An Econometric Examination of the Impact of Population Ageing on Personal Savings in Canada

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* The views expressed in this paper are solely those of the authors. No responsibility for them should be attributed to the Department of Finance.

Abstract

It is well known that over the next several decades, important demographic changes will occur in most industrialised countries. As the baby-boom generation reaches the age of retirement, the share of the population aged 65 and over will increase rapidly. There is a growing concern that the increasing proportion of elderly will create important macroeconomic problems and pose important public policy challenges. A key concern revolves around the possible consequences of a prediction of the life-cycle model, namely that population ageing will put downward pressure on private savings. In this paper, we estimate an aggregate personal savings rate equation for Canada, which captures the effects of the changing age structure of the population. A cointegration relationship is found and cannot be rejected at a 1% critical level. The impact of population ageing is also simulated using recent demographic projections until 2050. Simulation results from the estimated econometric model suggest that by 2050, the direct effect of population ageing may contribute to a reduction of the personal savings rate of close to 50%. Our results thus support a key prediction of the life-cycle model and testify to the usefulness of computable overlapping-generations models in investigating the general equilibrium effects of population ageing in Canada.

Sommaire

C’est un fait reconnu qu’au cours des prochaines décennies, la plupart des pays industrialisés subiront d’importants changements démographiques. À mesure que la génération des baby-boomers approchera l’âge de la retraite, la proportion de la population âgée de 65 ans et plus croîtra rapidement. De plus en plus d’observateurs croient que l’accroissement de la proportion des personnes âgées dans la population pourrait créer de graves problèmes macroéconomiques et poser d’importants défis pour les politiques publiques. Une de ces préoccupations concerne la pression à la baisse sur l’épargne privée conséquente à ces changements démographiques, telle que prédit par la théorie du cycle de vie. Dans cet article, nous estimons une équation de l’épargne personnelle agrégée qui prend en considération les effets provenant des changements de la pyramide d’âge de la population. L’estimation trouve une relation de cointégration qui ne peut être rejetée au seuil critique de 1%. L’impact du vieillissement de la population est aussi simulé à l’aide de projections démographiques disponibles jusqu’à l’an 2050. Les résultats de simulation du modèle économétrique suggèrent que d’ici 2050, le vieillissement de la population pourrait contribuer à une baisse du taux de l’épargne personnelle de près de 50%. Nos résultats confirment donc une prédiction clé de la théorie du cycle de vie, et supportent l’utilisation de modèles à générations chevauchantes dans l’examen des effets d’équilibre général du vieillissement de la population au Canada.

1. Introduction

It is well known that over the next several decades, important demographic changes will occur in most industrialised countries. As the baby-boom generation reaches the age of retirement, the proportion of the population aged 65 and over will increase rapidly. According to recent demographic projections, the old-age dependency ratio (the proportion of the population 65 and over to that of working age) is expected to double in Canada over the next 50 years.

Population ageing may have important implications for overall national savings. It may put upward pressure on public sector pensions and health care expenditures, but may also provide some relief to government spending targeted to children, such as education spending. Nevertheless, because of the size of public pension benefits and health expenditures, the net impact will likely be an increase in government expenditures, which could involve a reduction in public savings if fiscal policies were unchanged.

There is also growing concern that ageing may also lead to a reduction in private savings, which in turn would reduce investment and real output. According to the life-cycle hypothesis, saving for retirement is considered the most important savings motive for a household. Over the life cycle, the household accumulates wealth during the pre-retirement period by consuming less than its disposable income. During retirement, the household decumulates wealth to finance its consumption. As a result, the household saves during working life and dissaves during retirement. The generalised life-cycle hypothesis implies that the household savings rate depends on the age of the household. The prediction from the life-cycle model is that population ageing may put significant downward pressure on private savings.

Although studies based on macro data support the life-cycle model's prediction, some research based on cross-section tabulations of wealth holdings and savings rates by age suggest that the elderly do not dissave to the extent suggested by the life-cycle model.[1] On the other hand, more recent studies, such as Miles (1999) and Weil (1994) suggest a reconciliation of these studies with life-cycle models, and provide support for the predictions of the generalised life-cycle model.

In this paper, we provide an empirical examination of the relation between population ageing and personal savings in Canada with time-series data. We estimate an aggregate personal savings rate equation, which captures the changing age composition of the population, in addition to other explanatory factors. We also simulate the direct[2]

[1] For a survey of these studies, see for example Kotlikoff (1988).

[2] In this analysis, we do not attempt to account for possible indirect effects of ageing on savings, such as changes in interest rates, wealth and so on.

impact of population ageing on personal savings for the next 50 years using recent demographic projections from the United Nations.

Contrary to the popular view, our results indicate that over the last two decades, the changing age structure of the population has contributed to an increase in personal savings, rather than to a decrease. The reduction in the share of young dependants in the population has more than compensated the effect of the increase in the proportion of old dependants. Our results indicate that since the effect of the reduction in the share of young dependants is expected to continue to dominate over the next 10 years, the changing age composition of the population will still contribute to an increase in the personal savings rate until 2010. However, as soon as the increasing share of old dependants begins to dominate after 2010, population ageing will eventually contribute to a significant reduction in the personal savings rate. Simulation results from the econometric model estimated suggest that by 2050, the direct effect of population ageing may contribute to reducing the personal savings rate by close to 50%.

The paper is organised as follows. Section 2 reviews the arguments of previous studies that reconcile the life-cycle model predictions with household data evidence. Section 3 describes the model that we use to estimate an aggregate savings rate function. Section 4 reports our econometric results. Section 5 presents the results of simulations. Finally, section 6 provides some concluding remarks.

2. Life-Cycle Models and Household Studies: A Suggested Reconciliation

As mentioned in the introduction, agents in standard life-cycle models are assumed to save part of their labour income during the period before retirement, and consume from the accumulated wealth during retirement. As a result, household savings is positive during an agent's working life and turns mostly negative during retirement. This prediction is generally supported using aggregate data on savings, but not with micro level data. For example, using age-specific personal savings rates from micro series in a number of OECD countries, Miles (1999) shows that in most countries examined, the personal savings rate remains quite high after the age of 65. In Table 1, we generated the household saving series for 6 age groups in Canada, from Statistics Canada' Social Policy Simulation Database and Model (SPSD/M). [3] These results support the general findings from micro level data that, contrary to the prediction of life-cycle models, the savings rate remains positive after retirement.

However, according to Meredith (1995), there are two difficulties associated with the measurement of savings by the elderly in household data. The first is that income and wealth are often defined inappropriately, in the sense that no distinction is made between earned income and other source of income. The second is that household savings is not

[3] See Bordt *et al.* (1990).

observed directly and is inferred from hypothetically constructed wealth profiles of retired people.

