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ABSTRACT

This paper uses the Auerbach-Kotlikoff Dynamic Simulation Model to compare the projected demographic transitions in Canada and the United States. The simulation model determines the perfect foresight transition path of an economy in which individuals live to age 75. The model's preferences are life cycle augmented to include utility from bequests. In addition to handling changes in demographics and fiscal policies, the model can be run for closed or open economies.

In comparing Canada with the U.S., we first simulate the U.S. demographic transition, treating the U.S. as a closed economy. The time path of interest rates obtained from the U.S. simulations are then used in the Canadian simulations. In the Canada simulations, Canada is assumed to be an open economy which takes the U.S. interest rate as given.

The simulations indicate that demographics are likely to have significant effects on rates of saving and taxation in both the U.S. and Canada. However, the more abrupt demographic transition in Canada combined with the projected maturation of Canadian social security system leads to a more severe predicted long term decline in Canadian saving rates. Despite the predicted lower saving rates, capital deepening is likely to occur in both countries, and the associated increase in real wages is likely to more than offset projected higher tax rates, leaving the growth-adjusted welfare of future generations higher than that of current generations.

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1. Introduction

Recent political and economic events, such as the U.S.-Canada free trade agreement and the generally increasing integration of world capital markets, have strengthened the already close ties between the economies of the United States and Canada. These close ties, along with the two countries' shared cultural and economic characteristics, have provided researchers with a good justification for using the experience of one country to draw inferences about the effects of potential policy changes in the other (e.g. Carroll and Summers, 1987).

In this paper, however, we are concerned less with the lessons of policy differences than with their potential spillover effects. In particular, we shall consider how demographics and fiscal structure are likely to interact over the next several decades in influencing each country's rate of capital accumulation, and the implications of differences in projected saving with respect to patterns of trade and capital flows between the two countries. A U.S.-Canada comparison on this issue promises to be particularly interesting because the countries' future demographic characteristics are projected to be quite different and their fiscal systems for providing public expenditures for the elderly are also quite different.

Changes in population structure and fiscal policy are related in a very complex manner, and an accurate perspective on this relationship requires that one account for the general equilibrium effects of significant policy changes. For example, demographic changes leading to a higher dependency ratio of nonworking to working population may also induce saving and labor supply responses which, in turn, may affect capital-labor ratios and real wages, softening the increase in tax burden required to finance public old-age support programs. To provide such general equilibrium analysis, we utilize the model presented in Auerbach and Kotlikoff (1987) and extended in Auerbach et al (1989).

In the paper's next section, we review the model and how it will be applied to the current problem. Section 3 presents the data for the United States and Canada that are used to calibrate the model for the experiments we wish to consider, and section 4 presents the simulations of the model for the two countries. We offer some concluding comments in section 5.

2. Modelling a Demographic Transition

The model used in this paper is a numerical, general equilibrium simulation model of a single country, which we calibrate separately to study each country. This is a modified version of the model used by Auerbach et al (1989) in a related comparison study of the demographic transitions in four OECD countries, Japan, Sweden, the United States and West Germany. It contains three sectors: a household sector, a production sector, and a government sector. The optimal behavior of each sector gives rise to nonlinear equations, which are combined to solve numerically for a perfect foresight transition path for the economy as a whole that is consistent with the behavior of individual agents.

Among the features that distinguish this model from other general equilibrium models are its fully dynamic character, its specification of life-cycle household behavior, augmented to include bequests, and its explicit treatment of family structure and demographics. As we have described the model in some detail in our earlier work, we present only a brief review of the model here, concentrating on the features that are particularly relevant and the changes that have been made for the current investigation.

A. Household Behavior

At each date, the household sector comprises seventy-five overlapping generations, corresponding to children aged 1 to 20 and adults aged 21 to 75. Each year all the 75-year-olds die (there being no uncertainty in the model) and new children are born. At age 21, each individual changes status from child to adult and at the same time becomes the parent of a number of children determined exogenously by the model (but allowed to vary over different generations). Each generation between ages 21 and 75 has a representative household that consists of an adult and (for adults aged 21 to 41) that adult's minor children.

Each household maximizes an identical utility function of its lifetime consumption, labor supply, and bequests that is assumed to take the form:

$$(1)\quad U_t = \sum_{j=21}^{75}(1+\delta)^{-(j-21)}u_{pjt} + N_t\sum_{j=21}^{40}(1+\delta)^{-(j-21)}u_{kjt} + N_t(1+\delta)^{-54}u_{bt}$$

where δ is a pure rate of time preference, N_t is the number of children per parent, and u_{pjt}, u_{kjt}, and u_{bjt} are the instantaneous period utilities generated by parent's consumption, children's consumption and the parent's bequest per child, at age 75. The annual utility components, u_{pjt} and u_{kjt}, are functions of contemporaneous consumption and leisure assumed to have the constant elasticity-of-substitution form:

