mitigated by relatively straightforward means. The corporation income tax reforms that complement the consumption tax not only simplify the corporation income tax by permitting it to be levied on a cash-flow or modified cash-flow basis, but also involve no major international complications because, at least as far as investment out of retained earnings by U.S.-based multinationals is concerned, the destination-country corporate tax is already levied on a cash-flow basis. Windfalls upon transition to a consumption tax due to asset price revaluations can be expected to be limited in scope largely because of the open nature of the Canadian capital market while windfall redistributions across generations can be mitigated by both debt and structural tax policies.

Appendices

A Summary Tables on Principal Data Series (pertaining to Chapter 4)

Table A-1

Estimated Average Real Per Capita Human Capital Stock, by Year,* 1964-81

1964	82,833
1965	86,928
1966	94,500
1967	98,391
1968	98,230
1969	101,831
1970	87,598
1971	83,162
1972	88,868
1973	126,043
1974	167,582
1975	176,590
1976	123,534
1977	131,817
1978	136,180
1979	155,529
1980	163,809
1981	170,931

* In constant 1971 dollars.

Table A-2

Estimated Average Real Per Capita Unsheltered Capital Stock, by Year,* 1964-81

1964	7,270.3
1965	7,404.4
1966	6,946.2
1967	6,813.6
1968	6,822.7
1969	6,765.5
1970	6,377.8
1971	5,588.2
1972	5,975.5
1973	7,147.4
1974	8,045.2
1975	7,760.3
1976	7,105.2
1977	6,948.9
1978	7,830.7
1979	9,460.8
1980	10,385.0
1981	10,409.0

* In constant 1971 dollars.

Table A-3

Estimated Average Real Per Capita Sheltered Capital Stock, by Year,* 1964-81

1964	1,500.0
1965	1,614.6
1966	1,738.5
1967	1,872.1
1968	2,018.7
1969	2,178.2
1970	2,355.2
1971	2,551.5
1972	2,766.3
1973	2,993.0
1974	3,240.6
1975	3,511.7
1976	3,816.6
1977	4,149.8
1978	4,514.3
1979	4,906.8
1980	5,340.6
1981	5,824.8

* In constant 1971 dollars.

Table A-4

Estimated Average Real Per Capita Stock of Total Capital, by Year,* 1964-81

1964	91,603
1965	95,947
1966	103,184
1967	107,076
1968	107,071
1969	110,775
1970	96,331
1971	91,302
1972	97,610
1973	136,183
1974	178,868
1975	187,862
1976	134,455
1977	142,916
1978	148,525
1979	169,897
1980	179,535
1981	187,164

* In constant 1971 dollars.

Table A-5

Estimated Average Real Per Capita Stock of Total Capital, by Age Group,* 1964-81

Age group:	
Under 25	244,331
25-29	222,442
30-34	198,802
35-39	170,396
40-44	139,636
45-49	109,563
50-54	82,717
55-59	61,025
60-64	45,685
65 and over	40,015

* In constant 1971 dollars.

B Age-Specific Consumption Functions (pertaining to Chapter 5)

Simple life-cycle and naive regressions were also estimated for separate age groups in the sample. This way one could observe how the interest-rate effects rise across age groups in as unrestricted a fashion as possible, while allowing other regression parameters to vary as well. In order to preserve degrees of freedom, the original 10 age groups have been combined down to five: under 30; 30-39; 40-49; 50-59; and 60 and over. The two specifications estimated are:

$$C = \alpha + (\beta_0 + \beta_1 R)K + u \tag{B.1}$$

and

$$C = \beta_0 + \beta_1 R + \beta_2 YL + \beta_3 A + u, \tag{B.2}$$

where variables are as defined in the text. Estimation results for the slope coefficients and the $\bar{R}^2$s of the regressions are presented in Tables B-1 and B-2.

For the life-cycle regressions in Table B-1, it can be seen that *MPC* coefficients β_0 and β_1 rise dramatically and virtually monotonically with age. Thus the *MPC* itself also rises with age. At a zero (real after-tax) interest rate, it increases from −0.03 for the youngest age group up to 0.08–0.10 for the oldest. At a 3 per cent interest rate, it rises from −0.05 or −0.06 to 0.09–0.12. Thus higher interest rates accentuate this effect. That is, the effect of interest rates on the marginal propensity to consume flips sign from initially negative for younger ages to positive for older. Regressions also fit best for the oldest age groups.

For the naive or unrestricted regressions in Table B-2, one can see rather interesting mixed effects. The *MPC* on assets rises markedly with age, while the *MPS* or current earnings declines just as markedly with age. The interest-rate effect, on the other hand, shows an inverse U-shaped pattern that peaks positively for middle-aged groups (30-39).

Table B-1

Slope Coefficients of Simple Life-Cycle Regression, by Pooled Age Group

$$C = \alpha_0 + (\beta_0 + \beta_1 R)K$$

	β_0				β_1				$\bar{R}^2$			
	Eq. (1)	Eq. (2)	Eq. (3)	Eq. (4)	Eq. (1)	Eq. (2)	Eq. (3)	Eq. (4)	Eq. (1)	Eq. (2)	Eq. (3)	Eq. (4)
Age group:												
Under 30	−0.03012 (4.61)	−0.02734 (4.67)	−0.03841 (4.94)	−0.03451 (5.24)	−0.77054 (4.70)	−0.71348 (4.78)	−0.93220 (4.78)	−0.85809 (4.92)	0.4165	0.4243	0.4408	0.4504
30-39	−0.01107 (2.60)	−0.01153 (2.73)	−0.01589 (3.61)	−0.01606 (3.58)	−0.23243 (2.95)	−0.21834 (2.74)	−0.23522 (2.89)	−0.21683 (2.55)	0.2276	0.1987	0.3393	0.3846
40-49	−0.00537 (1.75)	−0.00716 (2.69)	−0.00560 (1.78)	−0.00716 (2.59)	−0.14729 (2.30)	−0.15559 (2.51)	−00.3540 (0.54)	−0.04210 (0.65)	0.1410	0.1835	0.1600	0.3159
50-59	0.01136 (2.67)	0.01013 (2.31)	0.01149 (3.02)	0.0106 (2.68)	−0.13227 (2.11)	−0.12067 (1.84)	−0.04748 (0.85)	0.05513 (0.93)	0.5550	0.4977	0.4886	0.4318
60 and over	0.08408 (9.95)	0.08407 (11.7)	0.10438 (10.2)	0.10513 (12.6)	0.18579 (2.13)	0.15918 (2.02)	0.59783 (5.68)	0.54810 (6.02)	0.8213	0.8583	0.7777	0.8429

NOTE Figures in parentheses are absolute *t*-ratios.