According to Miles (1999), one can reconcile household survey data with the prediction of the life-cycle model. Savings rates derived from household surveys are generally based on the difference between measured income (from employment, assets and receipts of private and state pensions, and other transfers) and measured consumption. Miles shows that income from pensions may dramatically be overestimated in household surveys. In particular, household surveys consider depletion of pension funds as pension income. This erroneously boosts the savings rate. The true savings rate can be defined as the change in the value of wealth as a ratio of income, which excludes the depletion of capital.

Table 1
Personal Savings by Age Group
from Household Survey, 1994

Age of Head of Household	Savings per Household	Savings Rate
Less than 25	-857	-0.04
25-34	2052	0.06
35-44	4346	0.10
45-54	6076	0.13
55-64	4523	0.11
65+	4102	0.13

Source: Social Policy Simulation Database and Model (SPSD/M)

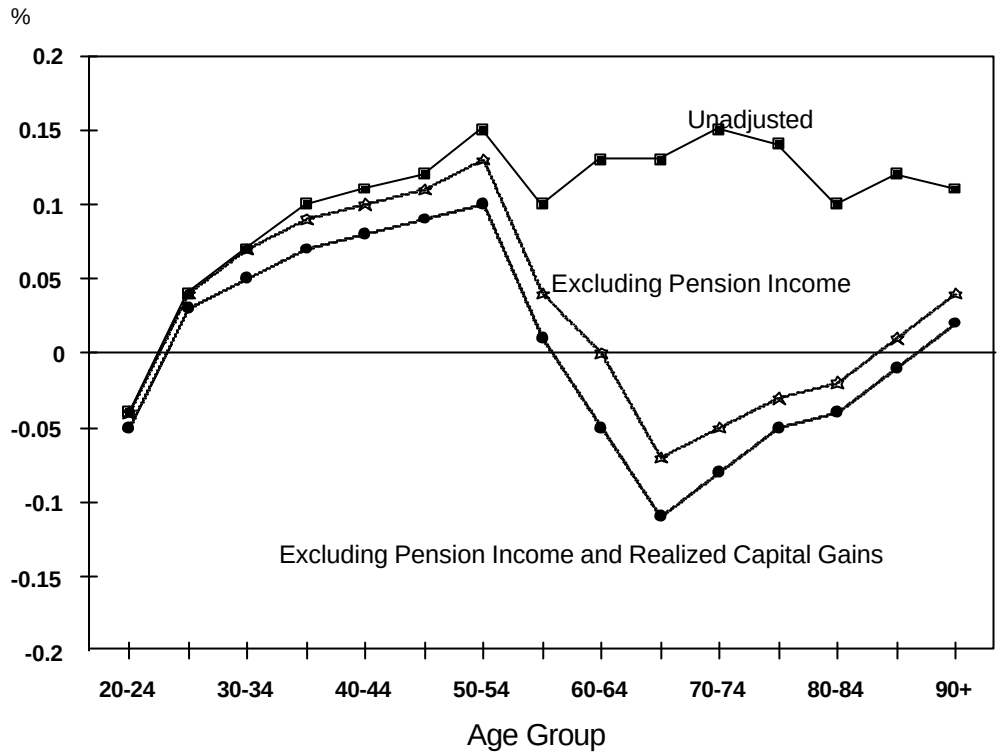
Bosworth *et al.* (1991) have adjusted household savings rates in the U.S. for the decline in the value of assets, especially cumulated pension funds. They found that average savings rates for US households with heads over 64 years of age change drastically with pension adjustments. For example for 1982-85, the average savings rate drops from 11.5% to –3.9% with pension adjustments.

To give an illustrative example for Canada, we have excluded private pension income from total income in SPSD/M and recalculated personal savings for specific age groups, with and without capital gains and losses.[4] As shown in Chart 1, the savings rate then follows a completely different pattern during the period of retirement. The new

[4] One may want to exclude gains and losses in capital to obtain the consumer's conscious decision to save a part of current income. This is the approach taken by Bosworth *et al.* (1991), who argue that savings behaviour analysis is biased if it includes unpredictable capital gains and losses.

pattern of savings is roughly similar to the unadjusted rates until age 50-54. However, after age 54, the savings rate declines rapidly, turns negative around age 60-64 and remains negative or close to zero for older households. This result is compatible with the predictions of the life-cycle model.

Chart 1
Personal Savings Rate per Age Group, Household Survey



The simple method of excluding all private pension income in the calculations underestimates the true savings rate for seniors, because it does not take account of the return on the remaining stock of asset, which should be counted as income. However, Meredith (1995) argues that interest income on the remaining principal is small relative to the rate at which the principal is being run down. The analyses of Bosworth *et al.* (1991) and Miles (1999) also suggest that the true savings rate pattern is closer to the adjusted pattern in Chart 1 than to the unadjusted one.

Weil (1994) proposes another way of reconciling the apparently contradictory results of studies using macro data on savings versus studies using micro data. He suggests that important intergenerational resource flows, such as bequests, affect savings. He also presents evidence, using the 1984 *Panel Study of Income Dynamics*,[5] that they

[5] The 1984 survey contains information on households' assets and also asks about bequests received and expectations of whether a bequest will be received over the next ten years.

are the plausible source of this discrepancy. He finds that the receipt of bequests has an important effect on the savings of the young. A household who expects to receive a bequest will tend to raise its consumption. His results also suggest that this effect may be of sufficient magnitude to explain the divergence between micro and macro estimates on the savings of the elderly. Moreover, by demonstrating the positive effect of expected bequests on the consumption of the young, he finds that even if the old do not dissave themselves, they lower the savings of the young via bequests, implying that an increase in the share of the old-aged population would reduce savings. The bequest channel thus supports both the life-cycle model's prediction and the use of macro level data to estimate the response of savings to demographic changes.

As Weil (1994, pp.76-77) himself argues:

> [t]he analysis of the effects of intergenerational relations on measured saving presented in this paper has important implications for how economists should put different sorts of data to use. For example, in the framework presented above, one cannot forecast changes in the saving rate in response to changing demographics by looking at current age-specific saving rates in micro data, because in the face of demographic change, these age-specific rates will change. Similarly, one cannot test a theory about individual behavior, such as the life-cycle model using macro data, since macro estimates include both individual's own saving and their effects on the saving of others. On the other hand, one can forecast the response of saving to demographic change using data at the macro level, even though one might not know to what extent macro saving coefficients represent individuals' own saving, and to what extent they represent individuals' effects on others.

So, based on the analysis of Miles (1999) and Weil (1994), we can test the prediction from the life-cycle model, using macro data. In the next sections, we estimate a reduced-form macro-model of the personal savings rate and examine the impact of population ageing on the personal savings rate.

