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WP/97/141

INTERNATIONAL MONETARY FUND

Western Hemisphere Department

**Reform of the Canada Pension Plan: Analytical Considerations**

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October 1997

**Abstract**

Like other transfer programs, a pay-as-you-go public pension system can significantly affect economic behavior and, hence, relative prices and macroeconomic aggregates. This paper illustrates some of these effects, which are important in weighing options for reforming public pensions, in the context of a stylized model of the Canadian economy. It shows that introducing such a system can reduce aggregate saving, income, and wages and increase interest rates. It also shows that a significant part of the distortion can occur because benefits are not explicitly linked to contributions and that creating a linkage can reduce the distortions associated with the wage tax that funds plan contributions.

**JEL Classification Numbers:** H30,H55

**Keywords:** public pensions; applied general equilibrium

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<sup>1</sup>We thank our colleagues in the Western Hemisphere Department for helpful comments and discussions, and also Steven James, Bart Turtelboom, Marijn Verhoeven, Jan Walliser, Steven Symansky, and George Mackenzie. We also thank Laurence J. Kotlikoff for providing the computer program used for the simulations.

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## SUMMARY

Like other transfer programs, a pay-as-you-go (PAYG) public pension system can have significant effects on economic behavior and, hence, on relative prices and macroeconomic aggregates. This paper illustrates some of these effects, which are important in weighing various options for the reform of public pensions, in the context of a stylized dynamic general-equilibrium model of life-cycle behavior in the Canadian economy. The analysis shows that the introduction of a public pension system can reduce aggregate saving, income, and wages and increase interest rates. It also shows that a significant part of the distortion caused by a public pension plan can result from the fact that benefits are not explicitly linked to contributions and that creating such a linkage can reduce the distortions associated with the wage tax that funds the contributions to the plan.

The issue is timely, as a number of countries are considering reforms of their pension systems. Over the postwar period, many countries (including Canada) have experienced dramatic changes in demographic and economic trends, particularly fertility rates, wage growth, and interest rates. These changes have important implications for the soundness of PAYG pension schemes, which transfer funds from workers to retirees using a payroll tax. Either the baby boom generation will face much lower retirement benefits than its parents did, or its children will pay sharply higher taxes. This paper illustrates some of the trade-offs inherent in the choices that will have to be made.

## I. INTRODUCTION

Like other transfer programs, a pay-as-you-go (PAYG) public pension system can have significant effects on economic behavior, and hence on relative prices and macroeconomic aggregates.<sup>2</sup> We illustrate some of these effects, which are important in weighing various options for the reform of public pensions, in the context of a stylized dynamic general-equilibrium model of life-cycle behavior.<sup>3</sup> Our analysis shows that the introduction of a public pension system can reduce aggregate saving, income, and wages and increase interest rates. It also shows that a significant part of the distortion caused by a public pension plan can result from the fact that benefits are not explicitly linked to contributions, and that creating such a linkage can reduce the distortions associated with the wage tax that funds the contributions to the plan.

The issue is timely, as a number of countries are considering reforms of their pension systems. Over the postwar period, many countries have experienced dramatic changes in demographic and economic trends, particularly fertility rates, wage growth, and interest rates. These changes have important implications for the soundness of PAYG pension schemes, which transfer funds from workers to retirees using a payroll tax. When there are many workers per retiree and wages are high, such plans thrive, as the base for contributions is large enough to fund generous benefits using a low payroll tax. Indeed, the postwar “baby-booms” in countries like Canada meant a substantial rise in the number of workers per retiree in the early years of the boom, making room for generous pension plans. Now the same workers whose numbers permitted this generosity are themselves approaching retirement. However, members of the baby-boom generation have fewer children per household than their parents did, and their parents are living longer lives than earlier generations did. As a result, the number of workers per retiree has been declining, and is expected to decline further as the baby-boomers retire. The consequences for public pensions are clear. Either the baby-boom generation will face much lower retirement benefits than its parents did, or its children will pay sharply higher taxes.

In this paper, we consider the effects that public pension schemes can have on economic aggregates, wages, and interest rates in the context of Auerbach and Kotlikoff’s (1987) general-equilibrium model. The first half of the paper discusses some details of the CPP and describes some of the reform options that have been proposed. The second half examines some of the economic effects of public pension plans in general and simulates the economic effects of changes in provisions of pension plans using the computable general

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<sup>2</sup>Public pension schemes also serve as a kind of insurance (James (1996)), although we do not discuss this function.

<sup>3</sup>We focus on theoretical issues in the context of a specific model. Other models and empirical evidence can provide other views. For a broader overview of relevant issues, including from a multi-country perspective, see Roseveare and others (1996).

equilibrium model of Auerbach and Kotlikoff (1987). The final section draws some conclusions.