Table B-2

Slope Coefficients of Simple Life-Cycle Regression, by Pooled Age Group

$$C = \beta_0 + \beta_1 R + \beta_2 YL + \beta_3 A$$

	β_0				β_1			
	Eq. (1)	Eq. (2)	Eq. (3)	Eq. (4)	Eq. (1)	Eq. (2)	Eq. (3)	Eq. (4)
Age group:								
Under 30	−2,507.9	−2,514.0	5,558.1	5,139.3	1.0244	1.0191	1.3075	1.2779
	(3.54)	(4.06)	(2.52)	(2.90)	(81.2)	(81.6)	(33.3)	(35.7)
30-39	1,897.1	−2,492.7	15,674.0	17,273.0	0.97068	0.98805	1.0117	1.0658
	(1.34)	(1.81)	(4.25)	(4.88)	(27.5)	(30.1)	(11.0)	(12.6)
40-49	2,089.0	−3,388.5	14,993.0	18,245.0	0.94351	0.96900	0.95058	1.0204
	(1.67)	(2.88)	(4.82)	(6.28)	(30.3)	(30.8)	(12.3)	(13.1)
50-59	−1,001.8	−766.92	2,841.5	2,948.6	0.80339	0.80005	0.64697	0.64997
	(2.55)	(1.79)	(4.22)	(4.30)	(21.1)	(19.6)	(10.6)	(10.9)
60 and over	−5,974.7	−4,380.8	8,204.2	8,637.3	0.58935	0.61255	0.74004	0.76217
	(2.55)	(1.79)	(4.22)	(4.30)	(14.2)	(15.5)	(21.6)	(23.4)

	β_3				R^2			
	Eq. (1)	Eq. (2)	Eq. (3)	Eq. (4)	Eq. (1)	Eq. (2)	Eq. (3)	Eq. (4)
Age group:								
Under 30	−0.10867	−0.12270	−0.27092	−0.22441	0.9979	0.9981	0.9864	0.9890
	(3.54)	(4.06)	(2.52)	(2.90)				
30-39	−0.01628	−0.01423	−0.04392	−0.03673	0.9656	0.9687	0.8135	0.8594
	(1.34)	(1.81)	(4.25)	(4.88)				
40-49	−0.00365	−0.00102	−0.02440	−0.01244	0.9708	0.9697	0.8309	0.8563
	(0.64)	(0.19)	(1.72)	(0.93)				
50-59	0.02257	0.02272	0.00697	0.00641	0.9699	0.9633	0.8442	0.8541
	(4.59)	(4.40)	(0.88)	(0.85)				
60 and over	0.05267	0.06148	0.06648	0.07586	0.9119	0.9129	0.9485	0.9512
	(7.37)	(8.76)	(11.2)	(13.1)				

NOTE See Table B-1.

Table B-3

$$C = (\alpha_0 + \alpha_1 L + \alpha_2 L^2 + \alpha_3 L{\cdot}TIME) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R{\cdot}T)K$$

	Lowest income group	Second income group	Third income group	Fourth income group	Fifth income group	Sixth income group	Top income group
α_0	5,471.8	15,694	18,181	21,514	23,491	33,994	33,502
	(2.51)	(4.03)	(3.28)	(3.08)	(2.90)	(3.49)	(2.51)
α_1	−329.49	−695.97	−843.75	−973.49	−1,078.9	−1,369.8	−1,170.2
	(5.03)	(5.91)	(5.01)	(4.58)	(4.38)	(4.57)	(2.87)
α_2	4.6195	8.5843	10,768	12,426	14,183	16,743	13,649
	(8.64)	(8.68)	(7.51)	(6.84)	(6.74)	(6.42)	(3.72)
α_3	1.1784	−0.7543	−1.0804	−1.8802	−3.2564	−5.8257	−11,255
	(3.42)	(1.11)	(1.09)	(1.52)	(2.30)	(3.29)	(4.69)
β_0	0.06157	0.10888	0.11078	0.10148	0.091738	0.081097	0.078699
	(10.9)	(12.4)	(11.3)	(10.6)	(10.9)	(10.0)	(8.40)
β_1	2.2816	3.4963	3.6788	3.3314	2.9134	2.6127	2.4080
	(12.6)	(13.8)	(13.4)	(12.7)	(12.6)	(12.0)	(11.1)
β_2	−0.0010275	−0.0020376	−0.0020249	−0.0018621	−0.0016620	−0.0015470	−0.0014670
	(12.7)	(17.0)	(15.0)	(14.2)	(14.2)	(13.6)	(12.1)
β_3	−0.041720	−0.066926	−0.068984	−0.062496	−0.054300	−0.050398	−0.046237
	(13.8)	(16.8)	(16.0)	(15.1)	(14.2)	(14.6)	(14.0)
$OLS{:}\bar{R}^2$	0.5850	0.7014	0.6375	0.6080	0.5974	0.6110	0.7083
F	71.27	118.1	88.67	78.33	74.97	79.32	122.1

NOTE See Table B-1.