3. The Macro-Model of the Personal Savings Rate

The life-cycle hypothesis (LCH) rests on the proposition that consumption of the representative household reflects the desire to achieve the preferred allocation of its life resources to consumption over the life cycle. Together with additional simplifying assumptions, this leads to an aggregate consumption function, which depends on current income, average expected future income and net worth:

$$C = \alpha_1 Y + \alpha_2 Y^e + \alpha_3 W_{(-1)} \ . \tag{1}$$

All the coefficients are positive.[6] We can also rewrite equation (1) for the savings rate:

$$S/Y = 1-(C/Y) = (1-\alpha_1) - \alpha_2 Y^e/Y - \alpha_3 W_{(-1)}/Y \tag{2}$$

where C is real consumption, S real personal savings, Y current real disposable income,

[6] See Ando and Modigliani (1963).

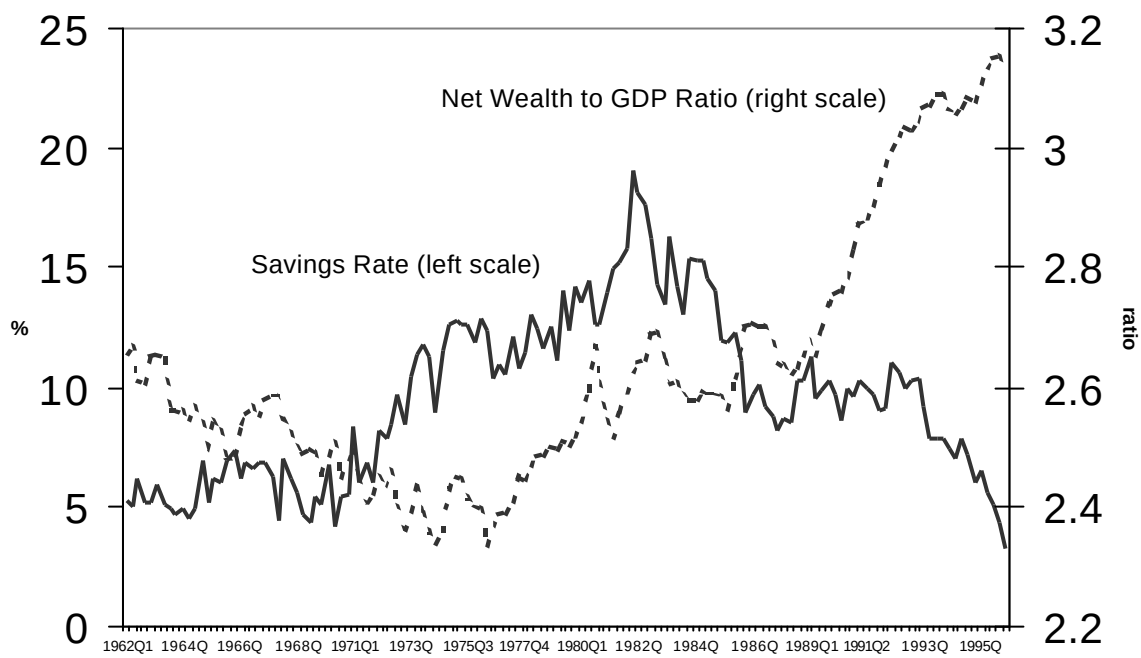
Y^e real average expected future income, and $W_{(-1)}$ beginning-of-period real net worth. If we assume that in the long run $Y^e = Y$, equation (2) becomes:

(3) $$S/Y = (1 - a_1 - a_2) - a_3 W_{(-1)}/Y .$$

According to the LCH, households reduce their savings if their net worth position improves. For example, an increase in capital gains, all else held equal, is expected to reduce personal savings. As illustrated in Chart 2, the personal savings rate (personal savings as a share of disposable income) and the ratio of net worth to GDP have tended to evolve in opposite directions over the past 35 years, giving support to the LCH.

However, equation (3) remains a simplistic model of household savings. There are numerous factors that are also important to consider. For example, in addition to wealth, the household savings rate can also depend on demographic factors, public sector savings, changes in real after-tax interest rates, public sector pension plans and so on. Let us now discuss these other determinants of personal savings in more detail.

Chart 2
Personal Savings Rate and Net Wealth to GDP Ratio



Source: National Income and Expenditure Accounts and National Balance Sheet

Demographic Factors

As indicated in the introductory remarks, according to the LCH, the fraction of income

saved varies over an individual's lifetime. Therefore, a change in the proportion of younger and older people in the population may alter the proportion of savers in the economy and affect the aggregate savings rate. A widely used approach to capturing the effect of a change in the age structure of the population is the age dependency ratio.

Chart 3 presents two alternative measures of the age dependency ratio, the old-age dependency ratio (ratio of the population 65+ to the working-age population) and the total dependency ratio (ratio of the population 0-19 and 65+ to the population 20-64).[7] The old-age dependency ratio has remained fairly stable between the period 1950 to 1970. It increased steadily during the 1980s and 1990s. Finally, because of population ageing, it is projected to increase sharply after 2010 and reach unprecedented levels by 2050. However, this measure does not account for the reduction in the share of young dependants. The total dependency ratio (which assumes that young and old dependants have identical consumption needs) presents a somewhat different picture. Because of the increasing proportion of children during the 1950s, the total dependency ratio has increased during that period, until 1965. After 1965, the trend completely reversed and the total dependency ratio fell sharply until 1987. It has continued to decline since, but at a much slower pace. The total dependency ratio is projected to continue to decline until 2008, but to increase again sharply thereafter, as the population ages. The projected level for 2050 is not unprecedented, however, as it is expected to equal that reached in 1970, although the age composition of dependants will have changed radically.

It can be argued that the effective consumption needs of young dependants is less than the consumption needs of elderly dependants. For example, Lazear and Michael (1980) assume that people 20 and older have identical consumption needs for nonmedical outlays, while those under 20 have needs one-half that of adults.[8] Chart 4 presents the total dependency ratio based on this alternative assumption. In comparison to the unadjusted total dependency ratio, the adjusted one does not increase as much during the 1960s, since the weight of young dependants is half that of elderly people. The adjusted series is also projected to increase slightly more over the next 50 years than the unadjusted series. Finally, the adjusted total dependency ratio would reach a higher level in 2050 than in 1965.

Both measures of the total dependency ratio suggest that the economic and fiscal effects of population ageing are more than offset by the fewer number of children per family until 2010. After 2010, the increase in the proportion of elderly people clearly dominates and the total dependency ratio increases rapidly.

