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THE DECLINE IN SAVINGS:
SHOULD WE BE SURPRISED?

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Abstract

This paper presents an overlapping generations general equilibrium model to explain how economic conditions affect the level of domestic savings in life-cycle economies. The model economies are populated by agents of overlapping generations with limited lifetimes. A government sector provides an employment insurance program to insure agents against temporary bouts of unemployment, and a public pension program to provide additional income to retired residents. The level of savings is compared in cases of high and low unemployment, and high and low interest rate conditions, to help explain movements in the Canadian savings rate. Model results show that the personal savings rate is primarily influenced by changes in the interest rate and not the unemployment rate. The unemployment rate has had a major impact on the government savings rate. Heading into a recession, with prevailing low rates of interest and mounting job losses, we should expect an environment with a low aggregate savings rate.

Keywords: saving, public pensions, employment insurance, overlapping generations.
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I. Introduction

An overlapping generations general equilibrium model is used to help explain movements in the savings rate of life-cycle economies subjected to different rates of unemployment and of the return to capital. Model economies are populated by agents with limited and uncertain lifetimes, and with employment uncertainty. A government sector provides unemployment insurance benefits and pensions for retirees, financed by payroll taxes. Aggregate savings rates are compared for the cases of high and low unemployment, and high and low interest rates. Model results suggest that personal rates of saving are influenced primarily by interest rates, and are not significantly affected by the unemployment rate in the aggregate. The government savings rate is affected by the unemployment rate, if it desires to smooth out the business cycle and run surpluses in good years, and run deficits in bad years. The results suggest we should not be surprised that the aggregate savings rate has declined over the last forty years as the unemployment rate has trended upwards, with a general fall in the government surplus. Canadians also have less incentive to save now than in the 1980s because of low interest rates. With the economy nearing a recession in 2001, and with the Bank of Canada's stimulative interest rate policy, one should expect the Canadian savings rate to remain at a low level, if not fall further.

Policymakers and economists have been concerned with the general decline in personal and national rates of saving in the industrialized nations since the 1970s. In the US, the personal savings rate has fallen from five percent in the 1960s to near zero in the late 1990s (Gordon (2000:512)). In Canada, the net aggregate savings rate fell from 15% in the mid-70s, to 5% in the mid-90s. Net personal savings rates fell from 9.2% in 1975 to 2.3% in 1999 (CANSIM matrices 8614, 8629). At the same time, government savings have also fallen. The US Government savings rate averaged 0.4% over 1960-73, and then fell to an average of –4.5% over 1984-87. The United States went from being a net supplier of capital to the rest of the world, to a net debtor (Berheim and Shoven, 1991:9). Government savings in Canada were 3% of GNP in 1974, and then were negative from 1975 to 1996, reaching a low of –8.5% of GNP during the recession of 1993. Even with Canada's social insurance programs, business cycles have a strong impact on individuals. The consequences of low saving include hardship for those experiencing unemployment, illness, or retirement. At the aggregate level, low rates of saving can lead to depressed investment, income, and productivity, and increased foreign indebtedness.

In Canada, the aggregate net savings rate fell from a high of 16.1% in 1974, to a low of 4.4% in 1993. However, the trend in the aggregate savings rate masks that of the components of aggregate saving. The personal savings rate rose from 4.8% in 1970 to a high of 14.5% in 1982, then experienced a steady decline to 2.3% in 1999. Government savings were 3% of GNP in 1974. From 1975 to 1996, the Canadian government ran budget deficits. Only recently have government savings returned to positive levels. Business savings have been relatively constant, with the exception of declines during the recessions in the early eighties and nineties. Figure 1 presents the Canadian net savings rate and its components from 1962-2000.

The unemployment rate rose from 4% in the sixties, to almost 12% in 1983, falling to just over 7% in 1989, then rising again to 11% in 1992. The natural rate of unemployment is now considerably higher than the rate prior to the 1970s. As a result of the rise in the unemployment rate, unemployment insurance benefits have dramatically increased. Benefits paid out by the federal Unemployment Insurance program rose from $2 billion in the early 1970s to $10 billion in 1988, and to $18 billion in 1993 (HRDC (2001)). The cyclical pattern in the unemployment rate mirrors the pattern in the government savings rate, as shown in Figure 2.

Burbidge, Fretz and Veall (1998) provide evidence that the Canadian personal savings rate has followed movements in the interest rate. It appears that the high personal savings rate during the early eighties can be ascribed to a decrease in financial liabilities as consumers were paying down debt at a time of increasing interest rates. Their work supports the analysis of Ragan (1994) and Sabelhaus (1997) showing that use of the Canadian RRSP program cannot explain the increase in the Canadian personal savings rate in the years leading up to 1985. Munnell (1977) found that changes in the unemployment rate were a factor in explaining changes in savings behaviour, as individuals consume out of accumulated wealth to offset income losses when unemployed. Individuals, however, may save more when employed as a result of increased employment uncertainty, so it is unclear in the aggregate whether higher unemployment leads to a higher or lower savings rate. Does the unemployment rate influence personal savings in the aggregate? Figure 3 shows the personal savings rate and interest rate data for Canada over 1962-2000. The personal savings rate appears to follow movements in interest rates and not movements in the unemployment rate. Is this personal savings behaviour consistent with that of rational, forward-looking life-cycle savers?