Table B-4

$$C = (\alpha_0 + \alpha_1 L + \alpha_2 L^2 + \alpha_3 L \cdot TIME) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T)KH + (\gamma_0 + \gamma_1 R + \gamma_2 T + \gamma_3 R \cdot T)A$$

	Lowest income group	Second income group	Third income group	Fourth income group	Fifth income group	Sixth income group	Top income group
α_0	6,921.6	13,450	13,454	13,212	10,438	6,919.9	5,530.3
	(3.04)	(4.37)	(3.61)	(2.94)	(1.97)	(1.05)	(0.51)
α_1	−350.28	−582.49	−575.77	−483.90	−294.95	46,775	269.48
	(5.12)	(6.19)	(5.03)	(3.47)	(1.77)	(0.22)	(0.80)
α_2	5.3739	8.8167	9.7310	8.9061	6.9113	2.8658	0.00094
	(9.87)	(11.4)	(10.0)	(7.34)	(4.69)	(1.49)	(0.00)
α_3	1.1263	−0.26871	−0.48297	−0.54817	−0.82083	−2.6332	−10,015
	(2.36)	(0.41)	(0.67)	(0.67)	(0.89)	(2.22)	(5.05)
β_0	0.040897	0.062067	0.055944	0.046749	0.040587	0.029166	0.051207
	(5.69)	(7.16)	(6.26)	(5.28)	(4.90)	(3.59)	(6.31)
β_1	1.4000	1.3797	1.1222	0.72134	0.51296	0.18888	1.2364
	(5.08)	(4.74)	(3.82)	(2.39)	(1.74)	(0.66)	(6.22)
β_2	−0.00079990	−0.0012794	−0.0011275	−0.00095704	−0.00080233	−0.00058679	−0.00094415
	(5.36)	(7.65)	(6.84)	(6.15)	(5.74)	(4.39)	(8.89)
β_3	−0.027563	−0.029606	−0.024078	−0.016540	−0.011865	−0.0064138	−0.024070
	(5.99)	(6.11)	(4.84)	(3.24)	(2.41)	(1.35)	(7.88)
γ_0	−0.51402	−0.77795	−0.86557	−0.77540	−0.58350	−0.41589	−0.23332
	(11.5)	(17.8)	(21.0)	(22.5)	(23.4)	(24.2)	(17.2)
γ_1	1.2951	−1.1021	−2.0160	−2.1170	−1.7457	−2.2231	−1.9114
	(1.07)	(0.87)	(1.63)	(1.86)	(1.81)	(2.71)	(2.71)
γ_2	0.015584	0.026661	0.028615	0.024915	0.018395	0.013218	0.0064190
	(7.03)	(12.7)	(15.5)	(17.5)	(18.7)	(19.8)	(17.3)
γ_3	−0.086029	0.035985	0.088290	0.11541	0.10408	0.11465	0.035695
	(1.11)	(0.46)	(1.18)	(1.79)	(2.20)	(3.60)	(2.10)
$OLS{:}\bar{R}^2$	0.7426	0.8806	0.8824	0.8766	0.8712	0.8697	0.8465
F	92.55	234.9	239.1	226.3	215.6	212.7	175.9

NOTE See Table B-1.

Table B-5

$$C = (\alpha_0 + \alpha_1 L + \alpha_2 L^2 + \alpha_3 L \cdot TIME + \alpha_4 UR) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T + \beta_4 UR)K$$

	Lowest income group	Second income group	Third income group	Fourth income group	Fifth income group	Sixth income group	Top income group
α_0	7,044.2	18,435	24,694	27,322	24,919	33,173	30,186
	(2.23)	(3.42)	(3.29)	(2.97)	(2.52)	(2.84)	(2.57)
α_1	−279.15	−561.00	−756.68	−799.72	−681.05	−640.23	133.45
	(2.71)	(3.18)	(3.05)	(2.59)	(2.01)	(1.57)	(0.30)
α_2	3.6702	6.3169	8.6232	9.1671	8.3224	6.3894	−5.2445
	(4.64)	(4.18)	(4.03)	(3.40)	(2.78)	(1.75)	(1.17)
α_3	3.6544	4.1593	5.1227	3.8074	−0.27911	−2.9659	−8.9953
	(5.11)	(3.39)	(3.07)	(1.93)	(0.14)	(1.26)	(2.95)
α_4	−43,556	−92,888	−126,499	−129,665	−100,682	−116,182	−116,216
	(3.45)	(4.31)	(4.32)	(3.77)	(2.90)	(2.80)	(2.15)
β_0	0.040475	0.075662	0.080413	0.069091	0.052619	0.029132	0.004762
	(5.67)	(8.09)	(7.86)	(6.81)	(5.94)	(3.45)	(0.55)
β_1	2.0550	3.0923	3.2145	2.7084	1.9905	1.5146	1.0918
	(11.2)	(13.3)	(13.1)	(11.8)	(11.1)	(9.25)	(6.87)
β_2	−0.00081383	−0.0016618	−0.0017079	−0.0014670	−0.0011010	−0.00079540	−0.00040154
	(5.70)	(8.76)	(8.24)	(7.26)	(6.39)	(4.82)	(2.51)
β_3	−0.037362	−0.059186	−0.061401	−0.052301	−0.038923	−0.032465	−0.025820
	(9.01)	(11.1)	(10.9)	(9.92)	(9.12)	(8.32)	(7.28)
β_4	0.17290	0.25381	0.20932	0.17237	0.13901	0.16860	0.20231
	(2.81)	(3.24)	(2.52)	(2.18)	(2.02)	(2.74)	(3.88)
$OLS{:}\bar{R}^2$	0.5924	0.7106	0.6471	0.6168	0.6048	0.6190	0.7141
F	57.36	96.20	72.09	63.42	60.36	64.00	97.86

NOTE See Table B-1.

C Grouped-Longitudinal Estimates of Consumption Functions (pertaining to Chapter 5)

While the present study was in progress, the Economic Council of Canada acquired from Revenue Canada a truly longitudinal data file on grouped individual tax-filers. This appendix reports on some preliminary econometric analysis performed on this file. It can be viewed as supplementing the principal regression results of the text. The principal advantages of this special data file are its truly longitudinal nature so that groups of tax-payers can be followed through time, its much larger size of 2,450 cells or observations (vs. 180 in the text), and its division into different cohort and permanent-income groups. The latter advantage allows one to distinguish cohort from time effects and to incorporate different income tax rates for the different permanent-income groups.