## II. THE CANADA PENSION PLAN: PROVISIONS AND ISSUES

Canada's retirement income system has three main parts. The first part is wage-related, and is financed by compulsory payroll taxes contributed by employees between the ages of 18 and 70 and their employers. This part of the pension plan is comprised of the CPP and the Quebec Pension Plan (QPP).<sup>4</sup> The CPP began operation in 1966. It is an important component of the Canadian old age support system as it provides benefits upon retirement, disability or the death of a contributor.<sup>5</sup> The second part is funded out of general revenues and includes the Old Age Security (OAS) and Guaranteed Income Supplement (GIS) programs.<sup>6</sup> The third part is private retirement saving that is encouraged by incentives such as deferral of the taxes on contributions and income earned on them before retirement. Vehicles for private retirement savings include employer-sponsored pension plans and Registered Retirement Savings Plans (RRSPs).<sup>7</sup> Our analytical work focuses on the wage-related component of public old age support, namely the CPP. Therefore, the operation of the CPP system will be explained in detail.<sup>8</sup> The main provisions of the plan are summarized in the tabulation below.

A Canadian aged 60 or older is eligible for a CPP retirement pension provided that he or she has made contributions for at least one calendar year during his or her working life. Once a person reaches age 70 or retires, he or she can no longer contribute to the plan.

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<sup>4</sup>Quebec has its own pension plan, which is separate from the CPP. However, its pensions are essentially identical to those of the CPP, so nothing is lost by focusing on the CPP.

<sup>5</sup>We focus on CPP retirement pensions. More detailed information about other benefits provisions of the CPP is available in Office of the Superintendent of Financial Institutions (1995).

<sup>6</sup>OAS is the basic public pension benefit for senior citizens in Canada, with a uniform benefit of \$385 per month currently paid to all pensioners. The GIS provides additional financial assistance to single pensioners with annual income below \$11,000 or married couples with annual income below \$14,500. In the 1996 budget, the federal government announced that OAS/GIS benefits will be combined into a new single benefit program (the Seniors Benefit) with stricter means-testing, starting in 2001.

<sup>7</sup>See IMF Staff Country Report No. 95/46, *Canada - Economic Developments and Policies* (1995), and Venti and Wise (1994).

<sup>8</sup>Detailed information on the other parts of the Canadian pension system is in IMF Staff Country Report No. 96/38, *Canada - Selected Issues* (1996).

Canadians are entitled to a full pension at age 65. Those retiring before age 65 face a reduction in benefits of ½ percent for each month of early retirement; those retiring after age 65 receive an increase in pension benefits of ½ percent for each month of late retirement up to 70 years of age. After retirement, pension benefits are fully indexed to inflation as measured by the consumer price index (CPI). The maximum pension benefit at age 65 was \$8,725 in 1996.

Provisions of the CPP in 1996 <sup>9</sup>	
Age for eligibility for CPP benefits	age 60
Age for full pension	age 65
Maximum age for contribution	age 70
Maximum pension benefit at age 65	\$8,725
Year's maximum pensionable earnings	\$35,400
Year's basic exemption	\$3,500
Replacement rate	25 percent
Drop-out provision	15 percent (up to 7 years)
Contribution rate	5.6 percent

Workers and employers contribute to the plan a fraction of wage income between a maximum value and a basic exemption. The fraction of wages contributed is known as the *contribution rate*; the maximum income is known as the *year's maximum pensionable earnings* (YMPE); and the minimum is known as the *year's basic exemption* (YBE). The YMPE rises each year in proportion to the rise in average earnings (the industrial aggregate calculated by Statistics Canada), but remains constant if average earnings decline. Benefits on retirement are 25 percent (the *replacement rate*) of average monthly pensionable earnings below the YMPE. When average pensionable earnings are calculated in order to determine benefits, the contributor can drop from his or her earning record 15 percent of nonworking or low-income years between age 18 and 65, up to 7 years. This is known as the *drop-out provision*, and the period of time that can be dropped from the earnings record is known as the *drop-out period*. The YBE is about 10 percent of the YMPE; in 1996, the YMPE was \$35,400, and the YBE was \$3,500.<sup>10</sup> The contribution rate in 1996 was 5.6 percent of wages, split equally between employees and employers (the self-employed pay the full contribution).

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<sup>9</sup>Effective January 1, 1997, the CPP contribution rate was increased to 5.85 percent. The maximum pensionable earnings were increased by \$400 to \$35,800 and the basic exemption was left unchanged at \$3,500.

<sup>10</sup>The maximum pension is less than 25 percent of the current YMPE, as the maximum pension is based on current and past earnings, whereas the current YMPE is based on current earnings.