The purpose of this paper is to examine how personal and government savings have reacted to changes in economic conditions. This paper presents an overlapping generations model of life-cycle economies to examine the impact on the aggregate savings rate of changes in the unemployment rate and changes in the interest rate. Model results suggest we should not be surprised with the decline in aggregate savings over the last forty years. The savings rate decline has been accompanied by an increase in the natural rate of unemployment since the 1970s, and the general decline in interest rates since the 1982 recession. Heading into a recession, we should not expect the aggregate savings rate to rise too soon with mounting job losses and falling interest rates.

II. An Overlapping Generations Model

The overlapping generations framework has been proven useful in modeling demographic transitions (Auerbach et al (1989), Rios-Rull (1994), Storesletten (2000), and Wilson (2001a)). It has been successfully applied to examine the distribution of wealth, income heterogeneity, and entrepreneurship in the US (Huggett (1996), Huggett and Ventura (2000), Quadrini (2000)). The overlapping generations framework has also been extensively used to examine social security and public pension reform (Bohn (1999), Huggett and Ventura (1999), Emery and Rongve (1999)). Wilson (2001b) and Wilson (2001c) use the overlapping generations model of life-cycle economies to investigate the impact of employment insurance and pension programs on aggregate savings. The framework is rich enough to incorporate uncertain finite lifetimes, heterogeneity in age and employment status, and other changing characteristics over the life cycle.

The Environment

The model economies to be examined are populated by overlapping generations of agents with uncertain and limited lifetimes, and employment uncertainty. Agents live to a maximum of I periods, start work at I_w, and retire at I_r. Agents face uncertain lifetimes, but commonly know age-dependent survival probabilities. The probability of surviving from age i to age i+1 is s_i. The unconditional probability of surviving to age k is $s(k) = \Pi_{j=1}^{k-1} s_j$. The population distribution by age cohort at a point in time is represented by the vector m_t, where $m = [\, m_1 \;\; m_2 \;\ldots\; m_I \,]^T$. Agents are heterogeneous in age, and in their employment history. The age i cohort consists of m_i agents. Agents within a cohort are indexed by h_i, where $h_i \in (1, m_i)$. In the model economies, steady-state equilibria will be examined. Therefore, age i agents make up a constant fraction of the population at any point in time and each cohort grows at the rate of n.

Agents maximize utility over a standard composite good, with time separable preferences and discount factor b. The composite good can also be used as capital, earning a risk-free one period return per unit, R. Agents maximize expected lifetime utility, given by:

$$\max E_{I_w}\left(U(c_{I_w}) + \sum_{j=1}^{I-I_w} b^{\,j} s(j + I_w - 1) U(c_{j+I_w})\right), \qquad \text{where } U(c) = \frac{c^{1-s}}{1-s}. \quad (1)$$

Agents face the probability p_i^e of being employed, and are endowed with age-specific labour efficiency units, denoted by e_i. If employed, $l(h_i) = 1$, and labour is supplied inelastically. If unemployed, $l(h_i) = 0$. In these economies, there is no aggregate uncertainty, but there exists uncertainty at the individual level. The probability of being employed in a given period for an individual is independent of being employed in any other time period.

At the aggregate level, production is deterministic and the production function is a standard Cobb-Douglas function:

$$Y_t = F(K_t, L_t) = \mathrm{B} K_t^{a} (A_t L_t)^{1-a}\ . \qquad (2)$$

Labour-augmenting technological progress, A_t, grows at a constant rate g, and capital depreciates at a constant rate d. B is a scale parameter.

A government sector runs an employment insurance and pension program for agents in the economy. Unemployed agents receive a benefit equal to a proportion, $b_{i,t}$, of their labour endowment (their expected earnings if otherwise employed). Individuals who survive past the age of I_{r-1} receive retirement benefits at a rate equal to an age-specific benefit rate, $b_{i,t}$, times a level, e_i, representative of the employment history of the average individual of that age cohort when $i \geq r$.[1] The government finances the employment insurance and the pension programs by levying payroll taxes equal to a proportion, p_t, on labour earnings.

In period t, an agent of age i chooses consumption, $c_{i,t}$, and asset holdings, $a'_{i,t} = a_{i+1,t+1}$ that are carried into the next period, with the following constraints:

$$c_{i,t} + a'_{i,t} \leq W_t = R_t a_{i,t} + (1 - p_t) w_t l(h_i) e_i + b_{i,t} w_t (1 - l(h_i)) e_i + T_t, \text{ and}$$

$$c_{i,t} \geq 0, \text{ and } a'_{i,t} \geq 0 \text{ for all } i, \text{ and } t. \tag{3}$$

In this context, T_t denotes the transfer of accidental bequests. Bequests have been treated several different ways. Huggett (1996) treats accidental bequests as fully taxed and redistributed amongst surviving agents in the economy. Accidental bequests are donated to newborns in a lump-sum transfer in the model economies of Storesletten (2000). In Rios-Rull (1994), agents write contracts with members of their own age cohort to share wealth or debts of members who die before age I. Since inheritances tend to be distributed amongst family members of varying ages, the most appropriate modeling strategy would be that of Huggett. Here, the value of accidental bequests is distributed equally amongst the adult population (those of age I_w or older).

In this model, agents are liquidity constrained and cannot have net debt. Agents are not capable of borrowing without collateral greater than or equal to the amount borrowed, but are allowed to mortgage capital. Agents are unable to borrow against the promise of future income to finance consumption. In the lifecycle model economy with survival uncertainty, this assumption restricts agents' borrowing so that they do not accumulate debts and die before repayment.

[1] This is done for simplicity, instead of keeping track of each individual's employment history and having benefits dependent on an individual's employment history.