$$u_{ijt} = \omega_{ij}\left(c_{ijt}^{1-1/\rho} + \alpha\, \ell_{ijt}^{1-1/\rho} \right)^{\frac{1-1/\gamma}{1-1/\rho}} \qquad i = p, k \tag{2}$$

where c_{ijt} and ℓ_{ijt} are, respectively, consumption and leisure of the generation t parent and this adult's child at the parent's age j. The term α is a leisure share parameter, while ρ and γ are, respectively, the intratemporal and intertemporal elasticities of substitution. In the model, retirement occurs endogenously when an individual chooses to consume his entire labor endowment as leisure. The term ω_{ij} is a weighting parameter, meant to account for the smaller consumption needs of children. It is set equal to 1 for adults and grows linearly from .25 to .50 for children between the ages of 1 and 20.

The utility of bequests term is assumed to take the form:

$$u_{bt} = \beta\, b_t^{1-1/\gamma} \tag{3}$$

where b_t is the bequest made to each child by adults in generation t and β is a preference parameter indicating the intensity of preferences for bequests. When $\beta = 0$, no bequests are left.

Households maximize the utility function (1) subject to a budget constraint that the present value of the labor endowment of the adult (from age 21 to 75) and the child (from age 1 to 20) plus the adult's inheritance, (received at age 55 from a dying parent) equal the consumption and leisure of the adult and child and the bequest left by the adult. Each individual's wage rate (adjusted for productivity growth) grows from childhood through late adulthood and then falls, reflecting observed empirical patterns.

The presence of government policy alters this budget constraint in several ways. The model includes proportional taxes on labor income, capital income, and consumption which affect the after tax wage, interest rate, and price of consumption goods, respectively. These taxes are assumed to finance general expenditures that do not directly influence the private decisions of households.

In addition, there is an autonomous social security system that finances public old-age pensions through a payroll tax. If each individual's pension were actuarially based on his own contributions, it would be appropriate to view payroll taxes as forced saving which (in our model without liquidity constraints) would not be perceived as "taxes" at all and would have no effect on the individual's choices. However, in both the United States and Canada, public pensions are only imperfectly related to individual payroll taxes. Hence, we assume that households consider a fraction λ of all payroll taxes as if they were ordinary taxes on labor income, treating the remaining payroll taxes and all benefits as if they were simply lump sum taxes and transfers, respectively.

B. Firm Behavior

The model has a single production sector that is assumed to behave competitively, using capital and labor subject to a constant-returns-to-scale Cobb-Douglas production function with capital's share of production (net of depreciation) equal to .25. Capital and labor are each homogeneous and assumed to be perfectly mobile within each country.[1] We assume that the economy experiences an exogenous, constant rate of technological change, set equal to 1.5% in all the paper's simulations.[2]

C. Government

As already mentioned, we divide the government into two sectors, a public pension system financed by payroll taxes and a general sector financed by proportional taxes on labor income, capital income and consumption. The model's social security benefits are determined as a fraction of the average of wage-indexed labor earnings from age 21 through the social security age of retirement (which may differ from the age of true retirement). The wage-indexation procedure involves multiplying earnings in years prior to the social security retirement age by the ratio of the standardized wage at retirement, adjusted for the 1.5 percent rate of technological change, to the standardized wage in the past year in which earnings were received.

Within the general government sector, we distinguish four categories of spending. One category, meant to encompass items such as national defense, is assumed to be independent of the age structure of the population, growing at a rate equal to the sum of the population's growth rate and the rate of technological change. The other expenditure categories are those targeted at three age groups, 1 to 24, 25 to 64, and over 65. In our baseline simulations, we calculate the shares of total spending accounted for by each type of targeted spending in 1985, and assume that thereafter the growth rates of each of these categories of expenditure equals the rate of technological progress plus the growth rate of the relevant age group. Hence, overall government spending will grow more quickly as the population shifts to a category that receives more age-specific expenditures per capita.

In addition to taxes and spending, the government is assumed to utilize public debt in financing its operations. The patterns of spending and revenues for both the general and social security sectors of the government are required to satisfy an intertemporal budget constraint specifying that initial debt plus the present value of expenditures equal the present value of taxes. We assume that debt per capita is constant (normalized for productivity growth) and use the level of debt as an initial condition in calibrating the model.

D. Solution for Equilibrium

Each country's economy is assumed to be in a steady state equilibrium in 1960, at which time a demographic transition begins. We study changes in government policy and population structure that take place over the period 1960-2050, after which time we impose the assumption that no further policy changes occur and birth rates are consistent with zero population growth. The economy is then allowed to converge to a new steady state, for which we allow an additional 160 years. Although the behavior of the economy during these later years is not of particular interest or relevance, such future conditions must be incorporated into the model to accommodate our assumption that households during the first 90 years have perfect foresight with respect to the economy for the remainder of their own lifetimes, which may extend well beyond the year 2050.