The CPP operates on a PAYG basis, with a balance maintained in the CPP account equivalent to two times the level of annual benefit payments. To ensure the sustainability of the plan, the schedule of contribution rates is reviewed every five years by federal and provincial finance ministers. Since past and current contributions were made at rates that were below the actuarially-fair rate (estimated at about 10 percent), the CPP faces a large unfunded liability.<sup>11</sup> For the CPP, this liability is estimated at about \$500-550 billion, equivalent to 70 percent of GDP, and it would grow by about \$50 billion per year under the current schedule of contribution rates. This liability has arisen because costs have grown more rapidly than expected at the plan's inception. The major reasons for the rise in costs include a higher-than-expected ratio of retirees to workers because of lower birth rates and longer life expectancy; slower-than-expected growth in real wages; enrichment of benefits; and the recent steep rise in disability expenditures (Chart 1 and Chart 2). The plan will experience additional financial pressures when the baby-boom generation begins to retire around 2011. According to the CPP's most recent actuarial report, the elderly dependency ratio is projected to rise from 21 percent in 2000 to 34 percent in 2025.<sup>12</sup>

As a result, the provisions of the CPP will need to change in order to finance the unfunded liability and maintain funds to pay pensioners. In fact, the contribution rate has already been legislated to increase from 5.6 percent in 1996 to 7.9 percent in 2005 and to 9.9 percent in 2015 (Chart 3). Despite the scheduled increases in contribution rates over the next 20 years, in the absence of additional changes to the current legislation, the CPP fund assets (currently about \$40 billion) are projected to be exhausted in 2015. Based on the benchmark calculations reported in the CPP's *Fifteenth Actuarial Report*, in order to maintain assets at about twice annual expenditures without other measures, the contribution rate will have to increase from 5.6 percent in 1996 to 8.9 percent in 2005 and to 11.6 percent in 2015, with even higher rates (up to about 14 percent) needed in subsequent years.

On February 14, 1997, the Canadian Finance Minister tabled draft legislation with proposed changes to the CPP. These changes would ensure the affordability of the CPP to future generations, and its sustainability, and would include fuller funding, a new investment policy, changes to the retirement pension calculation, and changes in the administration of benefits.

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<sup>11</sup>The unfunded liability is defined as follows. If the contribution rate were immediately increased to the actuarially fair rate, an amount equal to the unfunded liability would have to be added to the CPP's assets in order to cover future expenses over the medium term, absent further increases in contribution rates or reductions in benefits (Office of the Superintendent of Financial Institutions (1995) and Department of Finance (1996a)).

<sup>12</sup>The elderly dependency ratio is defined as the number of persons aged 65 years and over divided by the number of persons between the ages of 20 and 64 (Office of the Superintendent of Financial Institutions (1995)).

The major changes to the CPP would include the following. The contribution rate would rise to 9.9 percent of earnings by 2003, and would be held steady thereafter. The CPP reserve fund would grow to the equivalent of five years of benefits, with the new fund invested in a diversified portfolio of securities. Any borrowing by the provinces would occur at market rates. The YBE would be frozen at \$3,500. New retirement pensions would be calculated on the basis of the average of the last five years' maximum pensionable earnings. Other changes would be made to disability, survivor, and death benefits. These changes would substantially improve the financial standing of the CPP in the years ahead.

Comparison of Existing CPP and New CPP Proposals		
Retired CPP pensioners and persons over 65 as of December 31, 1997 would not be affected by the proposed changes. Persons currently receiving CPP disability benefits, survivor benefits, or combined benefits would also be unaffected.		
All benefits under the CPP will remain fully indexed to inflation.		
The age of retirement - early, normal, or late - remains unchanged.		
	Existing CPP	New CPP proposals
Reserve fund	Equal to two years of benefits and declining	Growing to five years of benefits
Contribution rates	Rising to 10.1% by 2016	Rising to 9.9% by 2003, then held steady
Year's basic exemption(YBE)	Currently \$3,500 indexed to wages	Frozen at \$3,500
Year's maximum pensionable earnings (YMPE)	Indexed to wages	No change
Investment policy	Invested in non-negotiable provincial bonds	New funds invested in a diversified portfolio of securities
Provincial borrowing	Provinces borrow at federal rates	Limited provincial borrowings at their own market rates
New retirement pensions and earnings-related portion of disability and survivor benefits	Based on average of last 3 years' YMPE	Based on average of last 5 years' YMPE
Eligibility for disability benefits	Must work and contribute in 2 of last 3 or 5 of last 10 years	Must work and contribute in 4 of last 6 years
Retirement pensions for disability beneficiaries	Based on year's maximum pensionable earnings (YMPE) when recipient turns 65, then indexed to prices	Based on YMPE at disablement with subsequent price indexing



Comparison of Existing CPP and New CPP Proposals ( <i>continued</i> )		
	Existing CPP	New CPP proposals
Combined survivor-disability benefits	Ceiling equal to maximum retirement pension plus larger of two flat-rate components	Ceiling is one maximum disability pension
Combined survivor-retirement benefits	Ceiling equal to maximum retirement pension	No change to ceiling
Death benefit	6 months retirement benefits, maximum of \$3,580 grows with wages	6 months retirement benefits to maximum of \$2,500 and frozen

Source: Department of Finance, Canada.

### III. THE ECONOMICS OF PUBLIC PENSION SYSTEMS

In this section, we review some of the economics of public pension systems before proceeding to describe the simulations in detail. Our discussion is intentionally brief; more details are available in Blanchard and Fischer (1994) and Auerbach and Kotlikoff (1987). Related work that focuses on Canada in particular includes Bayoumi (1994) and James and others (1995).