In the model economies to be investigated, steady-state equilibria will be examined, and the government budget will be forced to balance. Government pension and unemployment benefits must equal premiums received:

$$\sum_{i,h_i} (pp_i^e m_i we_i) - (b_i p_i^u m_i we_i) = 0.^2 \qquad (4)$$

Steady-State Equilibrium

The variables are transformed as follows to remove the effects of growth in the population and of technology:

$$\tilde{L}_t = L_t / L_t, \tilde{K}_t = K_t / L_t A_t, \tilde{T}_t = T_t / A_t, \tilde{a}_t = a_t / A_t, \tilde{c}_t = c_t / A_t, \tilde{w}_t = w_t / A_t,$$
$$\tilde{m}_t = m_t / L_t, \tilde{N}_t = N_t / L_t .$$

In the steady state, the transformed variables for capital and labour inputs, for transfers and for the age-distribution of agents in the economy are constant over time. The untransformed variables therefore all grow at constant rates.

Definition: A steady-state open economy equilibrium is $\{\{\tilde{c}_{i,h_i}, \tilde{a}'_{i,h_i}\}_{\forall i,h_i},$ $\tilde{w}, R, \tilde{K}, \tilde{K}_d, \tilde{K}_f, \tilde{L}, \tilde{T}\}$ such that:

(1) $\tilde{c}_{i,h_i}, \tilde{a}'_{i,h_i}$ are optimal decision rules $\forall i, h_i$;

(2) Input markets are competitive: $\tilde{w} = F_2(\tilde{K}, \tilde{L})$ and $R = 1 + F_1(\tilde{K}, \tilde{L}) - d$, with R set on international markets, and here assumed constant;

(3) The allocations are feasible:

(i) Domestic asset holdings equal domestic capital $\tilde{K}_d = \Sigma_{i,h_i} \tilde{m}_{i,h_i} \tilde{a}_{i,h_i} /(1+n)$;

(ii) Foreign capital is the difference between total capital and domestic capital: $\tilde{K}_f = \tilde{K} - \tilde{K}_d$;

(iii) Total aggregate wealth equals total consumption and next period domestic asset holdings:

$$\tilde{w}\tilde{L} + \Sigma_{i,h_i} \tilde{m}_{i,h_i} \tilde{a}_{i,h_i} R /(1+n) = \Sigma_{i,h_i} \tilde{m}_{i,h_i} \tilde{c}_{i,h_i} + \Sigma_{i,h_i} (1+g) \tilde{m}_{i,h_i} \tilde{a}'_{i,h_i} ;$$

(4) The number of employed is $E = \Sigma_i p_i^e m_i$, the number of unemployed is

$U = \Sigma_i p_i^u m_i$. Effective labour supply is $\tilde{L} = \Sigma_i \tilde{m}_i p_i^e e_i$;

(5) Transfers to the adult population equal accidental bequests:

$\tilde{T} = \Sigma_{i,h_i} \tilde{m}_{i,h_i} (1 - s_i) R\tilde{a}_{i,h_i} / \tilde{N}_a (1+n)$, where N_a denotes the number of adults in the steady-state population.

(6) Government saving (primary surplus) is equal to the total amount of premiums received less total benefits paid and is set to zero,

$\tilde{S}_g = \Sigma_i (pp_i^e - b_i p_i^u) \tilde{m}_i w e_i = 0.$

The method of computing the steady state is similar to that of Wilson (2001b and 2001c). First, the average total labour endowment of employed agents in the economy is calculated. Then, given benefit rates, b_i, the average total amount of employment insurance and pension benefits are calculated. The premium rate, p, is then set, and a guess of the transfer, T, is made. Given the level of transfers, the level of optimal asset holdings of agents in the economy can be computed recursively. The values of accidental bequests (transfers) are calculated and compared to the guessed level of transfers. If the two values are equal the procedure is completed. Otherwise, the guessed level of transfers is updated and the computational procedure is repeated until convergence is achieved.[3]

III. Model Calibration

In the model economies to be examined, each period corresponds to one year. Agents face uncertain lifespan, and may live up to a maximum of 95 years. Agents begin supplying labour and making decisions at 20 years of age, and fully withdraw from the labour force at 65. Agents face employment uncertainty, but there is no aggregate uncertainty. Agents accumulate capital under the precautionary and retirement motives to

[2] The model economies in many cases have rates of interest in excess of the rates of population growth, meaning that steady-state deficits will cause a continually rising debt to output ratio.

[3] A more detailed description is included in the appendix.

supplement income derived from the government insurance and pension programs, in order to smooth consumption over the lifecycle, when retired and when unemployed.

Population

A no-migration scenario was assumed for simplicity.[4] Age-specific survival rates were derived from the ratio of the population to the population plus deaths at each age. This ratio was calculated using the 1987 statistics for Canada, from the CANSIM database (Statistics Canada). The survival estimates are calibrated so that all agents die before 95 years of age. Fertility rates were constructed using the 1987 age-specific fertility rates of females from Statistics Canada (1993) in five-year cohorts from 15-19 years of age, to 45-49 years of age. Fertility rates were assumed constant over all ages in each cohort group. The sex ratio of births in Canada over 1960-2000 averaged 1.055 males for every female. In the model economies, the male-female split among newborns is set to 1.055:1.

The resulting steady-state population distribution for Canadian males was then used for the model economy. This was done for simplicity, to eliminate modeling female fertility decisions, and labour force participation decisions during child-rearing years. Given the survival and fertility rates for Canada in 1987, and a no-migration process, the population growth rate in the steady state was calculated to be –0.79%. A second model economy was calculated using fertility rates of Canadian females in 1970, which results in a steady-state population growth rate of 0.43%.[5] The steady-state population distributions are presented in Figure 4.