The special data file obtained was on cohorts of persons who filed tax returns over the 14-year period 1967-80 and who remained single over this period.[1] Individuals were aggregated into cohorts according to their age as of 1967. Two-year cohorts were provided from those aged 16-17 in 1967 through to those aged 64-65 then, making for a total of 25 age cohorts in the file. A second level of disaggregation is by income class. Average real labour income (or "permanent income") over the 14-year period was computed for each individual, and individuals were then divided into seven permanent-income classes in each cohort (with roughly equal numbers of persons in each income class overall). The disaggregation thus allows one to distinguish between different consumption responses for different permanent-income classes.[2] Data are therefore grouped into 14 years x 25 cohorts x 7 income classes or 2,450 cells or observations. The 14 years of data for each cohort and permanent-income class thus provide year-to-year longitudinal information on exactly the same panel of individuals over the 1967-80 period. There are thus 175 separate groups of persons corresponding to the two-dimensional grid of distinct age cohorts and income classes, and each such group is represented by a panel of 14 annual cells of data.

Variable Construction

Variables contained in each of these 2,450 cells are the same as those in Table 4-1 as reported in *Taxation Statistics*. Raw data variables were then combined into the 12 basic data series exactly as outlined in the first section of Chapter 4. In this case, the resulting real per capita figures are all expressed in constant 1980 dollars. By classifying people into different permanent-income classes, one is able to treat low-income people differently from high-income people as far as consumption, saving, and average tax rates are concerned. In addition, the longitudinal aspect of the data means that one is able to actually follow cohorts through time over the sample period rather than having to infer cohort behaviour from estimated trajectories.

Principal variables of the analysis were generated in essentially the same fashion as described in Chapter 4. The main differences are in the estimated regressions used in the construction of some of the variables. Regressions can now incorporate variables to represent cohort groups and permanent-income classes. For example, in the case of the (after-tax) net earnings equation of Table 4-4, the respecified equation is now estimated as:

$$\begin{aligned} ln\,(YEAT) = {} & \underset{(154.0)}{6.24816} + \underset{(39.8)}{0.158558}\,AGE \\ & - \underset{(30.4)}{0.00229854}\,AGE^2 - \underset{(23.5)}{0.096748}\,L \\ & + \underset{(18.8)}{0.001603947}\,L \cdot AGE + \underset{(124.0)}{0.268567}\,D \end{aligned}$$

$\bar{R}^2 = 0.8906$
$F(5, 2{,}444) = 3{,}986,$

where figures in parentheses are absolute t-ratios, L is an indicator of cohort level (taking values of 16, 18, 20, . . . , 64 corresponding to age group in 1967), and D is the mid-point of the permanent-income classes. An estimated earnings trajectory can now be generated directly by allowing AGE alone to vary in the above equation.

Separate consumption functions have been estimated for each of the seven permanent-income classes so as to allow for the effects of different income tax rates and different consumption pattern parameters across income groups. The consumption concept used is essentially cash-flow expenditures as defined under "Generation of Consumption Series" (see Chapter 4). The 350 observations or cells for each regression involve both a time-series and a cross-sectional dimension with their associated potential problems of both autocorrelation and heteroskedasticity. To handle these problems, a pooled estimation method (see Judge et al., 1985) based on the error-components model of Fuller and Battese (1974) has been used.

Basic Regressions: Specification and Estimation Results

The basic life-cycle consumption function regressions of the first section of Chapter 5 included a marginal propensity-to-consume term expressed as a function of R, the (real after-tax) interest rate, and T, the expected remaining lifespan and an intercept term that varied significantly and quadratically with time. The present regressions retain the same *MPC* specification, but allow a more detailed specification of the intercept terms so as to distinguish pure time effects from cohort effects. The latter are again captured quadratically and pure time effects are represented by an interaction term.[3] Accordingly, the basic specification estimated is:

$$C = (\alpha_0 + \alpha_1 L + \alpha_2 L^2 + \alpha_3 L \cdot TIME) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T)K + u, \qquad (C.1)$$

where K, as in the text, is the sum of the three components of life-cycle wealth. *TIME* takes on annual values 0 (for 1967), 1, . . . , 13 (for 1980), and L takes on cohort values 16 (for the youngest cohort), 18, . . . , 64 (for the oldest cohort). Separate consumption functions are estimated for each of the seven (permanent) income groups (and thus based on 350 observations each). The estimation results are displayed in Table B-3.[4]

The first thing to notice form these regression results is that the coefficients of the *MPC* terms are once again consistent with the basic life-cycle theory, and highly significant. All the β regression coefficients have the same sign patterns as obtained in Table 5-3 with a positive coefficient on R, a negative coefficient on T, and a negative interaction coefficient. In all seven regressions, the marginal propensity to consume increases with ages (as predicted from the theory), and is generally positively affected by interest rates, and more so among older than younger people.

Second, remark should be made of the very similar consumption pattern across income groups, thus lending support to the general robustness of the above results. The β regression coefficients exhibit exactly the same sign pattern across all seven regressions. The α coefficients are similar in all but one coefficient. Note also the opposite signs of the α_1 and α_2 intercept coefficients between the two tables. In Table 5-3, the generally positive concave pattern of consumption shifts over time is reflected in Table B-3 as a convex cohort effect where higher cohort values (for L in Table B-3) correspond to going further back in time (in Table 5-3). A formal F-test of equality of the regression coefficients across income groups yields a value of 35.5. Compared to a critical F value (at a 99 per cent level of confidence) of less than two, the test value is highly significant indicating very significant differences in regressions across the seven income groups.

Third, the income-disaggregated regressions provide additional detail about how the principal age and interest-rate effects vary across age groups. In Table 5-3, the weighted consumer expenditure regression implied an increase in the *MPC* by 0.0013 each additional year of age (evaluated at $R=0$). The present regressions imply increments of 0.0010, 0.0020, 0.0020, 0.0019, 0.0017, 0.0015, and 0.0015, from the lowest to the highest income groups. The same equation in Table 5-3 implied an interest-rate effect on the *MPC* (evaluated at age 40) of 0.50. The regressions in Table B-3 yield corresponding values of 0.74, 1.02, 1.13, 1.02, 0.90, 0.75, and 0.70, respectively. Thus both effects are somewhat larger when estimated from the present longitudinal data, with the interest-rate effect on the *MPC* as much as twice as large. Also, both effects peak in the second, third, and fourth income groups, and are lowest at both ends of the income scale.