A number of econometric studies[9] suggest that changes in the age composition of

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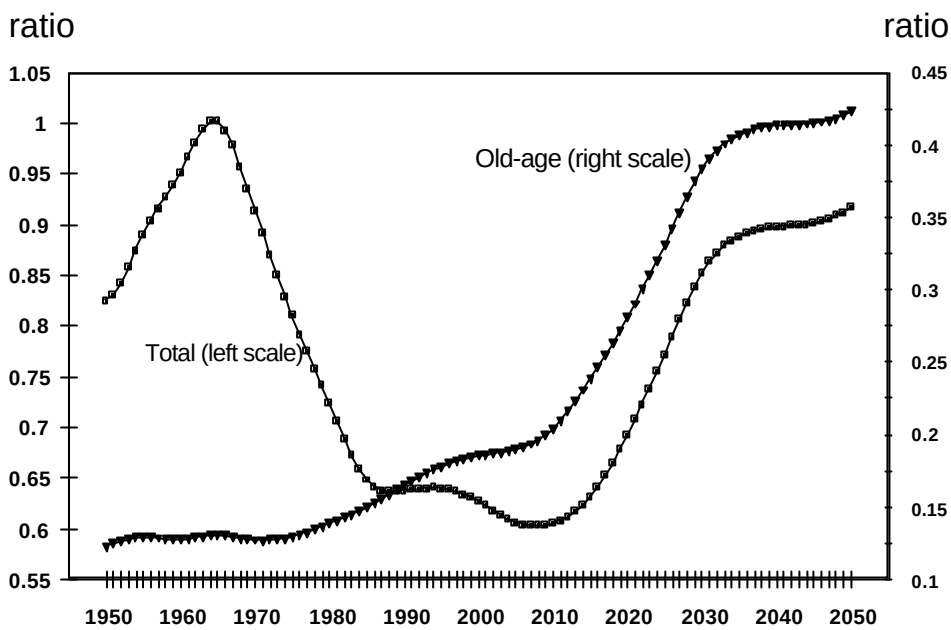
[7] There are alternative ways to define the dependency ratio. See for example Shryock and Siegel (1975) and Denton, Feaver and Spencer (1997).

[8] Cutler *et al.* (1991) use the same weights as Lazear and Michael (1980) to calculate a measure of the support ratio.

[9] See Bovenberg and Evans (1990) and Montgomery (1986) for the United States, and Lamy (1994) for Canada.

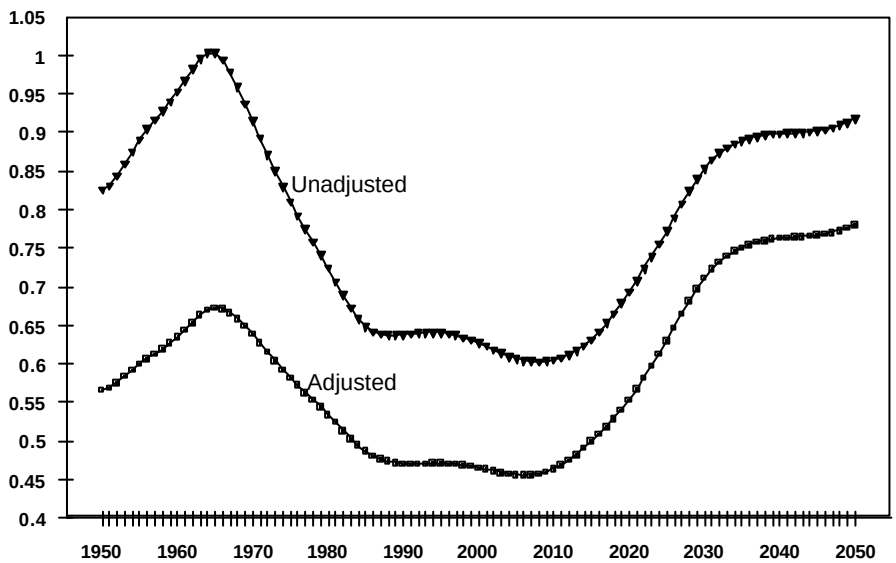
the population can significantly alter aggregate consumption and savings. We will test this hypothesis by including the total age dependency ratio, *AgeDep*, (adjusted and unadjusted) in the savings rate equation.

Chart 3
Age Dependency Ratio



Source: United Nations

Chart 4
Total Dependency Ratio



Source: United Nations

Public Sector Deficits

According to the Ricardian Equivalence Hypothesis (REH), when the government runs a deficit, consumers anticipate an increase in taxes in the future to repay the debt, and so increase their savings. We incorporate total public sector deficit (National Accounts basis) as a share of GDP, *Gbal/Y*, in the savings rate equation to take account of possible full or partial Ricardian equivalence.

Real After-Tax Interest Rates

The impact of real after-tax interest rates, *R*, on personal savings is indeterminate, as it reflects the opposing influences of substitution and income effects. An increase in interest rates raises the wealth forgone if one consumes, raising the incentive to save. On the other hand, the increase in the net return to non-human wealth increases lifetime income, which raises consumption. Therefore, the overall effect of real after-tax interest rates on savings remains an empirical question.

Inflation

Inflation may affect measured savings and savings behaviour in a number of ways. First, to the extent that nominal interest rates include a compensation for the reduction in the real value of financial assets, inflation can lead to some measurement errors of savings in the National Income and Expenditures Accounts (NIEA). In addition, inflation can affect savings by affecting real after-tax interest rates. Inflation can also raise uncertainty associated with future income and lead to an increase in precautionary savings for risk-averse households. Inflation also reduces the real value of fixed financial assets, such as bonds, requiring an increase in savings to compensate the real value loss. A number of studies have found a significantly positive effect of inflation on savings.[10] In light of this, we include the year-over-year change in the Consumer Price Index, *?*, lagged one period in the savings rate equation.

Unfunded Social Security Systems

The theoretical arguments of the effect of the social security system on the savings rate are based on the life cycle model of savings and consumption. Feldstein (1974) argues that an unfunded social security system reduces savings by altering the individual's budget constraint. He claims that with an unfunded social security system, the present value of benefits exceeds the present value of contributions paid, which in turn generates an increase in lifetime resources, raising lifetime consumption and reducing non-pension savings.

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[10] See for example Blinder and Deaton (1985), Montgomery (1986), and Bovenberg and Evans (1990) for the United States, and Lamy (1994) for Canada.

Hubbard (1986) argues that pension annuities provide insurance for retirement consumption in the face of an uncertain future. Anticipated social security pensions reduce the need for retirement saving from private sources. They also decrease the need for precautionary savings as they reduce the uncertainty about the necessary amount of savings for retirement. Summers and Carroll (1987) suggest that the improvement in relative income of the elderly due to social security pensions has reduced the perceived need for young generations to save.

Also, according to Evans (1983), social security produces a substantial redistribution of current income. If recipients of social security have a higher marginal propensity to consume than the average, an increase in the share of social security transfers in disposable income may increase consumption and reduce savings.