Since our model can only be solved for one country at a time, we approximate a full, two-country general equilibrium solution in the following way. We solve first for the equilibrium path of the United States, treating it as a closed economy by imposing the constraint that national saving equal national investment. We then take the implied U.S. interest rate for each year and assume that Canada is a small country that takes these (and hence the wage rate as well) as given.[3] Current account imbalances do arise in the solution for Canada, but not for the United States.

3. Calibrating the Model

For every simulation, projections begin in 1960 in order to produce conditions in the 1980s that actually prevailed, including the non-steady-state structure of the population. For both countries, the model's parameters are adjusted so that simulated household behavior patterns are realistic and aggregate variables match those actually observed during the period 1960-85. The targeted variables are the rate of national saving, the social security contribution rate, the share of government spending in national income, and the taxes rates on consumption, labor income, and capital income.

A. Demographics

We choose the birth rates N_t for the years 1961-2050 in order to approximate, as closely as possible, values by decade of the age distribution of the population, based on OECD data. Table 1 provides historical age distributions for 1960-1980 and projected age distributions for 1990-2050 for the U.S. (panel a) and Canada (panel b).[4] The table also presents the age distributions generated by the birth rates used in our model simulations.

The actual data show that Canada had a younger population in 1960, with 33.7% of the population below age 15 and 7.6% above age 65, compared to 31.0% and 9.2%, respectively, for the United States. However, by 1990, the population age structures have become more similar, with Canada still having a slightly smaller fraction above age 65, but the United States having a larger fraction under age 15. Both populations have aged considerably since 1960, with the fraction below age 15 dropping from about one-third to about one-fifth.

Beyond 1990, the projections indicate a much more gradual demographic transition for the United States than for that in Canada. By the year 2000, Canada is predicted to have a larger fraction of its population in the over-65 category as well as a smaller fraction younger than 15. The gap continues to widen for several more decades, until the age structures finally begin to converge again near the year 2050.

As can be seen by comparing the model's age distributions to these actual population figures, the assumed fertility patterns of the model provide a reasonably good approximation of the projected demographic transitions in both countries, at least if the age groups 55-64 and 65+ are combined.

B. Preference Parameters

There are several parameters which must be set in specifying household behavior. These are γ, the intertemporal elasticity of substitution, ρ, the intratemporal elasticity of substitution, α, the leisure intensity parameter, δ, the pure rate of discount, and β, the bequest intensity parameter. Following our past modelling work (Auerbach et al 1989), we set $\alpha = 1.5$, $\rho = .8$, and $\gamma = .35$. Because we are unaware of any evidence about the relative importance of bequests in the two countries, we use the same value of β for each country, 15,000,000.[5] Finally, we choose δ to ensure that the national saving rates in 1960 match actual national saving rates in each country. The resulting values are $\delta = 0$ for the United States and $\delta = 0.006$ for Canada.[6] This (as well as fertility) is the only difference between Canadian and U.S.

households in our model, although government policies also contribute to differences in simulated household behavior.

C. Fiscal Parameters

In 1960, tax rates for each country on capital and labor income are set at historical values of the average rates of tax on these types of income, according to the OECD Revenue Statistics.[7] We do the same for consumption taxes, and choose the initial level of government debt to produce the 1960 share of government in GDP for each country.

Between 1960 and 1985, income tax rates are kept at their historical levels, while we adjust the growth rate of government spending (measured net of the rate of growth of population plus total factor productivity) to ensure that the remaining general fiscal instrument, the consumption tax rate, also follows the appropriate trend between 1960 and 1985.

Although the normal age of initial public pension receipt is 65 in both countries, the systems and their funding differ considerably. In the United States, the primary function of the Social security system historically has been the provision of old age and survivors' pension benefits (OASI), although it also provides disability insurance (DI) and the growing health insurance (HI) component, Medicare. At the same time, the primary source of revenue for the OASDHI system, and the sole source of revenue for the pension component, has been the payroll tax.

In Canada, however, the payroll tax has traditionally funded such important components of social insurance as unemployment compensation (funded by employer payments in the United States), while a significant component of public old-age pensions has been funded through general revenues. The

Canada/Quebec Pension Plans, like the OASI system in the United States, are financed by payroll taxes, with benefits loosely and indirectly related to past contributions. Older Canadians also receive demogrants, called Old Age Security (OAS) payments, and many also receive Guaranteed Income Supplements; both systems are financed by general revenues. According to Bird (1987), Old Age Security payments were nearly twice as large, in the aggregate, as the CPP/QPP's in 1984.