Earnings

The age profile of labour endowment is adapted from the average earnings levels of CPP Male contributors in 1987, from Health and Welfare Canada (1989:Table 13), for agents between the ages of 20 and 64 (inclusive). The employment insurance benefit rate is set

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[4] This is done to eliminate complications that arise in trying to model differences in immigrant wealth holdings upon arrival and labour market characteristics in economies with employment uncertainty. See Storesletten (2000) for an illustration of modeling these differences in economies without employment uncertainty.

[5] The steady-state population calculation procedure is described in the appendix.

at 45% of earnings for i = 20 to 64.[6] The pension benefit profile is derived from the average amount of monthly benefits put into play for males, in 1987, of $305, an annual amount of $3,660 (Health and Welfare Canada (1987)). The endowment level at age 65 is set to the annual amount $3,660. The pension benefit profile declines at a rate of $(1+g)^{-1}$ after the age of 65, because wages are growing at rate g, and so each successive generation earns an average lifetime wage $(1+g)$ higher than the preceding generation. Pension benefits in Canada are indexed with the CPI, and so, will remain constant in real terms over an individual agents retirement years. The benefit rate is set to 1 for i = 65 to 94. The earnings and pension benefit profile is depicted in Figure 5.

Employment Uncertainty

Employment uncertainty was modeled by using the age-specific unemployment rates for males between the ages of twenty and sixty-four. Three different scenarios were examined. The first scenario assumes a low unemployment rate, using the age-specific unemployment rates for males in 1979. The second assumes a medium unemployment rate, using the age-specific unemployment rates for males in 1987. The third scenario uses the unemployment rates for males in 1992.[7] Agents in the model economy are either employed or unemployed. All agents are willing to work, but those who are unemployed cannot work due to a shortage of demand, and wages do not adjust to clear the market. The probability of being unemployed in a given period for an agent is unrelated to the probability of being unemployed in any other period. The moral hazard problem that arises with the existence of an unemployment insurance program is not considered (see Hansen and Imrohoroglu (1992)).

Preferences and Technology

The values of b and s were set to 1.011 and 1.12, following the estimates established by Hurd (1989). The production function is a standard Cobb-Douglas with the share to capital, a, set to 0.30. Depreciation is set at 0.06. The scale parameter, B, is set to 0.4, to

[6] The average weekly benefit was approximately 45% of the average weekly earnings over 1972-1994 (Statistics Canada (1995: 50)).
[7] Figures from CANSIM database.

keep the optimal asset holdings within the grid specified in the appendix. The value for *g*, technological progress is set at 0.01, 0.02, and 0.03. The real interest rate is also set to 0.01, 0.02, and 0.03. Table 1 presents model parameters that are fixed in the analysis.

IV. Model Results

The results for model economy 1, with a relatively high proportion of middle-aged in the population as shown in Figure 4, are presented in Table 2. These results indicate that, all else equal, an increase in the unemployment rate does not affect the personal savings rate. An increase in the rate of unemployment is associated with a decrease in output and total personal saving, however, the personal savings rate in the aggregate is unchanged (or rather, the change is negligible). At the individual level, those who are employed save more when the unemployment rate is high due to the increase in employment uncertainty in the future.

Unlike the unemployment rate, interest rates do have an impact on the personal savings rate in the aggregate. As the interest rate rises, the substitution effect dominates the income effect, and savings are increased. The results for model economy 2, with a younger population, are presented in Table 3 (different rates of unemployment were not presented since the unemployment rate has a negligible effect on personal savings rates). These results support the findings of Burbidge, Fretz and Veall (1998). The personal savings rate in Canada tracks the interest rate over the period of study. One must note, however, that the personal savings rate tracks the nominal interest rate more closely than the real interest rate, especially in light of the divergence between the nominal and real interest rates in the mid-1970s.

In the US, the personal savings rate appeared to be insensitive to interest rate movements. Burbidge, Fretz and Veall (1998) have shown that the increase in the Canadian personal savings rate was primarily due to the decrease in financial liabilities, in the face of large interest rates. Mortgage interest is not tax deductible in Canada, whereas it is in the US. However, Bosworth, Burtless and Sabelhaus (1991) show that changes in savings rates of homeowners in Canada were similar to those of renters, so it is unclear whether one can ascribe differences in savings to tax policy. In the US, the capital gains-inclusive savings rate does show a sustained rise in the late 1970s and 1980s when interest rates were high. This measure also shows a remarkable rise in the savings rate in the mid to late 1990s as a result of a booming stock market, while at the same time, the traditional measure of savings rates declined to –1.1% in the second quarter of 1999 (Gale and Sabelhaus (1999), Gordon (2000: 509-513)). A further investigation into these facts is left for future work.

Figure 2 shows that the government savings rate is tied closely with the unemployment rate. As the unemployment rate has risen, the government budget surplus has plummeted. However, the Employment Insurance program does not cover all individuals who are unemployed. For example, many may not qualify for benefits, and many will be unemployed for a period that outlasts their eligibility to receive benefits. In these cases, welfare programs are the last line of assistance. Canada has seen a dramatic increase in the number of social assistance recipients over the last three decades. In the early 1970s, six percent of the Canadian population received social assistance. By 1994, 10.6% of the population relied on welfare benefits. As the unemployment rate has trended upwards since 1970, so too has the ratio of individuals characterized as "unemployed employable" recipients to the total number of recipients. In the early 1970s, between 10 and 20 percent of recipients received welfare due to unemployment. By 1993, 45 percent of recipients were the "unemployed employable" (Rosen et al, 1997: 277-8). So, as the unemployment rate has increased, public expenditures on employment insurance benefits and social assistance have increased. As a result, the government savings rate in Canada has fallen. While increased expenditures in these programs are not the only reasons for the decline in the government surplus, they are major items of government spending (the EI program is the Canadian government's single largest expenditure program).