The traditional way to test the relationship between social security and savings has been to calculate a social security wealth variable[11] and estimate an aggregate consumption function by including social security wealth in the equation. However, empirical analysis using time-series data and a wealth variable has produced no conclusive results.[12] Evans (1983) argues that there are a number of important problems in the methodology used to generate a social security wealth series. Among these problems, one deals with the rationale underlying the construction of such a series. With an unfunded liability, social security wealth can be considered as "fictitious" because there are no corresponding real resources.

In order to account for the effect of the social security system on personal savings, we use a measure of the flow of pension income, by including the ratio of Old Age Security, and CPP/QPP benefits to GDP, *(OAS+CQPP)/GDP*, in the savings rate equation.

Uncertainty

According to the life-cycle hypothesis, an increase in uncertainty about future income streams leads households to raise their precautionary savings. In an attempt to capture more fully the effect of uncertainty on savings, we incorporate an index of job uncertainty based on the Gallup poll, *Gallup*. The index is based on answers to the following survey question: Do you think your present job is safe – or do you think there is a chance you may become unemployed? The value of the index is equal to the proportion of respondents who feel that there is a chance they will become unemployed.[13]

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[11] See Barro (1978), Darby (1979), Leimer and Lesnoy (1980,1982), and Evans (1983) for the calculation of the social security wealth variable.

[12] See for example Barro (1978), Darby (1979), and Leimer and Lesnoy (1980,1982).

[13] For more details, see Edwards and Hughes (1996).

An increase in the level of the index is expected to lead to an increase in precautionary savings.

4. Empirical Analysis

When we use econometric methods to test economic relationships, we have to be concerned about the possibility of spurious co-movements between variables. Spurious regressions may occur when economic time series exhibit nonstationary tendencies. For example, spurious regressions are likely when the adjusted R^2 is greater than the Durbin-Watson (DW) statistic. Cointegration analysis confronts the spurious regression problem. If we suppose that time series x and y are nonstationary, with stationary first differences, cointegrated series occur when a factor b exists such that $z_t = y_t - bx_t$ is stationary.

In addition, before we estimate the savings rate equation and test for cointegration, we have to determine the order of integration of each of the variables considered. Once we have found their order of integration, we can estimate a cointegrated regression using variables of the same order of integration and test for stationary residuals of the regression.

Stationarity Tests

We apply two stationarity tests on the variables considered: the augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests.[14] The variables are tested for the period 1951Q1-1996Q4, except for the variables *AgeDep*, $W_{(-1)}/Y$, *(OAS+CQPP)/Y* and *Gallup*, which are only available from the early 1960s (Y_d refers to personal disposable income). The stationarity test results are presented in Table 2.

As shown in Table 2, we cannot reject the presence of a unit-root for all the variables, even at a 10% critical level. However, the hypothesis of nonstationarity is rejected at a 1% critical level (5% for $W_{(-1)}/Y$ and *AgeDep* with the ADF statistic) for all the variables in first differences.

Cointegration Analysis

According to the results of Table 2, we can assume that all the variables are I(1), and test for a cointegrating relationship with all the variables in level form. We test the following relationship:

$$\log(S/Y_d) = b_0 + b_1 \log(W_{(-1)}/Y) + b_2 (Gbal/Y) + b_3 R + b_4 ?_{(-1)} + b_5 \log(AgeDep) + b_6 \log((OAS + CQPP)/Y) + b_7 Gallup \quad (4)$$

[14] See Dickey and Fuller (1979) and Phillips and Perron (1988).

Table 2
Stationarity Tests

Variable	ADF		Philips-Perron	
	Level	First diff.	Level	First diff.
S/Y_d	1.2	3.6**	1.7	18.5**
$W_{(-1)}/Y$	0.4	3.3*	0.7	9.2**
Gbal/Y	2.2	4.1**	2.5	14.6**
R	2.0	6.5**	2.1	9.5**
?	1.5	4.0**	2.5	7.8**
AgeDep	2.4	3.2*	0.3	14.3**
(OAS+CQPP)/Y	1.2	3.6**	1.8	15.7**
Gallup	0.7	5.3**	0.9	7.9**

** Nonstationarity rejected at a 1% critical level; * at a 5% critical level.

Equation (4) is estimated over the period 1962Q1 to 1996Q4 using both the adjusted and unadjusted total dependency ratios. The ADF test using the adjusted *AgeDep* in the equation does not reject cointegration at a 10% critical level, which is unsatisfactory. However, the ADF test using the unadjusted series cannot reject cointegration at a 1% critical level, which is quite satisfactory. The regression results using the unadjusted *AgeDep* are presented below as equation (5). According to these results, all the variables have the expected sign.

According to the results of equation (5), a change in household net worth relative to GDP has a significant and large negative effect on the personal savings rate, as suggested by the LCH. According to the model, a 1% increase in the ratio of net wealth to income results in a 3.9% reduction in the personal savings. This indicates that the increase in household net worth from 2.5 times GDP in 1981 to 3.1 times GDP in 1996 would explain, to a large degree, the reduction in personal savings observed over the period.

(5) $$\underset{(t)}{\log(S/Y_d)} = \underset{(6.2)}{2.97} - \underset{(-9.8)}{3.9}\log(W_{(-1)}/Y) - \underset{(-9.8)}{0.061}\,Gbal/Y + \underset{(4.3)}{0.052}\,R + \underset{(9.3)}{0.09}\,?_{(-1)} - \underset{(-4.9)}{2.05}\log(AgeDep)$$
$$- \underset{(-3.2)}{0.49}\log((OAS+CQPP)/Y) + \underset{(5.1)}{0.024}\,Gallup$$

$$AR^2 = 0.9, \qquad D.W. = 1.36 \qquad ADF = 6.9\,**$$

**Rejection of non-cointegration at a 1% critical level.

The results also provide evidence that an increase in public sector deficits leads to an increase in personal savings, supporting some Ricardian equivalence. The relationship between the personal savings rate and *Gbal/Y* is semi-logarithmic and the coefficient must be considered as a semi-elasticity. The estimated coefficient on *Gbal/Y* indicates that, for a savings rate of 10%, a 1% of GDP reduction in public sector deficits would lead to a 0.6 percentage point reduction in the personal savings rate. However, this result must not be considered as a formal test of the REH.[15] For example, the measure used here does not include corporate savings.

The net effect of the real after-tax interest rate on savings is positive, according to equation (5), which is consistent with other recent empirical evidence.[16] The results also support the view that inflation affects the measured savings rate. This implies that the sharp increase in inflation during the 1970s, and the corresponding decline during the 1980s and 1990s, contributed to movements in measured savings since the mid-1970s.

The results also indicate that the dependency ratio is an important variable determining long-run trends in the savings rate. According to our estimates, an increase in *AgeDep* of 1% leads to a reduction in the savings rate of about 2%. Moreover, over the last two decades, because of the reduction in the share of the young population, *AgeDep* contributed positively to personal savings. On the other hand, the expected increase in the dependency ratio, associated with population ageing will put significant downward pressures on saving in the future.