We accommodate these institutional differences by making two adjustments to each country's data so that they conform more closely to the structure of our model. The social security system we simulate is funded exclusively by payroll taxes and provides only old age-pension benefits. One data adjustment, discussed more fully below, is to include in general spending (rather than pension spending) the part of public pension spending that is funded by general revenues. Also, since all non-pension spending is excluded from our model's social security system and included instead in general spending, we reduce the measured payroll tax in each country to account for the nonpension spending financed by payroll taxes, increasing labor income taxes over their historical values by the same amount as we reduce payroll taxes.[8] The resulting adjusted values of labor income taxes and payroll taxes are shown (for 1960 and 1985) in Table 2, along with the values of capital income taxes and consumption taxes calculated from the OECD revenue data.

General (nonpension) government spending is divided into four categories: age-specific spending on the young (f_k), middle-aged (f_m) and old (f_o), and non-age-specific spending (f_n), with $\sum f_i = 1$. To determine these shares, we follow the following procedure. Using unpublished OECD data for 1985 on the levels of government expenditures on education, family benefits, health and unemployment compensation directed to each age group in each country[9], we form an estimate of the fraction of nonpension, age-specific expenditures going to each age group. We then use published data on all nonpension government spending (net of interest payments) for the same year to derive the fraction of all spending that is in these age-specific categories, and multiply this fraction by the fractions of age-specific spending on the young, middle-aged and old to arrive at the fractions f_i. Finally, we adjust the calculation by adding to age-specific spending on the old those public pension benefits that are funded by general revenues, rather than the payroll tax.

Thus, our social security system for each country accounts only for that part of old-age pensions financed by payroll taxes; all nonpension social insurance spending and all payroll taxes that finance nonpension spending are consistently accounted for in the general government budget calculations.

Based on our calculations, the government spending shares f_i for the United States are .291 (young), .060 (middle-aged), .071 (old) and .578 (non-age-specific). The corresponding shares for Canada are .306, .172, .141 and .381. Since the age distributions in the two countries were fairly similar in the 1980s, one can attribute the differences across the two countries primarily to differences in underlying policy. In Canada, relative to the United States, a much greater share of government spending (excluding payroll-tax-financed pension benefits) is targeted toward the middle-aged and the elderly. The larger old-age component in Canada is largely attributable to the large fraction of pension benefits financed by general revenues. The higher middle-age component is due to the higher levels of spending per capita on health benefits (for non-aged adults) and unemployment compensation.

Because the public pension scheme that remains is fully financed by payroll taxes, its characteristics are similar for the two countries. We set the parameter λ, corresponding to the fraction of payroll taxes actually perceived to be taxes rather than contributions, to .5 for both countries.

The final fiscal parameter, the level of initial public debt per capita, is used as a tool for achieving the correct share of government spending in the initial steady state.[10] The values chosen cause national debt to equal 46% of total private assets in Canada, and 31% in the United States.

4. Simulation Results

Our simulations for the United States are quite similar to those presented in Auerbach et al (1989).[11] For both countries, we begin by calibrating the initial steady states to match the 1960 shares of national saving and government spending in national income (GDP less depreciation), using as tools the pure rate of time preference δ and the level of initial public debt. This produces realistic values for both countries: national saving rates of approximately 10 percent for both the United States and Canada, and government shares of 20.4% of national income in the United States and 17.5% in Canada. For each country, all simulations presented share the same initial steady state.

A. Baseline Simulations

After fixing the initial 1960 steady states, we then run trial transition simulations to choose a base case rate of growth of per capita government spending that, given the assumed tax rates on labor and capital income (given in Table 2) and the level of per capita government debt established in the initial steady state, provides a consumption tax in 1985 that is consistent with the actual value that was observed.[12] The results for the base case simulations for the United States and Canada are given in Table 3. For each country, we present simulated values of several variables for the years 1960 (the initial steady state), 1985, 1990, 2010, 2030, 2050 and the "long run" (the final steady state with zero population growth).

The consumption and social security taxes for 1960 and 1985 may be compared to the actual values given in Table 2, which are closely approximated by the simulations. Table 3 also presents for each year the national saving rate (national income less private and public spending as a share of national income), the real, detrended after-tax wage rate[13] and the current account (relative to national income), which is constrained to be zero in the closed economy simulations for the United States.

As we already have discussed, the simulations are constrained to conform to fiscal measures in both 1960 and 1985, and to the aggregate national income shares of saving and government in 1960. After 1960, there is nothing to guarantee that simulated saving rates will conform closely to historical levels, and indeed the simulated patterns for both countries diverge from actual experience.

The model predicts a decline in saving for Canada and an increase in the United States between 1960 and 1990, a pattern that is precisely opposite to what actually occurred. The actual Canadian saving rate was 12.3% in 1985, and just 3.6% in the United States. These divergent trends in saving behavior over the past few decades have provoked some attempts at explanation (e.g Carroll and Summers 1987). In our own empirical analysis of the United States based on microeconomic consumption data (Auerbach and Kotlikoff 1990), we confirmed that demographic factors should have led U.S. saving to increase between 1960 and 1985, and encountered considerable difficulty identifying other factors (including fiscal policy) that could explain the observed decline.