The model economies examined were constrained to cases where the government budget balanced. For model economy 1, an increase in the unemployment rate from 5.2% to 10.1% causes an increase in the payroll tax rate from 6.9% to 10.1%, an increase of three percentage points. If the government were to run a deficit (or a surplus) in these steady-state equilibria, with the rate of interest greater than the growth rate of GNP, the debt (or wealth) to income ratio of the government would grow continuously, and be unsustainable at some point in time. During business cycles, the unemployment rate may fluctuate widely while the employment insurance premium tax rate will not, since the employment insurance program is designed as an automatic stabilizer in the economy. The EI program runs surpluses during most years to fund deficits in periods of high unemployment. Thus, over the business cycle, individuals may assume that temporary changes in the unemployment rate will not result in changes in the payroll tax rate. In this case, a temporary increase in the unemployment rate without a corresponding adjustment to the payroll tax rate will lead to a government deficit without a compensating increase in personal savings. As a computational example, if model economy 1 with an unemployment rate of 10.1% had a payroll tax rate of 8.1% (or 6.9%) instead of 10.0%, the government would run a primary deficit of 1.3% (or 2.2%) and the personal savings rate would increase by 0.2 percentage points (or 0.4 percentage points) based on steady-state equilibrium calculations.[8] These results, though unsustainable in the long-run, are instructive since equilibria with government deficits or surpluses are sustainable in the short run.[9] This indicates that decreases in government saving will not be offset by increases in personal saving over the business cycle.

The model economy results show that the personal savings rate in the aggregate, for life-cycle economies with employment uncertainty, are not sensitive to the unemployment rate, but will vary with the interest rate. When the rate of interest rises, the net personal savings rate also rises as the substitution effect dominates the income effect. However, changes in the unemployment rate will affect the level of government saving if the government uses the employment insurance program as an automatic stabilizer and attempts to maintain stable payroll tax rates over the business cycle. In the case of Canada during the 1970s and 80s, the decline in the aggregate savings rate is the result of government dissaving during periods of high unemployment. The decline in the savings rate would have been much more pronounced if the interest rate remained constant over this period. Instead, the rise in the interest rate in the late 1970s and early 1980s led to an increase in the personal savings rate to partially compensate for the decrease in the government savings rate. The model results also lead one to predict that the aggregate

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[8] These results hold for a model economy with the rate of interest set to 2% and the growth rate set to 2%, but do not vary significantly in the other cases examined in Table 2. The personal savings rate increases slightly because agents' after-tax pay is slightly higher than the case with a higher payroll tax rate.

savings rate will fall in the coming year if economic growth continues to stall and the interest rate remains low with the Bank of Canada's stimulative monetary policy. These results confirm the findings of Bosworth (1991) and Summers and Carroll (1987) where it is shown that the deline in savings internationally coincides with the decline in government surpluses, and the conclusion is made that the policy response to the low savings rate should be to decrease government deficits.

This paper has not focused on the positive correlation between the savings decline and the productivity decline. Other work, including Bosworth, Burtless and Sabelhaus (1991), has alluded to these trends and has stated that theoretical models, of consumers who base their decisions on forward-looking rational expectations, show that productivity growth and savings rates should be negatively related. However, the model results presented in this paper show otherwise, and are based on model economies populated by rational forward-looking agents. There are ranges of productivity growth where increases (or decreases) in growth lead to increased (or decreased) rates of saving (see Tables 2 and 3), and these ranges may vary for different types of population distributions. A thorough investigation into these results is beyond the scope of this paper, and is left for future work.

V. Conclusion

Should we be surprised with the decline in the aggregate savings rate in Canada? Has Canadian saving behaviour over the last forty years been inconsistent with life-cycle model results in the face of changing economic conditions? The answer to these questions appears to be no. So then, why was the aggregate savings rate so low in the eighties and early nineties? Model economy results suggest that the savings rate was low because interest rates were falling, and the government was running deficits. The savings rate has recently increased slightly due to the change from a government deficit position to a surplus. If interest rates rise in the future we should expect personal savings rates to also rise. Heading into 2002, interest rates are low, job losses are mounting and fears of a recession are being fulfilled. One would expect the unemployment rate to rise, and

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[9] A more thorough examination of business cycles and their impact on personal and government saving in a transitional environment will be left for further work.

government savings to fall, but personal savings will remain low due to the low rate of interest.