Regressions with Different MPCs

As pointed out in the first section of Chapter 5, it was found that asset or non-human wealth ($A = KS + KU$) empirically has different effects on consumption from those of human wealth (KH). In order to investigate this further with the present longitudinal data set, we consider another specification of the life-cycle model that allows *MPC* coefficients for human wealth to differ from those for non-human wealth:

$$C = (\alpha_0 + \alpha_1 L + \alpha_2 L^2 + \alpha_3 L \cdot TIME) + (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T)KH + (\gamma_0 + \gamma_1 R + \gamma_2 T + \gamma_3 R \cdot T)A + u. \qquad (C.2)$$

Regression estimation results are provided in Table B-4 (which may be compared to the results in Table 5-6 in the text).

Once again, the *MPC* expressions appear to differ very considerably between human and non-human wealth components. While the sign pattern on β_1, β_2, and β_3 is positive, negative, and negative, the corresponding sign pattern on γ is generally negative, positive, and positive. The sign pattern of β coefficients on the *KH* consumption propensities is also the same as that on the *MPC* expression for total life-cycle wealth in Table B-3. That is, the human wealth component appears to be the dominant determinant of the joint consumption propensity patterns - similar to that found in Table 5-6. While the interest-rate coefficient (β_1) in the human wealth *MPC* is uniformly positive, γ_1 on the *MPC* for non-human wealth is typically negative (though not always significantly so). The propensity to consume out of human wealth generally increases with age, while that out of non-human wealth generally declines. The present results thus support the findings in the text that consumption propensities differ markedly by source of life-cycle wealth, with human wealth being the dominant component of wealth in determining how consumption propensities behave. As before, regression coefficients are highly significantly different (estimated F value of 24.7 compared to a critical value of less than two) across the seven income groups.

Unemployment Rate Effects on Consumption

The life-cycle model as specified and estimated in this study essentially focuses on long-run behaviour, where individuals are assumed to adjust their consumption patterns on the basis of lifetime wealth, age, and assumed permanent interest rates. However, one might well expect, as an empirical proposition, that consumer expenditures would vary also with more short-run or cyclical factors as well. As a very crude test of this proposition, we tried adding the national unemployment rate, *UR*, to the basic life-cycle consumption function specification C.1 in both propensity-to-consume and intercept terms:

$$C = (\alpha_0 + \alpha_1 L + \alpha_2 L^2 + \alpha_3 L \cdot TIME + \alpha_4 UR)$$
$$+ (\beta_0 + \beta_1 R + \beta_2 T + \beta_3 R \cdot T$$
$$+ \beta_4 UR)K + u. \quad (C.3)$$

It is fully acknowledged that this is a rather ad hoc modification of the above-estimated consumption function. Ideally, one would wish to rework the formal life-cycle theory to show exactly how structural equations are changed to incorporate such factors. But the simple additions of *UR* in equation C.3 are interpreted only as an informal test of one of the likely limitations of pure life-cycle specifications (analogous to Flavin, 1985).

Equation C.3 was accordingly estimated for each income group, and the regression results are presented in Table B-5. It is first of all clear that all of the unemployment rate coefficients in both the intercept (α_4) and *MPC* (β_4) expressions are quite significant across all seven income groups. Intercept coefficients all turn out negative, indicating that higher unemployment shifts down the consumption significantly. The β_4 coefficients in the propensity-to-consume expressions, however, all turn out positive indicating a steepening of the consumption function as the unemployment rate rises. The net outcome of these two effects (computed at the mean value of life-cycle wealth for each income group) is a reduction in consumption for all but the top income group. For the lowest income group, a 1 percentage point increase in the unemployment rate is associated with an 8.5 per cent drop in consumer expenditures; of the second lowest income group, an 8.9 per cent drop; and for the rest, drops of 10.6, 8.7, 4.7, and 3.0 per cent; and a rise of 0.4 per cent for the top income group. Interest-rate and age effects on the propensity to consume are attenuated slightly relative to the results in Table B-3, but all retain their same signs as before and remain highly significant. In general, then, it does indeed appear that marked systematic cyclical effects occur in consumer expenditures which are not accounted for by the simple life-cycle specifications. Not surprisingly, regression coefficients once again differ in highly significant fashion across income groups (estimated F-value of 93.9 compared to a critical value of less than two at a 99 per cent level of confidence).

D Marginal Propensities to Consume, by Age Group (pertaining to Chapter 7)

Table D-1

Marginal Propensities to Consume out of Life-Cycle Wealth and Permanent Income,* by Age Group

	MPC out of *K*	*MPC* out of *YP*
Age group:		
Under 25	0.019	0.55
25-29	0.031	0.83
30-34	0.039	0.99
35-39	0.048	1.12
40-44	0.056	1.20
45-49	0.065	1.23
50-54	0.073	1.19
55-59	0.082	1.07
60-64	0.090	0.86
65 and over	0.100	0.48

* Based on the life-cycle equation in Table 5-3 (second column) and evaluated at the real after-tax interest rate for 1971.

Table D-2

Marginal Propensity to Consume Lifetime Earnings, by Age Group

	Equation*			
	5-3	5-4	5-6	5-7
Age group:				
Under 25	0.01410	0.01329	0.00627	0.00443
25-29	0.02997	0.02222	0.01292	0.01093
30-34	0.02934	0.02855	0.01756	0.01549
35-39	0.03633	0.03505	0.02258	0.02063
40-44	0.04342	0.04169	0.02770	0.02586
45-49	0.05005	0.04829	0.03249	0.03059
50-54	0.05653	0.05483	0.03176	0.03518
55-59	0.06333	0.06159	0.04207	0.04004
60-64	0.07001	0.06825	0.04688	0.04478
65 and over	0.08034	0.07901	0.05429	0.05192

* By table number.

E Interest Elasticities of Consumer Expenditures and Savings from Grouped-Longitudinal Estimates of Consumption Functions (pertaining to Chapter 7)

In Appendix C, consumption function regressions were estimated from a special data set of grouped-longitudinal data based on following individuals in seven "permanent-income" groups through the 14-year period 1967-80. Regression results were presented in Tables B-3 to B-5. Short-run interest-rate elasticities have been calculated for these equations and are presented in this appendix. Elasticities were calculated here in exactly the same fashion as in Chapter 7. The principal difference here is that the disaggregation by income group allows for quite different income tax rates to be incorporated in the calculation of corresponding real after-tax interest rates. Table E-1 indicates the variation in tax rates by age cohort (i.e., age in the initial year 1967) and income group. Figures are evaluated in the year 1971. As can be seen, the average tax rates vary considerably across observations allowing the real after-tax interest rate (*R*) or the year to vary between 1.4 and 3.81 per cent. Interest-rate elasticities can thus vary across income groups as well as age groups in the data.