While we could induce the model to track actual saving behavior in each country more closely, for example by changing taste parameters over time, we believe this is unwarranted in light of the scant evidence on the subject. Instead, we present the simulations based on constant preferences and emphasize the changes in rates of saving over time associated with demographic factors rather than the saving rate levels themselves.

Certain patterns associated with the shift to an older population are observable in both countries' baseline simulations. Both countries experience a decline in needed consumption taxes after 1985, although the rate rises again in Canada. These patterns result from the interaction of several factors. First, in each country, as the population in each country ages, consumption per capita rises, reducing the required consumption tax rate. This is particularly significant in Canada, which depends more on consumption taxes than does the United States. On the other hand, the old receive more government spending per capita, which raises the amount of revenue required, particularly in Canada. Finally, the timing of the demographic transition differs across the two countries, with Canada's shift occurring earlier and more sharply, leading to an earlier decline in consumption taxes, but also to a stronger reversal of the initial effect.

This difference in timing is also apparent in the predicted pattern of social security tax rates. These tax rates rise in both countries, and the ratio of retired population to working population declines. However, the

United States tax rate is roughly constant at its peak level of 12.8% over the period 2030-2050, not declining until later. In contrast, the Canadian tax rate peaks in 2030 and has already begun declining to its long run value by 2050, when the ratio of retired to working population will already have begun to decline from its peak value associated with the retirement of the baby boom generation.

The relatively larger and more rapid Canadian demographic transition also influences the predicted pattern of national saving over the next 60 years. The simulations predict that the U.S. saving rate will decline steadily through the year 2050, with the most significant drop during the period 1990-2030. In Canada, however, the saving rate is projected to rise slightly until 2010, but then drop much more sharply than in the United States. This difference is easily understood in terms of the changing fractions of the population of young, old and middle aged in each country.

One may simplify things a bit by thinking of the young and old as dissavers and the middle-aged as savers. A demographic shift toward an older population has offsetting effects, then, as the population share of the young declines but that of the old rises. In Canada, with an initially much younger population than the United States, the first effect dominates initially. However, this sharper change in the birth rate ultimately leads to a larger increase in the share of the elderly in the population, causing a sharper decline in the saving rate.

Many who have considered the coming demographic transition have emphasized the potential fiscal burden associated with the increasing dependency ratio. We have found here that social security tax rates will rise in each country. However, there are other factors that act to counterbalance this burden. First, as we have already discussed, general expenditures per capita will rise, but so may tax bases. Second, as the population ages, one may expect an increase in capital-labor ratios and hence a rise in real wages. In the simulations presented, the real U.S. wage rate (normalized for trend growth) rises by over 8 percent between 1985 and 2050. By assumption, the same growth in real wages is experienced in Canada.

One way of combining these factors is in terms of the real, after-tax wage rate (relative to trend), which, beginning in 1985, rises in both countries through the year 2010. It then levels off in the United States, but falls in Canada, as the consumption tax rises once again. However, even in Canada, the real after-tax wage rate in 2050 is predicted to be higher than it was in 1985.

The last set of numbers given in Table 3 are for the current account in Canada, which we have assumed in these simulations to be a small open economy that takes its factor returns from the United States. One must recognize that this polar open economy assumption, with no adjustment costs to trade or capital flows and assets being perfect substitutes across national borders, can give rise to large and volatile annual measures of the current account surplus or deficit. Taking this into account, the predicted current account balances in the table provide an interesting picture of the influence of the demographic transition on trade and capital flows.

The model predicts a Canadian current account deficit of 1.5% of national income in 1960, higher than the actual deficit of about .4%. It then swings away from reality, predicting an increase to a 5.0% deficit in 1985, when there was actually a surplus of 2.7%. The error is clearly associated with the model's significant underprediction of the 1985 Canadian national saving rate; once again, future patterns are more useful in predicting changes than levels. The model predicts that the Canadian current account will swing strongly toward surplus from the present until around 2010, after which, with the saving rate declining, Canada will move again toward a deficit position.

B. Alternative Simulations

In this section, we consider the effects of alternative dynamic fiscal policies on the transition paths for the United States and Canada. Table 4 presents the alternative U.S. simulations, while those for Canada appear in Table 5. For convenience, the first column of each table repeats the baseline simulation from Table 3. Since all simulations are the same in 1960, we do not report the results for this year. Likewise, we focus our attention on three of the variables reported in Table 3, the consumption tax, the social security tax rate and the national saving rate.

The first set of alternative simulations, given in the second columns of Table 4 and 5, impose a different assumption about the response of general government spending to a change in the age structure of the population. Previously, we assumed that age-specific spending stayed constant (except for trend productivity growth) per member of the relevant age group. As the populations shift toward those groups toward which more spending is targeted (the young and the elderly), this leads to an overall rise in government spending, relative to the population as a whole. As we have defined it, to include public pension payments financed by general revenues, the Canadian general public sector has a considerably larger fraction of its spending targeted toward the elderly. This helps explain the rise in the required consumption tax rate in Canada after 2010 in the baseline simulation.