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Appendix

Steady-State Population Distribution

The age distribution of the population at a point in time is denoted by the (2*I* x 1) vector m_t, where $m = [\, m_{1,f}\ m_{2,f} \ldots\ m_{I,f}\ \ m_{1,m}\ m_{2,m}\ \ldots\ m_{I,m}\,]^T$. Agents of age *i*, and gender *h* (*f* for females and *m* for males), face a probability $s_{i,h}$ of surviving from the age of *i* to the age of *i*+1 that is constant over time. The unconditional probability of surviving to age *k* is $s(k) = \Pi_{j=1}^{k-1} s_j$. The vector of age and gender specific fertility rates is *f*, and is assumed constant over time. The number of gender newborns at time t is:

$$m_{1,k,t} = \sum_{i,h} f_{i,h}^{k} m_{i,h,t-1}$$

where k denotes the gender of the newborn, and h denotes the gender of the agent (birth-parent). The population of age i agents (where $i > 1$) at time t is:

$$m_{i,h,t} = s_{i\text{-}1,h} m_{i\text{-}1,h,t\text{-}1}.$$

The law of motion of the population is represented by the matrix Γ, where, Γ =

$$\begin{bmatrix} f^f{}_{1,f} & f^f{}_{2,f} & \dots & f^f{}_{I-1,f} & f^f{}_{I,f} & f^f{}_{1,m} & \dots & f^f{}_{I-1,m} & f^f{}_{I,m} \\ s_{1,f}(1+q_{1,f}) & 0 & \dots & 0 & 0 & 0 & \dots & 0 & 0 \\ 0 & s_{2,f}(1+q_{2,f}) & \dots & 0 & 0 & 0 & \dots & 0 & 0 \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & \dots & s_{I-1,f}(1+q_{I-1,f}) & 0 & 0 & \dots & 0 & 0 \\ f^m{}_{1,f} & f^m{}_{2,f} & \dots & f^m{}_{I-1,f} & f^m{}_{I,f} & f^m{}_{1,m} & \dots & f^m{}_{I-1,m} & f^m{}_{I,m} \\ 0 & 0 & \dots & 0 & 0 & s_{1,m}(1+q_{1,m}) & \dots & 0 & 0 \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & \dots & 0 & 0 & 0 & \dots & s_{I-1,m}(1+q_{I-1,m}) & 0 \end{bmatrix}$$

so that $m_t = \Gamma m_{t\text{-}1}$.

In order to compute the steady-state of the model economy, the steady-state age distribution of this economy must be derived. To do this, the eigenvalues and eigenvectors of the matrix describing the law of motion of the population are computed. The largest eigenvalue of the matrix Γ is equal to the steady-state growth rate of the population. The steady-state age distribution of the population is defined by the product $m^* = \tilde{\Gamma}^b m$, where each element of $\tilde{\Gamma}$ is equal to the corresponding element of Γ scaled by its' largest eigenvalue, and where b is sufficiently large so that $\tilde{\Gamma}^{b+1}m - \tilde{\Gamma}^b m \cong (0)$.

Solution Method

In the small open economy framework the return on capital is determined on international markets. Given the steady-state age distribution, the aggregate steady-state capital stock is calculated by solving the equation that defines the return on capital. Wages are set to the marginal productivity of labour. Steady-state equilibria are computed using the following algorithm:

(1) Given there is no aggregate uncertainty, calculate the expected value of the aggregate labour supply, the expected value of the capital stock, total output, and the wage rate. Then, given the insurance benefit rate, and the expected

number of unemployed agents and the number of pensioners of each age cohort, calculate the premium rate.

(2) Guess the value for the transfer of accidental bequests, $\tilde{T}$.

(3) Calculate the optimal decision rules, $\tilde{c}$, $\tilde{a}'$, of all agents aged I_w (15) to I (94), with the values of $\tilde{a}_{I_w - 1}$ and $\tilde{a}_{I+1}$ set to zero, and aggregate over the model economy. To do this, the individual's dynamic programming problem must be solved:

$$V(\tilde{a}, l, i) = \max_{(\tilde{c}, \tilde{a}')} u(\tilde{c}) + b(1+g)^{1-s}\ s(i) E[V(\tilde{a}', l', i+1) \mid (\tilde{a}, l, i)],$$

subject to,

(a) $\tilde{c} + \tilde{a}'(1+g) \leq R\tilde{a} + (1-p)\tilde{w} l(i) e(i) + b\tilde{w}(1 - l(i)) e(i) + \tilde{T}$

(b) $\tilde{c} \leq 0, \tilde{a}' \leq 0, \tilde{a} = 0$ if $i = I_{w-1}$ or I.

(c) $l(i) = 1$ with prob = p_i^e and 0 with prob 1- p_i^e .

The decision rules are calculated by maximizing the value function on gridpoints defined over the state space. 2000 evenly spaced gridpoints were used for the asset variables a and a', and two gridpoints were used for l. For each period of an individual's life, the value function was calculated on eight million gridpoints. The optimal value of a' for a given value of a and l was that value where the value function was maximized.

(4) Construct population samples with random labour characteristics using the age-specific labour endowments and employment probabilities. Calculate the asset holdings of each agent of the sample, given his employment history. For each population sample, calculate the value of accidental bequests, $\tilde{T}$, from a random sample of agents from each cohort who die within in a given period, for each population sample, and find the average over samples.

(5) If the average value of $\tilde{T}$ calculated in step (4) differs from the initial guess in step (1), repeat the procedure using the result from step (4) as the initial guess until convergence is achieved.

The population samples were constructed using the steady-state population distribution for the model economy. Thirty samples of fifty thousand agents were used to find the average values in step (4).