The simulations we present in subsequent sections are derived from a dynamic general equilibrium model with endogenous prices and quantities. However, in order to illustrate the relevant issues in a simple fashion, the discussion in this section focuses on the steady state properties of a simple dynamic economy. Also, for the moment it is assumed that wages and interest rates are exogenous.<sup>13</sup> Consider an economy consisting of two generations of households, young and old. The number of young households grows each period at the rate  $n$ . Assume that the young supply one unit of labor inelastically, earning wage  $W$  and consuming an amount  $C_y$ . The labor income that the young do not consume is saved in assets ( $A$ ) that accrue interest at rate  $r$ . Old households do not supply labor, but only consume their assets  $(1+r)A$ , so that consumption when old,  $C_o = A(1+r)$ . Since lifetime income is just the wage earned when young, each household faces the lifetime budget constraint (expressed in terms of resources when young in period  $t$ )

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<sup>13</sup>Wages, interest rates, and labor supply are all endogenous in the simulations presented in the next section.

$$C_{y,t} + \frac{C_{o,t}}{1+r} = W_t \quad (1)$$

i.e., the present value of lifetime consumption is the value of wage earnings when young.

Now suppose that a PAYG public pension is introduced, with contribution rate  $\theta$  and benefits  $B$ . The old now consume  $A(1+r) + B$ , while the young have after-tax earnings of  $W(1-\theta)$ . The present value of lifetime resources is thus  $W(1-\theta) + B/(1+r)$ , so that the lifetime present-value budget constraint for a young household in period  $t$  is

$$C_{y,t} + \frac{C_{o,t+1}}{1+r} = W_t (1-\theta) + \frac{B_{t+1}}{1+r} \quad (2)$$

The PAYG structure of the public pension scheme means that benefits equal contributions in each period, or

$$B_t = \theta W_t (1+n) \quad (3)$$

where the  $(1+n)$  term accounts for the fact that with a growing population, there are  $(1+n)$  times as many young people this period than there were last period, and hence  $(1+n)$  times as many young people as there are old ones this period. Combining (2) and (3) and considering steady-state values for all variables (dropping the time subscripts) yields

$$C_y + \frac{C_o}{1+r} = W \left[ 1 + \frac{(n-r) \theta}{1+r} \right] \quad (4)$$

Comparing (1) and (4), it is clear that the steady-state effects of PAYG public pensions on lifetime resources depend critically on whether the interest rate is smaller or larger than the growth rate of the population. The population growth rate is important because it is the source of growth in aggregate wages, the base for pension contributions.<sup>14</sup> If the interest

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<sup>14</sup>In an economy where the wage per worker grows, the relevant comparison would be between the interest rate and the rate of growth of the wage base, e.g., (approximately) population growth plus the growth in the wage per worker (James and others (1995)). In the  
(continued...)

rate is the same as the population growth rate, then lifetime resources are unchanged (the term in brackets in (4) is equal to unity) by the introduction of a PAYG pension scheme.<sup>15</sup> This makes sense, as the public pension scheme merely substitutes forced public saving at an "interest rate" equivalent to  $n$  (the population growth rate) for voluntary saving at rate  $r$ ; if  $r$  and  $n$  are equal, young workers pay in  $\Theta W$  and receive  $\Theta W(1+r)$  when old, so that the yield on public pension saving is the same as the yield on private saving. If, on the other hand, the interest rate  $r$  is lower than the population growth rate  $n$ , the term in brackets is greater than unity, and hence the introduction of a PAYG public pension increases lifetime resources in the steady state. Finally, if the interest rate  $r$  is higher than the rate of population growth  $n$ , the scheme lowers lifetime resources; while benefits are greater than contributions, they are lower in present value, and hence lifetime resources are smaller than they would be in the absence of a public pension plan (that is, if  $\Theta$  were 0).

Another way to view this issue is by comparison to the return on a fully-funded plan. A fully-funded plan has a rate of return equal to  $r$ , whereas the PAYG scheme has a rate of return equal to  $n$ . Clearly, households are better off with whichever scheme has the higher rate of return.<sup>16</sup> In the stylized example above, the public pension scheme can improve households' circumstances by creating a "security" that could not exist in the private market, because no private contract could enforce it. In a broader context, efficiency is the relevant consideration. In a more general setting, the introduction of a PAYG pension scheme can be Pareto-improving if the economy is dynamically inefficient (e.g., is saving too much).<sup>17</sup>

This simple model can also yield some insights into population dynamics and the evolution of public pension plans. In the steady state, a higher population growth rate means a more favorable stance of a PAYG system compared to a fully-funded one. Holding  $W$  constant in equation (3), for example, it is clear that when  $n$  increases,  $B$  must increase or  $\Theta$  fall to maintain PAYG balance. This corresponds to the situation of the 1960s, when the CPP was introduced. The reverse holds as well, of course; during a "baby bust," when  $n$  falls,  $B$

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<sup>14</sup>(...continued)

case of Canada, then, the simplified comparison presented above is somewhat biased against PAYG schemes.