Since the absolute level of elasticities can vary from year to year depending on the value of interest rates at the time, interest-rate elasticities have been evaluated in the year 1971 as in Table 7-10. Elasticities or consumer expenditures (for each of equations C.1 to C.3) are presented in Table E-2, and the corresponding elasticities for savings are provided in Table E-3. As the results are preliminary and based on slightly different time periods and rather different populations (tax-filers who remained employed and single over the full 14-year period), the absolute levels of the figures are not directly comparable to those in the text. Nonetheless, they show a remarkably similar pattern across age groups. Consumption elasticities, with one exception, generally rise with age from negative to positive figures.[1] There is also a tendency for consumption elasticities to rise with income class among young and middle-aged cohorts, and to fall slightly across income class for older cohorts.

Savings elasticities in Table E-3 also show similar patterns across age groups to those in Table 7-10. Excepting the relatively unrestricted regression results in the middle column, savings elasticities generally decrease with age almost monotonically from positive to small negative values, similar in pattern to that of the life-cycle restricted elasticities in Table 7-10. In addition, the elasticities tend to decrease across income groups for the young and middle-aged cohorts; for the older cohorts, they tend to follow a slight U-shaped pattern from lower- to higher-income groups. In summary, then, the disaggregated grouped-longitudinal results further support the general finding of markedly different interest-rate sensitivities by age group. The life-cycle restricted savings elasticities decrease almost monotonically with age.

Table E-1

Average Income Tax Rates, by Age Cohort and Income Group, 1971

	Age cohort		
	16-17	40-41	64-65
	(Per cent)		
Income group:			
Lowest	10.3	8.3	7.4
Second	12.3	12.2	12.0
Third	13.8	14.5	13.8
Fourth	14.9	15.8	15.2
Fifth	16.3	17.1	16.7
Sixth	17.8	18.4	18.1
Top	21.1	24.6	25.2

Table E-2

Elasticity of Consumption, by Age Cohort and Income Group, 1971

	Lowest income group*			Fourth income group*			Top income group*		
	B-3	B-4	B-5	B-3	B-4	B-5	B-3	B-4	B-5
Age cohort:									
16-17	−0.369	−0.085	−0.454	−0.056	0.142	−0.127	−0.080	−0.042	−0.246
20-21	−0.248	−0.112	−0.287	−0.055	0.083	−0.087	−0.053	−0.059	−0.094
24-25	−0.190	−0.137	−0.201	−0.061	0.054	−0.071	−0.048	−0.068	−0.047
28-29	−0.155	−0.153	−0.152	−0.063	0.036	−0.063	0.031	−0.075	−0.032
32-33	−0.129	−0.164	−0.118	−0.054	0.023	−0.050	−0.016	−0.076	0.003
36-37	−0.092	−0.163	−0.079	−0.033	0.016	−0.030	0.010	−0.074	0.020
40-41	−0.017	−0.123	−0.008	0.006	0.015	0.002	0.048	−0.065	0.038
44-45	0.069	0.072	0.071	0.060	0.020	0.047	0.097	−0.053	0.059
48-49	0.167	0.002	0.159	0.134	0.026	0.108	0.152	−0.037	0.080
50-53	0.270	0.084	0.251	0.213	0.030	0.172	0.221	−0.023	0.106
56-57	0.329	0.168	0.302	0.283	0.022	0.228	0.280	−0.015	0.128
60-61	0.304	0.205	0.276	0.267	−0.002	0.216	0.258	−0.017	0.115
64-65	0.166	0.138	0.150	0.198	−0.024	0.160	0.306	−0.018	0.135

* By table number.

Table E-3

Elasticity of Savings, by Age Cohort and Income Group, 1971

	Lowest income group*			Fourth income group*			Top income group*		
	B-3	B-4	B-5	B-3	B-4	B-5	B-3	B-4	B-5
Age cohort:									
16-17	0.884	0.258	1.074	0.276	−0.474	0.545	0.171	0.191	0.417
20-21	0.551	0.285	0.625	0.229	−0.190	0.325	0.117	0.194	0.165
24-25	0.399	0.308	0.420	0.217	−0.075	0.243	0.093	0.186	0.092
28-29	0.300	0.298	0.296	0.200	−0.018	0.199	0.046	0.179	0.057
32-33	0.248	0.295	0.233	0.169	0.016	0.162	0.059	0.173	0.047
36-37	0.180	0.261	0.165	0.120	0.033	0.116	0.043	0.161	0.036
40-41	0.089	0.189	0.080	0.052	0.038	0.058	0.019	0.141	0.025
44-45	0.019	0.128	0.017	−0.017	0.036	−0.000	−0.006	0.117	0.015
48-49	−0.035	0.073	−0.030	−0.082	0.033	−0.054	−0.029	0.095	0.008
52-53	−0.068	0.030	−0.058	−0.125	0.035	−0.088	−0.049	0.077	0.001
56-57	−0.086	−0.009	−0.073	−0.146	0.045	−0.106	−0.061	0.069	−0.002
60-61	−0.092	−0.038	−0.077	−0.148	0.061	−0.108	−0.064	0.071	−0.003
64-65	−0.094	−0.066	−0.078	−0.151	0.088	−0.110	−0.065	0.080	−0.002

* By table number.

Notes

CHAPTER 1

1 A fuller discussion of the reasons for this may be found in Boadway and Clark (1986).

2 The utility function might read:

$$u = u[f(c_1, c_2)^{\alpha} L^{\beta}],$$

where c_1 and c_2 are present and future consumption, and L is labour. In the text, we simply suppress L and write the utility function as $u(c_1, c_2)$.

3 Assets are assumed to be liquid so their value is unchanged by interest-rate changes. With illiquid assets whose interest rate is fixed, the income stream from them is exogenously given and could be considered part of the earnings stream.