Table 1: Fixed Model Parameters

a	*b*	*d*	*s*	I_w	I_r	*I*	b_{20-64}	b_{65-94}	*s*
0.3	1.011	0.06	1.12	20	65	94	0.45	1	1987 rates, Canada

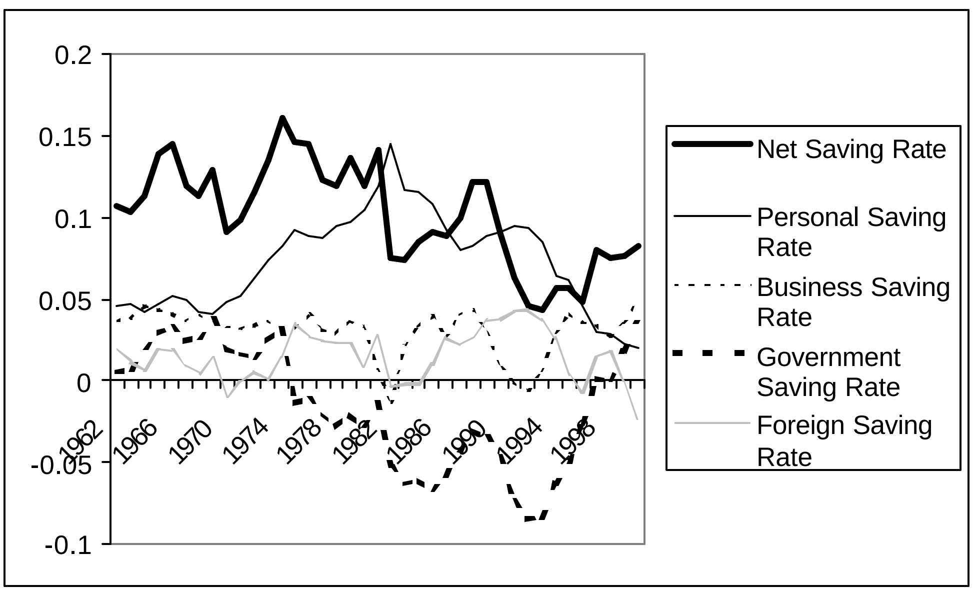
Table 2: Model Economy 1 Results

	Model Economy 1 (*n* = -0.79) All figures in percentages								
Aggregate Unemployment Rate		5.2			7.5			10.1	
Payroll Tax Rate (*p*)		6.9			8.1			10.0	
Productivity Growth Rate (*g*)		**1.0**			**1.0**			**1.0**	
Interest Rate (*r*)	1.0	2.0	3.0	1.0	2.0	3.0	1.0	2.0	3.0
Aggregate Savings Rate	0.9	1.2	1.5	0.9	1.2	1.6	0.9	1.2	1.5
Foreign Capital Inflow Rate	0.0	-0.5	-0.9	0.0	-0.5	-1.0	0.0	-0.5	-0.9
Productivity Growth Rate (*g*)		**2.0**			**2.0**			**2.0**	
Interest Rate (*r*)	1.0	2.0	3.0	1.0	2.0	3.0	1.0	2.0	3.0
Aggregate Savings Rate	3.6	5.0	6.5	3.6	5.0	6.5	3.6	4.9	6.4
Foreign Capital Inflow Rate	1.6	-0.5	-2.7	1.7	-0.5	-2.7	1.7	-0.4	-2.7
Productivity Growth Rate (*g*)		**3.0**			**3.0**			**3.0**	
Interest Rate (*r*)	1.0	2.0	3.0	1.0	2.0	3.0	1.0	2.0	3.0
Aggregate Savings Rate	4.5	6.3	8.5	4.5	6.3	8.5	4.5	6.2	8.4
Foreign Capital Inflow Rate	5.2	2.1	-1.3	5.2	2.2	-1.2	5.2	2.2	-1.3

Table 3: Model Economy 2 Results

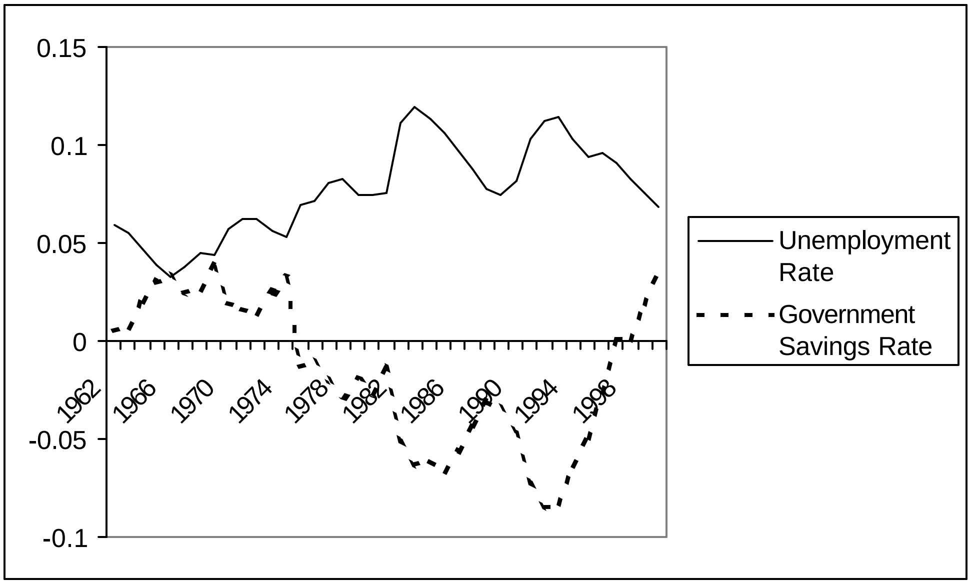
	Model Economy 2 (n = 0.4) All figures in percentages		
Aggregate Unemployment Rate		7.8	
Payroll Tax Rate (p)		6.7	
Productivity Growth Rate (g)		**1.0**	
Interest Rate (r)	1.0	2.0	3.0
Aggregate Savings Rate	5.5	7.4	9.4
Foreign Capital Inflow Rate	0.6	-2.2	-5.2
Productivity Growth Rate (g)		**2.0**	
Interest Rate (r)	1.0	2.0	3.0
Aggregate Savings Rate	6.4	9.1	11.6
Foreign Capital Inflow Rate	4.2	0.3	-4.0
Productivity Growth Rate (g)		**3.0**	
Interest Rate (r)	1.0	2.0	3.0
Aggregate Savings Rate	6.0	8.6	11.7
Foreign Capital Inflow Rate	9.0	4.6	-0.3