<sup>15</sup>This is true (absent imperfections in financial markets) even if the amount of forced saving is greater than what agents would save voluntarily, as they can offset such forced saving by borrowing at the same interest rate.

<sup>16</sup>Indeed, one proposal for CPP reform suggests that the plan vary its degree of funding depending on the prevailing interest rate--so-called "smart funding" (Canadian Institute of Actuaries (1996)).

<sup>17</sup> Blanchard and Fischer (1994). Also, in settings with uncertainty, public pension schemes can improve welfare by remedying failures in the private insurance market (James (1996)).

must fall,  $\Theta$  increase, or both. The latter situation corresponds to the problems the CPP faces in the years to come as the baby-boomers retire.

Further insight into the effects of the introduction of a PAYG pension scheme can be gained by considering redistributive effects that take place outside the steady state. For example, when a PAYG scheme is introduced, the initial generation of retirees receives benefits without having paid contributions. These benefits are in effect paid for by a transfer of resources from the current young and future generations. Since young households have a lower marginal propensity to consume than old ones (in this simple model, the older generation consumes all its wealth, and so has a marginal propensity to consume of unity), the transfer of one dollar from a young to an old household increases aggregate consumption, and hence decreases aggregate saving.<sup>18</sup> In general equilibrium, the resulting lower capital stock means a higher interest rate and a lower wage, further making the elderly better off and the young worse off.

The magnitude of the transfer to the initial elderly or near-elderly when a public pension scheme is introduced can be substantial in practice. The entabulation below shows the internal real rate of return on contributions to the CPP for various generations, as calculated by the CPP's actuaries. These rates of return imply a substantial transfer of resources to the initial elderly, as they are very high in absolute terms for the initial retirees under the CPP and comparatively low for later generations of retirees.

Internal Real Rate of Return on CPP Assets <sup>19</sup>	
Year of Birth	Internal Real Rate of Return (In percent)
1911	22.4
1929	10.4
1948	4.9
1968	2.8
1988	1.7
2012	1.5

Another way to view these crowding-out effects is by analogy to deficit finance. Auerbach and Kotlikoff (1987) show how relabeling contributions as "borrowing" and

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<sup>18</sup>Also, there is more crowding out in the short run than in the long run, since future generations will reduce their consumption in response to their transfer to the initial old household.

<sup>19</sup>Canadian Institute of Actuaries (1996).

benefits as "principal plus interest payments" and augmenting the pension "deficit policy" with a set of transfers produces an economy with a deficit policy. Auerbach and Kotlikoff note that this implicit deficit policy crowds out private investment just as the traditionally-defined deficit can. In this relabeled economy, the amount of pension debt outstanding each period is equal to the amount of contributions collected each period. In an actual economy, of course, the amount of public pension "debt" can be much higher than annual contributions, since it would include the present value of the difference between past contributions and past benefits.

A final important issue is the linkage between contributions and benefits. One reason that public pension schemes may distort labor supply decisions is that marginal contributions may not yield any direct marginal benefit.<sup>20</sup> Auerbach and Kotlikoff (1987) show that linkage of contributions to benefits can reduce the distortionary effects of the wage tax that funds contributions, by in effect eliminating the marginal distortion associated with that tax. In practice, of course, it is not clear that such a linkage exists for most public pension schemes; indeed, it seems that their salient characteristic is that in the past contributions per worker have risen more slowly than benefits per retiree, while in the future, the opposite is expected. Also, even with a dollar-for-dollar linkage of contributions and benefits at the margin, contributions and benefits may not be the same in present value for every household. For example, those who are elderly when the scheme is introduced receive benefits without making contributions. Hence, there is an implicit lump-sum tax or transfer, which may distort the decision whether to work. These considerations are illustrated in the simulations that follow.

#### IV. THE SIMULATION MODEL

We next describe the model used to illustrate the economic effects discussed above.<sup>21</sup> The model we employ is Auerbach and Kotlikoff's (1987) dynamic general-equilibrium model, though with tax parameters that match those in the Canadian economy.<sup>22</sup> The economy consists of three sectors: households, firms, and government. For the purpose of simplicity, there is no uncertainty (all agents have perfect foresight), the economy is closed, and there is no money (the numeraire is the single consumption good).

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<sup>20</sup>Marchildon, Sargent, and Ruggeri (1996) discuss the distortionary effects of payroll taxes. At the individual level, the implicit tax may be positive or negative; as the tabulation above shows, for those who were close to retirement when the CPP was introduced, a dollar of contributions yielded much more than one dollar of benefits in present value.

<sup>21</sup>The Appendix contains details of the model, including parameter choices.

<sup>22</sup>Laurence Kotlikoff generously provided a copy of his simulation software. Jan Walliser also provided helpful advice on the simulations.

The household sector consists of 55 generations (a household of age 1 can be thought of as an adult of age 21, who lives to age 75). Each period, each household makes decisions about how much to consume and how much labor to supply, based on a lifetime budget constraint and preferences for consumption and leisure.<sup>23</sup> Households that choose not to supply labor are "retired" (there is no involuntary unemployment in the model). As in the simple model described above, in each year, the number of age-1 households increases by  $n$  percent. Relative prices (current and future interest rates and wages), taxes, transfers, and households' preferences determine how much each household saves, consumes, and works, and hence, aggregate saving, consumption, and labor supply.