4 This is adopted from Feldstein (1978), and Atkinson and Stiglitz (1980).

5 For the case of uncertain T, see Davies (1981) and Skinner (1985).

6 This assumes full loss offsetting and interest deductibility in the tax system.

7 We could more generally have allowed for *inter vivos* transfers of wealth.

8 We are implicitly assuming that life begins at the start of "economic life," say, 18 years of age.

9 Notice that one must be careful not to double-count here. If a stream of asset income is treated as predetermined, its asset value must not be included in a_o as well.

10 We are using the no-bequest case for illustration here, though bequests can be incorporated without affecting the basic estimating equations (see "The Addition of Bequests").

11 This is again partly for expositional simplicity. One of the data sources we use actually allows us to disaggregate by income class within cohorts.

12 See, for example, Sato (1967) Feldstein (1974*b*), and Boadway (1979).

13 Actually, many of the ideas in this area may be found in Feldstein (1977*a*).

14 See, for example, the analysis in Samuelson (1958) and Diamond (1965).

15 This is argued fully in Feldstein (1977*b*).

16 Previous to that, the largest interest elasticities of savings were found to be of the order of 0.4 by Boskin (1978).

CHAPTER 2

1 An alternative discussion of the nature of personal income tax stressing tax reform may be found in Boadway, Bruce, et al. (1985).

2 Actually, capital income exemption applied only to interest and dividends until 1977 when taxable capital gains were added.

3 The definition of maximum allowable pension benefits is rather complicated.

4 The details of the operation of an expenditure tax system may be found in Boadway, Bruce, et al. (1985).

5 Strictly speaking, this will not be exactly the case when exchange rate fluctuations are taxed as capital gains to foreigners. Then, the Canadian inflation rate can affect the real rate of return that must be paid by Canadian debtors. This is fully discussed in Boadway, Bruce, and Mintz (1984).

CHAPTER 3

1 Note that these shares refer to *net* saving, i.e., saving net of capital consumption.

2 We stress "measured" saving here because, as we shall see, inflation has distorted these measures.

3 These remarks refer to the period ending in December 1981. Since that time, public saving rates have declined sharply even when adjusted for inflation.

4 On the basis of the small open-economy assumption, we have maintained the assumption that foreign saving rates are accommodative.

5 Apparently, a similar negative wealth effect on consumption was also found by Helliwell whose wealth series is used in this study.

CHAPTER 4

1 Preliminary calculations were also done with a rate on 5- to 10-year federal government bonds, but the results were fairly similar, so only the longer rate was used in the subsequent regression analysis.

2 Data are presented in *Taxation Statistics* both for all tax-filers and for those in a tax-paying position. We have chosen to use the former for our analysis.

3 The form in which data were available precluded the use of more conventional ARIMA-based time-series techniques as used, say, by Flavin (1985) or Seator and Mariano (1985).

4 It could be argued that, since 1982 was a strongly recessionary period, withdrawals were abnormally high. This may well be; we simply do not have any further evidence on withdrawals for any other year.

5 For the purpose of estimating unsheltered savings, we have eliminated annuity income from trusts from the capital income series. Neither of these is presumed to have

been generated by new savings. Annuity income includes, for example, the conversion of the past stock of sheltered savings (RRSPs, DPSPs) into annuities. Income from trusts includes income generated by bequests received.

Chapter 5

1 No distinction is made between lending rates (or returns on gross assets) and borrowing rates (particularly with respect to the tax-adjusted rates for mortgage holders) as this would substantially complicate the empirical analysis by making rates endogenous to income levels and portfolio composition - on neither of which do we have appropriate information in our data set.

2 Where it can be shown that $\frac{\partial \Theta}{\partial T} \leq 0$ and $\frac{\partial \Theta}{\partial R} \geq 0$ or positive R.

3 Attempts to estimate the fully non-linear theoretical equation 1.31 in Chapter 1 resulted in severe convergence problems, so resource constraints precluded pursuing this option further.

4 Since some of the regressions use "generated" variables, their coefficient standard errors may not be consistently estimated (Pagan, 1984), so the t-ratios should be treated with some reservation.

5 Summers does not report estimates of γ for his own work, so comparison is not possible. Indeed, it is difficult to interpret even his reported coefficient values for α, β_0, and β_1 since they are of grossly different orders of magnitude than we have found. His α lies between -0.337 and 0.012; β_0 lies 0 between 0.318 and 0.405; and β_1 lies between 0.066 and 0.090. Yet all variables are said to be in per capita terms. Recall that in Chapter 3 our own estimates of this specification with aggregate Canadian data did not fare very well either.

6 Since we do not have data on lagged consumption, this option is not open to us for investigation here.

Chapter 6

1 Versus a critical value of 4.79 at the 99 per cent level of confidence with 2 and 120 degrees of freedom. One hundred and twenty degrees of freedom is used (in lieu of 173) simply because it was the closest available figure in the available F-tables.

2 Versus a critical value of 3.95 at the 99 per cent level of confidence with 3 and 120 degrees of freedom. Individually, the terms are also quite significant in both equations.

3 The critical value for the intercept shifts alone is 4.79 at the 99 per cent level of confidence with 2 and 120 degrees of freedom, and for the joint intercept and *MPC* shifts is 3.95 at the 99 per cent level of confidence with 3 and 120 degrees of freedom. Individually, all the time-shift coefficients are also quite significant in all four equations.

4 The critical value is 3.95 at the 99 per cent level of confidence with 3 and 120 degrees of freedom.

5 The same conclusion holds, indeed even more so, if assets are decomposed into their separate components *KS* and *KU* and the generalized equations 6.6 to 6.8 rerun.

6 The substantial differences in *MPC* coefficients between *YL* and *KH-YL* may reflect not just primary behavioural differences, but also econometric considerations that *KH-YL* is likely to incorporate greater errors in measurement than *YL* and *KH-YL* is much more strongly correlated with age (T), which appears as a separate independent variable, than is *YL* itself.

Chapter 7

1 Note that the way R has been defined as a decimal rather than a percentage means that each of these terms has to be deflated by 100. Thus to (minus) the figures in Table 7-1, one adds A/100 for each age group.