In the alternative simulations labelled "No Spending Rise", we assume instead that all general government spending remains constant per member of the overall population, not per member of the affected age group. Implicitly, this assumes that age-specific spending per capita is reduced as benefit-intensive age groups become a more important component of the population. The results of these simulations confirm that this alternative fiscal policy assumption leads to lower spending and hence lower required consumption tax rates. Also as expected, the effect is considerably larger for Canada. While the U.S. consumption tax is reduced by as much as .7 percentage points (in 2050 and the long run), the Canadian consumption tax is reduced by 5.4 percentage points in 2030 and 3.5 percentage points in the long run. This reduction in Canada, unlike the much smaller one simulated for the United States, is important enough to influence the national saving rate, which is .8 percentage points higher in 2030.[14]

The next set of simulations, presented in the third columns of Tables 4 and 5, considers the impact of a gradual, announced increase in the retirement age, modelled after the one currently in process in the United States. The simulations assume that the retirement age rise from 65 to 66 in the year 2000 and from 66 to 67 in the year 2010, remaining constant thereafter. These experiments have an obvious impact on the social security tax rates in each country. In the United States, the tax rate peaks at 10.2% in 2030, rather than 12.8%. In Canada, the tax rate peaks at 4.4% rather than 5.3%, also in 2030. In both countries, this leads to a higher rate of saving. Given the nature of pay-as-you-go social security systems and our life-cycle model, such an increase is to be expected: individuals must save more for their own retirement. In the United States, the saving rate rises by as much as .7

percentage points (in 2030), and .3 percentage points in the long run. The respective numbers for Canada are .3 (also in 2030) and .1, smaller because of the smaller size of the payroll-tax-financed portion of public pensions.

Our final simulation, which we present for Canada, is motivated by the recent relative trends in payroll tax rates and benefit levels. Unlike the United States, the Canadian public pension system is relatively young. Immature pension schemes operating on a pay-as-you-go basis initially run surpluses, as few individuals are eligible to receive benefits in the early years of operation. Once the pension plan has been in place for enough years for the retired population to be fully eligible for benefits, one gets a truer picture of whether promised benefit levels can be sustained by payroll taxes.

In Canada, expenditures on benefits were less than the pension contribution component of payroll taxes until about 1985. By the year 2000, they are projected to rise to a level about 70% higher than pension contributions, suggesting that the payroll tax rate will have to rise in the near future (Bird 1987, p. 668). To model this, we alter the baseline assumptions by letting the social security replacement rate rise gradually by 70% over the period 1985-2000, remaining constant thereafter.

The results of this simulation are given in the last column of Table 5. The payroll tax rate rises to a peak of 9.1% in 2030, instead of 5.3%, making the level of the Canadian tax rate much closer to that for the United States. Note that this tax increase is slightly higher than 70%, since the increased tax rate does reduce labor supply somewhat. For the same reason, the levels of consumption taxation must be higher than in the baseline simulation, by about 1.2 percentage points 2030 and thereafter.

The higher level of benefits in this simulation leads to a lower level of national saving as well. This is because our simulations enforce cash-flow balance of the social security pension system: our earlier baseline simulations implicitly assumed that benefits would be set at whatever level would be appropriate to maintain such balance. Since benefits as currently scheduled appear to require a considerable increase in payroll taxes, the benefit levels in our baseline simulations are much lower than those currently planned. Hence, the alternative simulation amounts to an increase in benefit levels, relative to the baseline assumptions.

The simulated effect of this increase on national saving is considerable, depressing the saving rate by as much as 1.3 percentage points in 2030 and .8 percentage points in the long run. This effect is several times larger in magnitude than the increase in saving that we project for a gradual increase in the retirement age.

5. Conclusions

Our analysis indicates that demographic transitions are likely to have significant effects on rates of saving and taxation in both the United States and Canada. These two countries and their fiscal systems differ in several ways, which we have tried to incorporate in our analysis.

Canada's economy differs from the United States in being much smaller, relying more heavily on consumption taxes to finance public spending, and financing much of its public old age pensions out of general revenues. Moreover, the relative immaturity of the pay-as-you-go part of Canada's pension scheme suggests that, even without a demographic transition, a considerable rise in payroll taxes may be required. Combined with the sharper demographic transition that is projected for Canada, these fiscal differences lead one to predict a later and more severe drop in the national saving rate in Canada, with a potentially much greater increase in the payroll tax as well.

As our real wage calculations indicate, one should not necessarily infer that lower national saving reduces welfare. Tax increases may be more than offset by rising real wages. Ultimate judgments about changes in welfare really require a fuller treatment of **why** these demographic transitions are occurring, in these two countries and most other highly developed ones as well.