A competitive production sector is represented by a Cobb-Douglas production function that converts capital and labor into the consumption good. Technology is assumed to be fixed over time, and firms can costlessly adjust capital and labor inputs. The labor of older workers is more productive than the labor of young ones. Technological parameters, interest rates and wages determine total demands for labor and capital.

The government can levy taxes on consumption, labor income, capital income, and total income. Taxes can be set exogenously (in which case the deficit is endogenous), or one tax can be determined endogenously in order to meet an exogenous deficit target. Government expenditures per capita, other than for pension benefits, are assumed constant over time, and are assumed to have no direct effects on household or firm behavior. A public pension system is funded on a PAYG basis by a separate wage tax from the one used for general revenues. On retirement at age 46 (age 66 in real-world years) the pension replaces a fraction of average lifetime wages. Contribution rates are determined endogenously in accordance with the plan's PAYG structure. The government, like households, faces an intertemporal budget constraint. In the steady state, the budget is in balance, but the government may issue one-year debt when the budget is not in balance during transition years. The government may also have an outstanding stock of debt in the initial steady state.

In equilibrium, the following conditions hold. Households demand the consumption good and supply labor and savings according to preferences and relative prices. Firms demand labor and capital according to technology and relative prices. Government finance and household and factor demands obey intertemporal budget constraints. The goods and factor markets clear (labor supply equals labor demand and investment equals savings). The solution algorithm follows the same structure. Test values for capital and labor are posited; wages and interest rates are derived from these test values and factor demand functions; and consistency with household factor supply functions is checked, which leads to new test values for capital

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<sup>23</sup>In this model, households are self-contained units, in that they do not make bequests to future generations. The effect that bequests have depends upon their form. For example, "joy of giving" bequests that do not link utility across generations will have only small economic consequences, while Barro-style bequests can mean that public pension schemes (and other fiscal policies) have no economic effects (Blanchard and Fischer (1994)).

and labor.<sup>24</sup> The model starts with an initial steady-state equilibrium, then determines the transition to another steady state over 150 years (in practice, it may take much less than 150 years for the model to settle down to a new steady state after a policy change). In steady states, the government budget is balanced and economic aggregates are constant on a per-capita basis, though this need not hold true during transitions, of course.

## V. POLICY EXPERIMENTS

In order to illustrate the economic effects that changes in the provisions of public pensions have, we performed six experiments with the stylized model described above.<sup>25</sup> They shed some light on the economic effects that changes in provisions such as the CPP has experienced over the last 30 years and on possible effects of the changes that might occur with reform. For example, the introduction of the CPP itself has likely had some macroeconomic impact. Hence, the first experiment simulates the introduction of a public pension scheme. Also, the generosity of the CPP has increased over time, and there is a question as to whether reforms will reverse that increase. Hence, the second and third experiments simulate increases in the replacement rate; one permanent, one temporary. A third important issue is the linkage of contributions and benefits. Hence, the last three experiments repeat the first three, but with a marginal linkage of contributions and benefits, so as to illustrate the effects of the marginal distortion from the payroll tax. Table 1 summarizes the policies underlying each simulation experiment, and Tables 2-7 summarize the results of each experiment, while Charts 4 and 5 show the effects of various policies on key variables over time.

The first experiment is the *introduction of a public pension plan*. As mentioned above, the introduction of a PAYG public pension plan is equivalent to an explicit deficit policy, or a transfer from current and future (unborn) generations to the current elderly generation. This means that saving, capital formation, and output should fall. Table 2 shows that just such effects occur. In this experiment, the replacement rate rises linearly from 0 percent in year 0 (the initial steady state) to 25 percent in year 10, and stays at 25 percent thereafter, mimicking the gradual introduction of the CPP. The effects of the introduction of a PAYG pension scheme are to decrease income and consumption relative to the baseline; note that consumption falls by proportionally less than income, implying a decrease in saving. The decrease in saving is reflected in a drop in the capital stock of about 20 percent in the long

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<sup>24</sup>Auerbach and Kotlikoff (1987) provide further details on the method of simulation.

<sup>25</sup>Experiments using the model were carried out by manipulating the replacement rate. This allows much more general types of experiments than it might seem at first. In all experiments, the public pension scheme remains a strict PAYG system. In such a system, only one parameter (either the replacement rate or the contribution rate) can be determined endogenously. Indeed, the design of the CPP recognizes this fact by periodically adjusting the schedule of contribution rates so as to target the level of assets.

run. Labor supply also contracts due to the higher tax on wages (it contracts by more in the short run than in the long run, as in the long run, income effects tend to dominate in the model).<sup>26</sup> The average wage falls, since labor demand contracts with the fall in the capital stock, while interest rates rise. Finally, the tax rate on income rises to make up for the fall in the tax bases (consumption, income, and wages).