Consistent with the findings of Evans (1983) for the U.S., we find a negative relationship between the ratio of public pension benefits to GDP and personal savings. A 1% increase in public pension benefits relative to GDP would result in a 0.49% reduction in the savings rate.

Finally, an increase in uncertainty, as indicated by the sign of the coefficient on *Gallup*, also leads to an increase in savings.

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[15] For more details on tests of the REH, see for example Bernheim (1987).

[16] See, for example, Lamy (1994) and Bovenberg and Evans (1990).

Error-Correction Model

As an additional test of significance, we have also estimated an error-correction model[17] for the savings rate, in a one-step procedure, using the method of non-linear least squares. The use of a one-step approach allows the simultaneous estimation of both short- and long-run coefficients, as well as the error-correction term. It is another way of testing the strength of the posited empirical relationship and the stability of the long-run coefficients.

In addition to the long-run effects, we have included a number of variables that are susceptible to affect savings in the short run. These include the unemployment rate, the fertility rate and short-term nominal interest rates. An increase in the unemployment rate may have two offsetting effects on personal savings in the short run. First, it can reduce confidence and lead to an increase in precautionary savings. Second, households may have to reduce their savings in more difficult times in order to maintain a certain level of consumption.

The change in the fertility rate is used as a proxy for changes in family size. An increase in the fertility rate is expected to raise consumption in the short run and to reduce savings. Finally, it can be argued that households may have some money illusion in the short run and would be influenced by changes in nominal interest rates.

The error-correction model estimated has the following form:

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\begin{aligned}
(6) \qquad \Delta\log(S/Y) = {} & a_0 - j\,[(\log(S_{(-1)}/Y_{(-1)}) - b_1\log(W_{(-2)}/Y_{(-1)}) - b_2(Gbal_{(-1)}/Y_{(-1)}) \\
& - b_3 R_{(-1)} - b_4\Pi_{(-2)} - b_5\log(AgeDep_{(-1)}) - b_6\log((OAS_{(-1)} + CQPP_{(-1)})/Y_{(-1)}) \\
& - b_7 Gallup_{(-1)}] + a_1\Delta\log(S_{(-1)}/Y_{(-1)}) + a_2\Delta U + a_3\Delta(Gbal/Y) + a_4\Delta Rs \\
& + a_5\Delta\log(F) + a_6\Delta\log(AgeDep)
\end{aligned}
$$

where *DU* is the change in the unemployment rate, *DRs* the change in the nominal short-term interest rate and *Dlog(F)* the rate of change in the fertility rate. The b coefficients correspond to the same long-run elasticities as in equation (4). The a coefficients are short-run elasticities and φ is the coefficient on the error-correction term. It also corresponds to the speed of adjustment toward the long run. If j is not significantly different from zero, the cointegrating relationship is rejected.

The results are shown below as equation (7). The estimated b coefficients all have the expected signs and are significantly different from zero, at least at a 5% critical level. This reinforces the original results. An interesting result is that under both approaches,

[17] See Engle and Granger (1987).

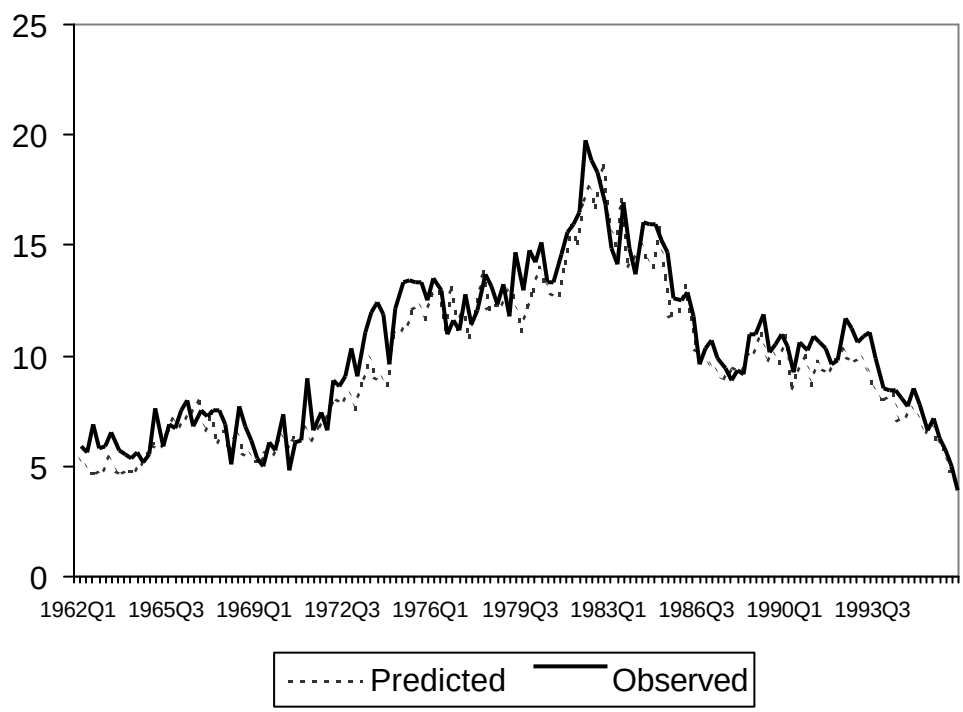
the *b* coefficient on *AgeDep*, which is of prime interest for this paper, is 1.9, which is only slightly below the value found in equation (5). The value of the other *b* coefficients has changed somewhat, but their value remains reasonably close to the result of equation (4) in most cases.

(7)
$$\Delta\log(S/Y_D) = \underset{(t)}{3.6} - \underset{(4.5)}{0.53}\Big[\underset{(-6.1)}{\log(S_{(-1)}/Y_{D(-1)})} + \underset{(-6.0)}{4.3}\log(W_{(-2)}/Y_{(-1)})$$
$$+ \underset{(-3.3)}{0.038}Gbal_{(-1)}/Y_{(-1)} - \underset{(-4.0)}{0.083}R_{(-1)} - \underset{(-7.0)}{0.12}?_{(-2)} + \underset{(4.8)}{1.89}\log(AgeDep_{(-1)})$$
$$+ \underset{(2.5)}{0.62}\log((OAS_{(-1)} + CQPP_{(-1)})/Y_{(-1)}) - \underset{(-3.6)}{0.027}Gallup_{(-1)}\Big] - \underset{(-1.82)}{0.13}\Delta\log(S_{(-1)}/Y_{D(-1)})$$
$$- \underset{(-2.9)}{0.082}\Delta U - \underset{(-7.0)}{0.076}\Delta(Gbal/Y) + \underset{(3.4)}{0.029}\Delta Rs - \underset{(-3.7)}{6.6}\Delta\log(F) - \underset{(-2.8)}{3.5}\Delta\log(AgeDep)$$