Table 1a

Population Age Distributions: United States

(Percent of Population)

Year		Age Group 0-14	15-34	35-54	55-64	65+
1960						
	Actual	31.0	26.3	24.8	8.6	9.2
	Model	30.0	31.7	22.2	8.4	7.7
1970						
	Actual	31.0	26.3	24.8	8.6	9.2
	Model	27.3	32.9	23.0	8.8	8.0
1980						
	Actual	22.5	35.3	21.3	9.6	11.3
	Model	23.1	34.0	24.9	9.5	8.6
1990						
	Actual	21.8	31.9	25.4	8.6	12.3
	Model	23.4	30.3	26.6	10.2	9.3
2000						
	Actual	21.1	27.4	30.5	8.8	12.2
	Model	21.0	28.9	28.4	11.3	10.3
2010						
	Actual	19.3	27.0	28.5	12.6	12.6
	Model	20.2	28.5	26.7	12.8	11.7
2020						
	Actual	19.0	26.0	25.2	13.7	16.2
	Model	18.3	27.7	26.6	13.7	13.6
2030						
	Actual	18.5	24.9	25.4	11.5	19.6
	Model	19.1	26.5	27.4	12.2	14.8
2040						
	Actual	18.2	25.0	25.4	11.4	20.0
	Model	18.2	26.5	27.5	14.1	13.7
2050						
	Actual	18.3	24.9	24.8	12.2	19.7
	Model	19.0	26.1	26.4	13.4	15.1

Table 1b

Population Age Distributions: Canada

(Percent of Population)

Year		Age Group 0-14	15-34	35-54	55-64	65+
1960						
	Actual	33.7	28.2	23.4	7.1	7.6
	Model	34.1	32.1	21.4	7.9	7.0
1970						
	Actual	30.3	31.3	22.5	7.9	8.0
	Model	30.7	33.3	22.3	8.2	7.3
1980						
	Actual	23.0	36.5	22.3	8.8	9.5
	Model	24.3	35.7	24.5	9.0	8.0
1990						
	Actual	20.8	32.4	26.3	9.0	11.4
	Model	21.5	32.9	27.7	10.2	9.0
2000						
	Actual	19.5	27.5	30.7	9.5	12.9
	Model	19.3	28.2	31.3	11.9	10.5
2010						
	Actual	17.2	26.4	29.0	12.9	14.6
	Model	17.3	26.3	30.6	14.2	12.6
2020						
	Actual	16.9	24.8	25.6	14.0	18.7
	Model	16.6	24.8	27.7	16.5	15.5
2030						
	Actual	17.2	23.1	25.3	11.9	22.5
	Model	17.2	23.6	27.1	14.7	18.5
2040						
	Actual	17.6	23.6	24.6	11.6	22.6
	Model	17.8	24.3	27.1	14.7	17.3
2050						
	Actual	18.2	24.4	23.5	12.1	21.8
	Model	18.7	25.1	26.0	14.7	16.8

Table 2

Tax Rates for 1960 and 1985

	United States		Canada	
	1960	1985	1960	1985
Tax Rate				
Wage Tax	19.2	18.7	11.3	21.4
Capital Income Tax	16.2	15.7	10.0	16.6
Consumption Tax	9.8	9.7	21.0	22.2
Social Security Tax	7.1	7.6	0.0	2.4

Table 3
Base Case Simulations

	United States	Canada
Consumption Tax Rate		
1960	9.8	21.0
1985	8.3	21.8
1990	8.6	19.5
2010	5.7	14.3
2030	5.8	17.5
2050	5.5	17.6
long run	5.3	17.1
Social Security Tax Rate		
1960	7.1	0.0
1985	7.6	2.4
1990	8.0	2.5
2010	10.2	3.6
2030	12.8	5.3
2050	12.8	4.7
long run	12.3	4.1
National Saving Rate*		
1960	10.1	9.8
1985	12.2	8.1
1990	11.7	8.9
2010	9.5	9.1
2030	6.5	3.3
2050	5.8	2.1
long run	6.3	5.0
Real After-tax Wage**		
1960	.70	.73
1985	.74	.65
1990	.74	.67
2010	.78	.78
2030	.78	.72
2050	.79	.72
long run	.79	.67
Current Account*		
1960	0	-1.5
1985	0	-5.0
1990	0	-4.1
2010	0	1.6
2030	0	0.9
2050	0	-3.3
long run	0	-1.3

*saving rate and current account expressed as fractions of national income
**real wage is detrended, net of wage tax, consumption tax and half of social security tax