In Canada, there has been a trend increase in the generosity of benefits since the introduction of the CPP. Table 3 presents the results of a simulation of an *expansion of the public pension scheme*. In this simulation, the replacement rate rises from 0 to 25 percent over 10 years (as in the previous simulation), then rises an additional 5 percentage points over the subsequent 30 years (similar to the expansion of the CPP since its introduction). The relatively small increase in the replacement rate has concomitantly minor macroeconomic consequences; in the long run, income is about 1½ percent lower, the capital stock is about 3½ percent lower, and interest rates are 30 basis points higher than under the baseline.

Some of the proposed reforms to the CPP are equivalent to a *reduction in benefits back to historical levels* (for example, a decrease in the replacement rate to offset increased life expectancy). Hence it is useful to see the effects of a temporary increase in benefits, as opposed to the permanent increase in the previous simulation. Table 4 presents the results of a simulation in which the replacement rate is reduced to 25 percent in the long run after its increase to 30 percent as in the previous simulation. While the short-run effects of the increase in benefits are clearly present, the temporary increase has no long-run effects--the long-run steady state effect is about the same as in the case where replacement rates rise to 25 percent over ten years and stay there.

One important aspect of public pension plans is the effect that the linkage of contributions and benefits has on labor supply. If an additional dollar of contributions does not result in an additional dollar of benefits in present value, the contribution that funds the pension scheme has the same distortionary effect on labor supply as an ordinary tax. Some proposals for the reform of public pension schemes have suggested that such a linkage be built into them, thereby removing at least part of the distortion. The last three experiments replicate the results above, but with a dollar-for-dollar marginal linkage of contributions and benefits in present value.<sup>27</sup>

Table 5 presents the results of a simulation of the introduction of a *pension scheme with linkage of contributions and benefits*. The long-run reduction in income and

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<sup>26</sup>Auerbach and Kotlikoff (1987). In fact, in their experiments, labor supply sometimes expands slightly in the long run in response to the introduction of a public pension scheme.

<sup>27</sup>Of course, distortions from other sources, such as the transfer of resources from young and future generations to the initial generation of old households, will still have an effect in this experiment.



consumption is about half that under the introduction of the pension scheme without the linkage. Labor supply actually expands slightly in the long run, which as noted above is due to income effects. Indeed, it makes sense that such effects prevail when the marginal distortion is removed. The contraction in the capital stock and increase in interest rates, while smaller than under the unlinked scheme, are still substantial. Finally, the required increase in the income tax is actually smaller than under the unlinked plan. This makes sense, as more of the fiscal gap can be closed with revenues from consumption and wage taxes than under the plan without linkages. Similar conclusions are implied by a simulation of an increase in the generosity of the plan with linkage of contributions and benefits (Table 6) and by a temporary increase in benefits (Table 7).

## VI. CONCLUSIONS

The CPP, like the public pension schemes in a number of other countries, faces significant challenges in the years ahead. These challenges mean that reform measures must be taken soon. The Canadian authorities recognize this urgency, and also recognize that in choosing among reform options, it is important to bear in mind the economic costs of each proposed change.<sup>28</sup> We have discussed some of the reform options and sketched some of the economic implications of changes in the provisions of a public pension plan in the context of a stylized dynamic general-equilibrium model.

The model implies that PAYG public pension schemes can have significant adverse effects on output and capital formation. Specifically, the intergenerational redistribution and distortionary taxes that fund such schemes can reduce aggregate savings and labor supply, which work to reduce the capital stock and output. Also, simple reforms, such as reversing an increase in generosity or linking benefits and contributions, can alleviate the impact that these schemes have on the economy.

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<sup>28</sup>For example, in the statement released after the October 4 meeting of Ministers (“Principles to Guide Federal-Provincial Decisions on the Canada Pension Plan”), it is recognized that decisions about increases in contribution rates must be guided by consideration of their fiscal and economic impact.

### Description of the Model

The functional forms and parameter choices employed in the model are sketched here. To keep the notation simple, taxes are ignored in the descriptions (all calculations use the full set of taxes described in the main text). More details are available in Auerbach and Kotlikoff (1987).

In the Auerbach and Kotlikoff model, households choose paths for consumption ( $c$ ) and leisure ( $l$ ) over a 55-year lifetime, according to constant-elasticity-of-substitution (CES) preferences:

$$U(c,l) = \left[ \frac{1}{1-1/\gamma} \sum_{i=1}^{55} (1+\delta)^{-(i-1)} u(c_i, l_i)^{(1-1/\gamma)} \right] \quad (5)$$

where preferences for year- $t$  choices are given by

$$u(c_t, l_t) = \left[ c_t^{1-1/\rho} + \alpha l_t^{1-1/\rho} \right] \quad (6)$$

Workers have an ability profile  $\{e_t\}$  that represents increases in wages relative to the wage of a new adult ( $w_t$ ) along with increases in ability over time. This profile reflects the accumulation of human capital with experience. The profile is assumed to reflect one obtained from cross-sectional data on earnings.<sup>29</sup> Agents choose the sequence  $\{c_t, l_t\}$  so as to maximize  $U$  subject to the constraint that the present value of lifetime consumption is no larger than the present value of lifetime earnings;

$$\begin{aligned} & \text{Max } U(c,l) \text{ subject to} \\ & \sum_{t=1}^{55} D_t w_t e_t (1-l_t) \geq \sum_{t=1}^{55} D_t c_t \\ & \text{where} \\ & D_t \equiv \prod_{s=1}^t [1+r_s]^{-1}. \end{aligned} \quad (7)$$

$D_t$  is a discount factor, and  $r_s$  is the one-year interest rate prevailing in year  $s$ .