$CR^2 = 0.52$ $\quad D.W. = 2.07$ $\quad s = 0.098$

$LM(1) = 0.14$ $\quad LM(2) = 0.25$ $\quad Arch(1) = 0.8$ $\quad White = 0.41$

Chart 5
In-Sample Dynamic Forecast of the Personal Savings Rate



In addition, we find that in the short run, an increase in the unemployment rate reduces the savings rate. We also find that an increase in the fertility rate has a negative

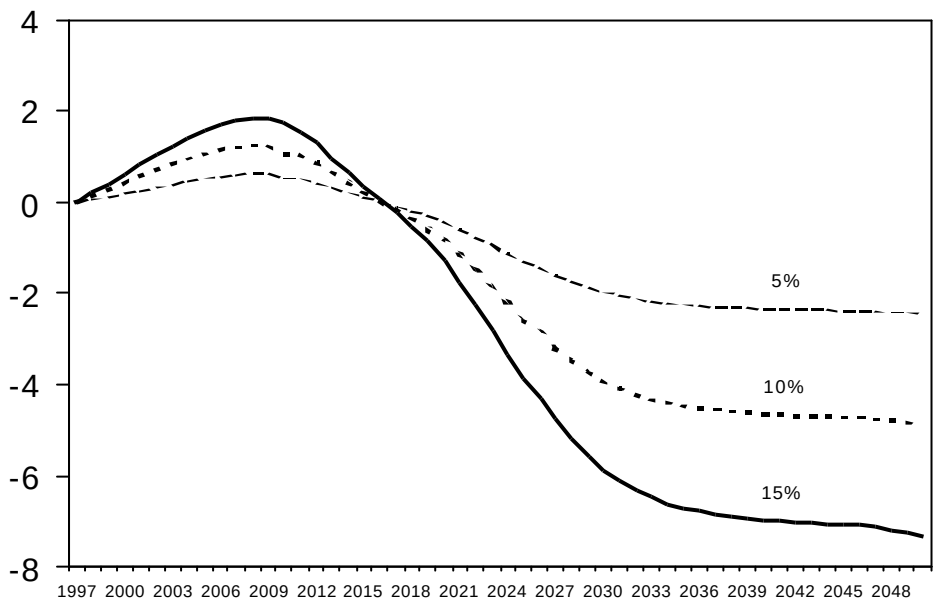
effect on savings. This suggests that in the short run, an increase in family size tends to raise family consumption and to reduce savings. Finally, short-term nominal interest rates have a significantly positive effect on savings.

A dynamic in-sample forecast was conducted for the period 1962 to 1996. As shown in Chart 5, the dynamic model tracks history reasonably well.

5. Simulations of the Effect of Ageing on Personal Savings

In this section we present the simulation results of the effect of population ageing on the personal savings rate, for the period 1997 to 2050, using the United Nations demographic projections. Since the relationship between the personal savings rate and the total dependency ratio in the cointegrated model is a log-log specification, the long-run effect of a demographic shock on the personal savings rate will depend on the initial level of the savings rate. As a result, the simulations are conducted using three alternative baseline savings rate: 5%, 10% and 15%. The shock-minus-control results are presented in Chart 6.

Chart 6
Impact of Population Ageing on the Savings Rate
Shock-Minus-Control Changes in the Personal Savings Rate
(Initial savings rate: 5%, 10% and 15%)



As illustrated in Chart 3, the increase in the share of old-age dependants, in the short run, is more than compensated by the reduction in the share of young dependants. This leads to a reduction in the total dependency ratio between 1997 and 2010, but to a dramatic increase thereafter. As a result, in the short run, the changing age structures of

the population result in an increase in the personal savings rate (see Chart 6). By 2010, the personal savings rate increases by 12% relative to each baseline solution. However, in the long run (by 2050), the impact of population ageing leads to a 49% reduction in the personal savings rate. The size of the impact in percentage points is also sensitive to the level of the baseline savings rate. With a savings rate of 5%, close to the level reached in 1996, the projected increase in the dependency ratio leads to a 2.4 percentage point reduction in the savings rate over the next 50 years. With a baseline savings rate of 10% and 15%, the impact reaches 4.9 and 7.3 percentage points, respectively.

These results represent partial equilibrium effects, since population ageing is likely to affect production, household net worth, real interest rates, marginal tax rates, public sector deficits and public sector pension benefits and contributions, which in turn will have an induced effect on savings. Our analysis also does not account for the impact of the recent CPP/QPP reform on personal savings.

On the other hand, the results found in this paper are consistent with the prediction of the life-cycle model of consumption and savings. They are also within the range of results found by Miles (1999), Auerbach and Kotlikoff (1987), Auerbach *et al.* (1989), Hviding and Mérette (1998) and Fougère and Mérette (1998), who used computable overlapping generations models for some industrialised countries.

6. Conclusion

In this paper, we estimated a cointegrating relationship for the personal savings rate. We incorporated various factors that determine the long-run trend in personal savings, as measured by the National Income and Expenditure Accounts, such as changes in the age composition of the population. Our econometric results are quite satisfactory and indicate that many important economic variables have affected the long-run trend in personal savings over the last 35 years.

We also identified some of the important factors that have contributed to the reduction in the personal savings rate since the early 1980s. Sharp increases in household net worth, the increase in public pension benefits as a share of GDP, the reduction in inflation and real after-tax interest rates, and recent improvements in general government balances, all contributed to the reduction in the personal savings rate. We also found that changes in the age composition of the population have contributed to an increase in personal savings since the 1970s, because the reduction in the proportion of young dependants has more than compensated for the increase in the proportion of old dependants.

However, over the next several decades, the proportion of the old-age population is expected to double. This situation is likely to put significant downward pressure on personal savings. If changes in the young age dependency ratio have the same impact on savings as changes in the old age dependency ratio, our results indicate that, because the

reduction in the proportion of young dependants is expected to continue to dominate the increasing proportion of old dependants until 2010, the change in the demographic structure of the population will still contribute to an increase in the personal savings rate for some time. However, our results also indicate that as soon as the increasing proportion of old dependants begins to dominate and the total dependency ratio begins to rise, population ageing will eventually put downward pressure on the personal savings rate. In our simulation analysis we found that by 2050, the direct effect of population ageing may contribute to reduce the personal savings rate by close to 50%.

As predicted by the LCH, our results provide support for the hypothesis that population ageing may lead to a significant reduction in personal savings. It must be noted, however, that since we do not account for the possible induced economic effects of population ageing on savings through effects on wealth, real interest rates, the government balance and so on, these results remain a partial analysis. The induced effects could be important and may either partially offset or act to reinforce the downward pressures of ageing on savings. To investigate the full general equilibrium effects, the use of computable OLG models is recommended, since in these models household sector behaviour is dominated by the LCH.