Figure 1: Canadian Net Savings Rates, 1962-2000



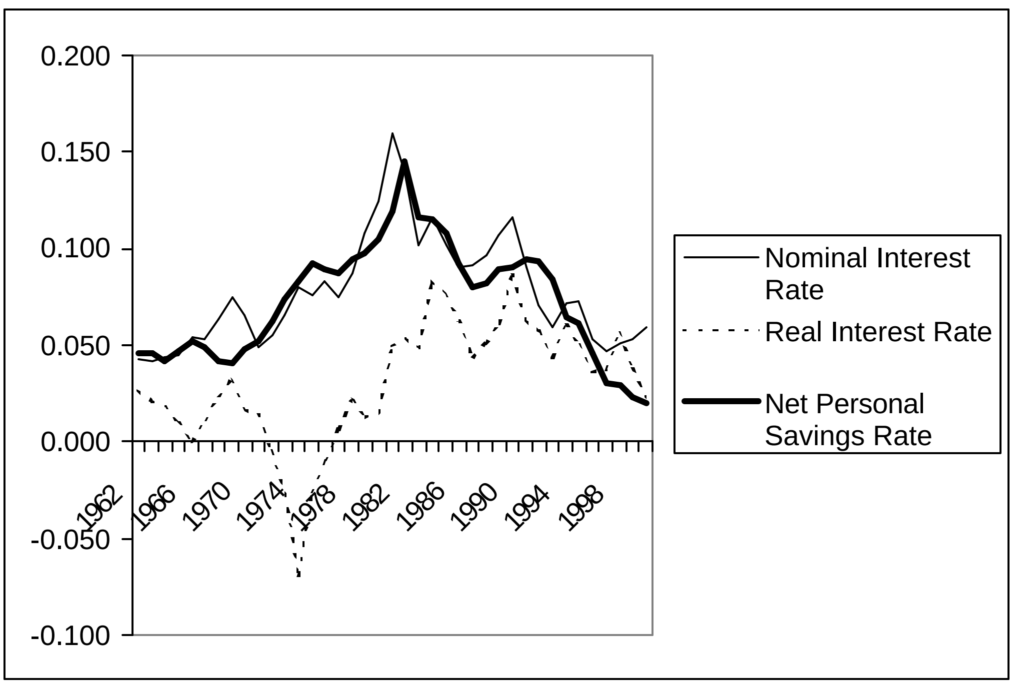
Source: CANSIM Matrices 8614, 8629.

Figure 2: Canadian Government Savings Rate and Unemployment Rate, 1962-2000



Source: Unemployment rate – Urquhart and Buckley (1981), 1962-1965, CANSIM series label D44950, 1966-1980, CANSIM series label D28599, 1981-2000.

Figure 3: Canadian Interest Rates and Personal Savings Rates, 1962-2000



Source: CANSIM; interest rate series – Government of Canada Bonds, average yields, 1-3 year bonds (annual average), label v122558; implicit price deflator, label D23203.

Figure 4: Steady-State Population Distribution

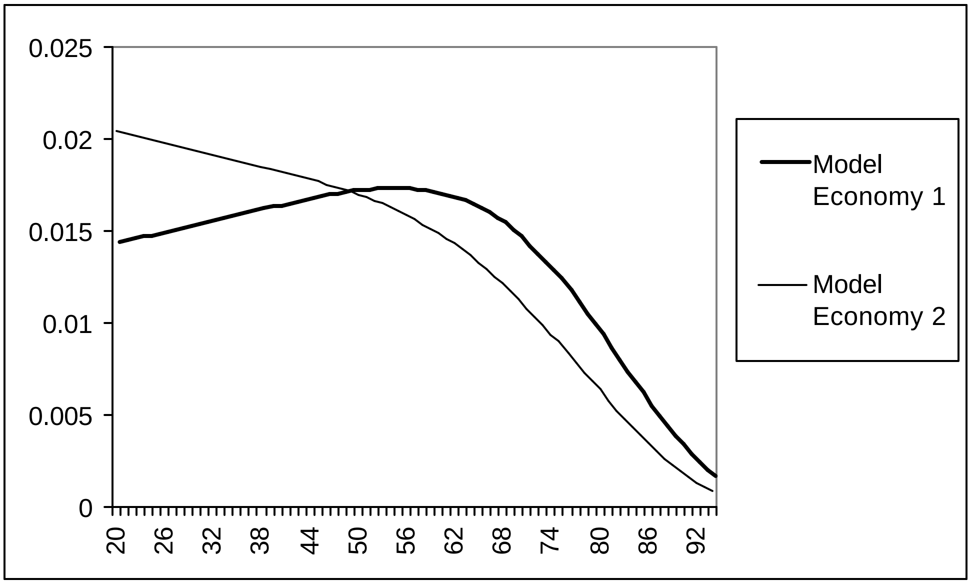


Figure 5: Model Economy Earnings and Pension Benefit Profile