2 The relative effects were then obtained by dividing the (weighted-average) level effects by the weighted-average consumption level for each age group. In all cases, consumer expenditures were used rather than non-durable consumption.

Chapter 9

1 Also, we assume for simplicity that there is no inflation. More generally, the after-tax real return is $r(1-t_r) - t_r\pi$, where π is the inflation rate.

2 The effective tax rate is calculated as $(0.3)(0.027 + \pi)/ 0.027 + 0.3\pi$, where π is the inflation rate.

3 That is, excess burdens are not expressed as end-of-life values as in equation 9.8 but are discounted by $(\frac{1}{1+rt})^{T-t}$, where t is the person's age.

4 Monetary policy, which involves changing the liquidity of government debt, is ignored.

5 A sufficient condition for non-neutrality of the government debt is that some households face binding constraints (e.g., non-negativity constraints) on their ability to alter intergenerational gifts and bequests.

6 Of course, if debt policy is neutral as in the Ricardian-Barro world, this approach is inadequate. Tax policy changes with the incumbent changes in relative prices faced by households may be the only means of reallocating resources intertemporally.

7 Some authors, notably Feldstein and Horioka (1980), disagree with this assessment. The view expressed here is widely accepted within Canada.

8 For simplicity, in this figure we ignore the distinction between the compensated and uncompensated supply of funds. In practice, this distinction is necessary because the level of tax revenues is measured with respect to the uncompensated curve, whereas the efficiency loss is measured with respect to the compensated curve.

9 In fact, the U.S. system taxes income to foreign-owned capital only upon repatriation so U.S. taxes may be deferred. Also, it allows firms to aggregate foreign tax credits across countries. These features would complicate the analysis somewhat but not materially change the conclusions.

10 In fact, other authors such as Atkinson and Stiglitz (1980) have argued that the goal of horizontal equity may conflict with other social welfare criteria including efficiency and vertical equity, so this presumption is not unreasonable.

11 However, the justification for such "progression" in the tax structure in terms of simple vertical equity criteria (as may be codified in a social welfare function) is not transparent, as demonstrated in the seminal work of Mirrlees (1971) and others.

12 Indeed the existence of averaging in what are, nominally, income tax systems reflects the presumption that current income is not the appropriate vertical equity criterion of ability to pay.

Chapter 10

1 See, for example, Jenkins (1985).

2 Specifically, the constant dollar historic value of the capital should be used (i.e., the purchase price of the capital adjusted for general price level changes but not relative price changes).

3 Also, because a large part of the capital stock in Canada is owned by foreign households, the corporation income tax permits income to foreign capital to be taxed at least in part in Canada in accordance with the general origin principle underlying the income tax, which is generally accepted under international fiscal law. This issue is discussed further.

4 Although pecuniary costs of acquiring human capital such as tuition fees are deductible under the existing "income" tax, they would not be deductible under the pure income tax.

5 The pure income tax, recall, requires that both the expenditure on the consumer durable be taxed as income is earned and services of the consumer durable be imputed to the tax base as they accrue. Note that the pure income base could be approximated with the prepayment method by adding expenditures on consumer durables to the tax base in addition to taxing income as it is earned. This would be administratively costly, politically impossible and, in principle, incorrect since the pure income tax should only tax income, including returns to consumer durables, as it accrues.

6 Recall, however, that the premise of the pure income tax system that some short period measure of the flow of income is appropriate for determining ability to pay suggests, if taken to the extreme, that averaging is not appropriate in a pure income tax system. The logic of the pure consumption tax base with its implicit acceptance of a longer, lifetime concept of utility or ability to pay does demand averaging in principle.

7 Perhaps most importantly, a graduated rate structure can interfere with the consumption-savings decision of the household as individuals time their consumption to minimize their tax burden rather than to maximize utility. This reintroduces the savings inefficiency that the proportional consumption tax removes.

8 For further details on the modified cash-flow system, see Boadway and Bruce (1984).

9 A pure income tax would fully index capital income for inflation so the efficiency cost in the zero-inflation case is the relevant comparison.

10 While second-best considerations may suggest that some taxation of the return to saving (i.e., heavier taxation of future consumption) may be desirable in view of the subsidization of leisure, it is difficult to imagine that interest should be taxed at two or more times the rate at which labour income is taxed, which is what happens at inflation rates of 10 per cent under a non-indexed tax system.

11 However, empirically, consumption varies much less over time than does income so the problem is not as severe as in the income tax case.

12 Some provisions of the existing system correspond to neither the consumption or income tax bases. Failure to index capital income on non-registered assets means that the inflation component which is not real income is included in the tax base. Also, lifetime capital gains exemption and pension income deduction exclude income/consumption that should be included under both bases.

13 Here we assume, reasonably, that the marginal transaction in the bond market is undertaken by individuals who have exhausted the limits on tax-deductible saving and face the after-tax interest rate at the margin.

Appendix C

1 While this doubtless suggests the likelihood of sample selection bias (over which we have no control), this sample does provide advantages of likely smoother consumption profiles and not having to control for changes in family size and composition (Barten, 1964; Jorgenson and Slesnick, 1984; and Hayashi, 1985*a*) and changing labour-supply conditions (Smith, 1977), and less expenditures on consumer durables, particularly housing (Statistics Canada, 1973, pp. 117, 146). For other recent studies of consumption behaviour using longitudinal data, see Hall and Mishkin (1982) and Hayashi (1985*b*).

2 For recent discussion of the effects of "liquidity constraints" on consumption behaviour likely at the lower end of the income distribution, see Hayashi (1985*a*), Flavin (1985), or Seater and Mariano (1985).

3 Alternative specifications were also tried with linear and quadratic time variables, but they were generally not at all significant.

4 The $\bar{R}^2$ and F summary regression statistics are taken from the corresponding *OLS* regression estimates, whose regression coefficients were very similar to those in Table B-3.

Appendix E

1 The principal exception is for the middle-income group and the relatively unrestricted specification of equation C.2 where different *MPC*s are allowed on the human wealth and non-human wealth components. The more restrictive life-cycle specifications all follow the indicated pattern of rising consumption elasticities from negative to positive values.

List of Tables and Figures

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