Finally, the demographic shock may affect relative prices, since ageing is likely to make labour scarcer relative to physical capital. Therefore, the reduction in savings that would follow the demographic shock may simply reflect a reduction in the optimal level of savings in physical capital. This would not necessarily imply a permanent real output loss. For example, Fougère and Mérette (1998) have demonstrated with an OLG model featuring endogenous growth, that the reduction in savings may reflect a change in portfolio from savings in physical capital to savings in human capital, which in turn would lead to an increase in economic growth.

References

Ando, Albert and Franco Modigliani (1963), "The Life Cycle Hypothesis of Saving: Aggregate Implications and Tests", *American Economic Review*, Vol. 53, pp. 55-84

Auerbach, Alan J. and Laurence J. Kotlikoff (1987), *Dynamic Fiscal Policy*, Cambridge University Press, Cambridge, UK

Auerbach, Alan J., Laurence J. Kotlikoff, Robert P. Hagemann and Giuseppe Nicoletti (1989), "The Economic Dynamics of an Ageing Population: The Case of Four OECD Countries", *OECD Economic Review*, no. 12, pp. 97-130

Barro, Robert (1978), *The Impact of Social Security on Private Saving: Evidence from US Time Series*, American Enterprise Institute for Public Policy Research, AEI Studies, no. 199, Washington

Bernheim, B.D. (1987), "Ricardian Equivalence: An Evaluation of Theory and Evidence," *NBER Macroeconomics Annual 1987*, Cambridge, MIT Press

Blinder, Alan S., and Augus Deaton (1985), "The Time Series Consumption Function Revisited", *Brookings Paper on Economic Activity:2*, pp. 465-521

Bordt, Michael, Grant J. Cameron, Stephen F. Gribble, Brian B. Murphy, Geoff T. Rowe and Michael C. Wolfson (1990), "The Social Policy Simulation Database and Model: An Integrated Tool for Tax/Transfer Policy", *Canadian Tax Journal*, Vol. 38, no.1, pp. 48-65

Bosworth, B., B. Burtless, and J. Sabelhaus, (1991), "The Decline in Saving: Some Microeconomic Evidence", *Brookings Papers on Economic Activity:1*, pp. 183-241

Bovenberg, A. Lans and Owen Evans (1990), "National and Personal Saving in the United States", *IMF Staff Papers*, Vol. 37, pp. 636-669

Darby, Michael (1979), *The Effects of Social Security on Income and the Capital Stock*, American Enterprise Institute for Public Policy Research, Washington

Denton, Frank T., Christine H. Feaver and Byron G. Spencer (1997), *Immigration, Labour Force and the Age Structure of the Population*, QSEP Research Report no. 335, McMaster University, Hamilton

Dickey, David A. and Wayne A. Fuller (1979), "Distribution of the Estimators for Autoregressive Time Series with a Unit Root", *Journal of the American Statistical Association*, vol. 74, pp. 427-431

Disney, Richard, Paul Johnson and Gary Stears (1998), "Asset Wealth and Asset Decumulation Among Households in the Retirement Survey", *Fiscal Studies*, Vol. 19, no.

2, pp. 153-174

Edwards, R. Gary and Jon Hughes (1996), "Four in Ten Employed Canadians Fear for Their Jobs", *The Gallup Poll*, Vol. 56, September

Engle, Robert and C. W. J. Granger (1987), "Co-integration and Error Correction: Representation, Estimation and Testing", *Econometrica*, Vol. 55, pp. 251-276

Evans, Owen (1983), "Social Security and Household Saving in the United States", *IMF Staff Papers*, Vol. 30, pp. 601-618

Feldstein, Martin (1974), "Social Security, Induced Retirement and Aggregate Capital Accumulation", *Journal of Political Economy*, Vol. 82, pp. 905-926

Fougère, Maxime and Marcel Mérette (1998), *Population Ageing and Economic Growth in Seven OECD Countries*, Department of Finance Working Paper no. 98-03, Ottawa, also forthcoming in *Economic Modelling*.

Hubbard, R. Glenn (1986), "Uncertain Lifetimes, Pensions and Individual Savings", in *Pensions and Retirement in the United States*, edited by Zvi Bodie, John B. Shoven and David A. Wise, Chicago, University of Chicago Press

Hviding, Ketil and Marcel Mérette (1998), *Macroeconomic Effects of Pension Reform in the Context of Ageing: OLG Simulations for Seven OECD Countries*, OECD Working Paper no. 201, June, Paris

Kotlikoff, Laurence (1988), "Intergenerational Transfers and Savings", *Journal of Economic Perspectives*, Vol. 2, pp. 41-58

Lamy, Robert (1994), *Income Measurement, Terms of the Interest Rate, Long-Term Consumption and Error Correction Model: An Application of Cointegration with the Engle and Granger Two-Step Procedure*, Department of Finance, Canada, Paper presented at the Annual Meeting of the CEA in Calgary, June 1994

Lazear, Edward ad Robert Michael (1980), "Family Size and the Distribution of Real Per Capita Income", *American Economic Review*, Vol. 70, pp. 91-107

Leimer, Dean and Selig D. Lesnoy (1980), *Social Security and Private Saving: A Reexamination of the Time Series Evidence Using Alternative Social Security Wealth Variables*, U.S. Department of Health, Education and Welfare, Office of Research and Statistics, Working Paper no. 22, Washington

Leimer, Dean and Selig D. Lesnoy (1982), "Social Security and Private Saving: New Time-Series Evidence", *Journal of Political Economy*, Vol. 90, pp. 606-629

Meredith, Guy (1995), "Demographic Change and Household Saving in Japan", in *Saving Behavior and the Asset Price*, edited by Ulrich Baumgartner and Guy Meredith, IMF Occasional Paper no. 124, Washington DC

Miles, David, (1999), "Modelling the Impact of Demographic Change Upon the Economy", *Economic Journal*, 109, pp. 1-36.

Montgomery, Edward (1986), "Where Did All the Saving Go? A Look at the Recent Decline in the Personal Saving Rate", *Economic Inquiry*, Vol. 24, pp. 681-697

Phillips, P. C. B. and P. Perron (1988), "Testing for a Unit Root in Time Series Regression", *Biometrika*, Vol. 75, pp. 335-346

Shryock, Henry S. and Jacob Siegel (1975), *The Methods and Materials of Demography*, Vol. 1, US Department of Commerce, Bureau of the Census, Washington

Summers, Lawrence and Chris Carroll (1987), "Why is National Saving So Low?", *Brookings Papers on Economic Activity:2*, pp. 607-635

Weil, David N. (1994), "The Saving of the Elderly in Micro and Macro Data", *Quarterly Journal of Economics*, Vol. 109, pp. 55-82