Table 4

Alternative Simulations: United States

	Base Case	No Spending Rise	Increase in Retirement Age
Consumption Tax Rate			
1985	8.3	8.3	8.2
1990	8.6	8.6	8.4
2010	5.7	5.5	5.2
2030	5.8	5.2	4.9
2050	5.5	4.8	4.5
long run	5.3	4.6	4.1
Social Security Tax Rate			
1985	7.6	7.6	7.5
1990	8.0	7.9	7.9
2010	10.2	10.2	8.0
2030	12.8	12.8	10.2
2050	12.8	12.8	10.1
long run	12.3	12.3	9.9
National Saving Rate			
1985	12.2	12.2	12.4
1990	11.7	11.7	12.0
2010	9.5	9.4	10.1
2030	6.5	6.6	7.2
2050	5.8	5.9	6.3
long run	6.3	6.3	6.6

Table 5

Alternative Simulations: Canada

	Base Case	No Spending Rise	Increase in Retirement Age	Initial Rise in Benefits
Consumption Tax Rate				
1985	21.8	21.9	21.8	22.0
1990	19.5	19.5	19.5	19.9
2010	14.3	12.5	14.2	15.2
2030	17.5	12.1	17.2	18.7
2050	17.6	13.1	17.4	18.8
long run	17.1	13.6	16.9	18.2
Social Security Tax Rate				
1985	2.4	2.4	2.4	2.4
1990	2.5	2.5	2.5	3.1
2010	3.6	3.6	2.8	6.1
2030	5.3	5.3	4.4	9.1
2050	4.7	4.7	3.8	7.9
long run	4.1	4.1	3.3	7.0
National Saving Rate				
1985	8.1	7.8	8.2	7.4
1990	8.9	8.5	9.0	8.1
2010	9.1	8.8	9.4	8.0
2030	3.3	4.1	3.6	2.0
2050	2.1	2.5	2.4	1.3
long run	5.0	5.1	5.1	4.2

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Footnotes

1. In the simulations for Canada, we also assume that capital can enter and leave the country freely.

2. Introducing technological progress into a model with variable labor supply requires some care. The simplest approach of assuming constant tastes and rising wage levels would lead to successive generations working more and more or less and less, depending on the value of the intratemporal elasticity ρ. To avoid this problem, we allow each generation to experience the steeper wage profile implied by technological progress, but interpret the rise in the overall wage profile experienced by each generation as if it were time-augmenting, and hence neutral with respect to the choice between market and nonmarket uses of labor. See Auerbach et al (1989) for further discussion.

3. In assuming that Canadians face the U.S. interest rate, before-tax, we are essentially assuming that U.S. capital income taxes on Canadian investments are fully creditable against Canadian taxes, if Canadians are the marginal investors in the two countries.

4. The figures for 1990 are "projected" in the sense that they were calculated in the late 1980s.

5. This value is consistent with the simultaneous achievement of realistic rates of national saving and realistic household consumption profiles.

6. The slightly higher rate of discount for Canada arises because Canada's lower rate of government absorption of GDP and its greater emphasis on consumption taxes would otherwise lead (in our model) to a higher rate of national saving, while the rates in 1960 for the two countries were actually quite similar.

7. OECD revenue statistics for Canada begin only in 1965, so we extrapolate values for 1960.

8. For the United States, we use the adjustment made by Auerbach et al (1989) using unpublished OECD data. For Canada, we use an estimate that one-third of all payroll taxes were CPP/QPP contributions from 1966-85, based on the number cited in Bird (1987). From 1960-65, before the advent of these plans, we assume all payroll taxes were for nonpension expenditures.

9. We used 1980 as a base year for the United States in Auerbach et al (1989), and so use these U.S. calculations again rather than redoing all the calculations for 1985. The differences between the two years should be minimal.

10. Since the interest rate exceeds the growth rate in our simulations, a higher level of debt per capita leads to a lower level of government spending, given taxes.

11. They differ primarily in two ways. First, we have introduced the term λ, representing the fraction of social security pension contributions viewed as taxes. Previously, we implicitly set this term equal to zero. Second, we have chosen to calibrate government spending so that government's share of output corresponds to the value actually observed in 1960. This leads to more private saving (via a lower assumed pure rate of time preference) and a reduction in public saving (via a higher assumed level of national debt per capita).

12. This requires a U.S. government growth rate of 0.5% per capita, and a Canadian one of 2.6%. Although government's share of income did grow more quickly in Canada, these growth rates understate the actual rate of growth in the United States and overstate the actual growth rate in Canada. The differences are due to the fact that our model does not account for all components of the government budget.

13. The formula for this variable is $[w_t \cdot (1-\tau_t-\lambda \cdot \theta_t)/(1+\phi_t)]/1.015^t$, where w_t is the wage rate at date t, τ_t, θ_t and ϕ_t are the wage tax rate, the social security tax rate and the consumption tax rate, respectively, and λ is the fraction of the social security tax perceived to be a tax, equal to .5 in all the simulations presented here.

14. It is lower in earlier years, such as 1990 and 2010, because individuals feel wealthier and hence spend more, knowing that government taxes will be lower in the future.