The parameter values used were the same as those employed by Auerbach and Kotlikoff (1990), for a study of Canada. The elasticity of substitution between consumption

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<sup>29</sup>See Auerbach and Kotlikoff (1987).

and leisure (the percentage change in the ratio of leisure to consumption in response to a one percent change in the wage) is given by the parameter  $\rho$ ; it was set to 0.8. This value is high, relative to estimates from panel studies, though it is lower than the value (unity) used in James and others (1995), in a study of the CPP. Also, as Auerbach, Kotlikoff and Skinner (1983) point out, the empirical evidence is consistent with a wide range of estimates of  $\rho$ ; 0.8 is at the midpoint of this range.<sup>30</sup> The rate of discounting on future preferences is described by the parameter  $\delta$ ; it was set to 0.015. Household preferences for leisure versus consumption are described by  $\alpha$ , which was set to 1.5. The remaining parameter is  $\gamma$ , which describes the intertemporal elasticity of substitution; this parameter was set equal to 0.25.

The behavior of firms is governed by a production function that exhibits constant elasticity of substitution between capital  $K_t$  and labor  $L_t$ . It is assumed that the production sector is competitive with representative production function

$$Y_t = A \left[ \epsilon K_t^{(1-1/\sigma)} + (1-\epsilon)L_t^{(1-1/\sigma)} \right]^{1/(1-1/\sigma)} \quad (8)$$

The parameter  $\sigma$  governs the substitutability of labor and capital (the percentage change in the capital/labor ratio in response to a one percent change in the ratio of the wage to the interest rate). This was set to unity, yielding a Cobb-Douglas production function. The parameter  $\epsilon$  determines the intensity of capital relative to labor in the production function. This was set equal to 0.25. Total factor productivity  $A$  is held constant, and is calibrated so that the wage in the initial steady state ( $W_0$ ) is scaled to unity.<sup>31</sup>

The remaining parameters are tax rates. All the taxes employed in the Auerbach and Kotlikoff model, except for the tax on capital income, were employed in the simulations. The tax rates (assumed to be proportional) were estimated by dividing tax revenues by the tax base for a recent year (either 1995 or 1994, the latest year for which full data were available). The tax rates were estimated as follows. To estimate the income tax rate, general government personal tax revenues for 1994 as a percent of GDP were divided by personal income as a percent of GDP. To estimate the tax on consumption, general government indirect taxes as a percent of GDP were divided by consumption as a percentage of GDP. Finally, to estimate the payroll tax rate, total payroll tax revenues as a percentage of GDP (excluding pension contributions) were divided by wages as a percentage of GDP. This yielded tax rates (combined federal and provincial) of 23 percent for the consumption tax, 12 percent for the payroll tax (not including CPP contributions), and 23 percent for the income tax.

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<sup>30</sup>Also, the simple model presented in section IV makes it clear that public pensions can have macroeconomic effects even when labor supply is inelastic.

<sup>31</sup>This corresponds to  $A = 0.94$ .

### List of References

- Auerbach, Alan, and Laurence Kotlikoff, 1987, *Dynamic Fiscal Policy* (Cambridge, Massachusetts: Cambridge University Press).
- , 1990, “Tax Aspects of Policy Towards Aging Populations: Canada and the United States,” NBER Working Paper No. 3405 (Cambridge, Massachusetts: National Bureau of Economic Research).
- , and Jonathan Skinner, 1983, “The Efficiency Gains from Dynamic Tax Reform,” *International Economic Review*, Vol. 24 No. 1 (February), pp. 81-100.
- Bayoumi, Tamim, 1994, “Aging Populations and Canadian Public Pension Plans,” IMF Working Paper WP/94/89 (Washington: International Monetary Fund).
- Blanchard, Olivier, and Stanley Fischer, 1994, *Lectures on Macroeconomics* (Cambridge, Massachusetts: MIT Press).
- Canadian Institute of Actuaries, 1996, *Report of the Task Force on the Future of Canada/Quebec Pension Plans* (Ottawa: Canadian Institute of Actuaries).
- de Callatay, Etienne, and Charles Kramer, 1996, “The Canada Pension Plan: Problems and Policies,” in *Canada: Selected Issues* (Washington: International Monetary Fund).
- Department of Finance, 1996a, *An Information Paper for Consultations on the Canada Pension Plan*, (Ottawa, Canada).
- , 1996b, *Report on the Canada Pension Plan Consultations* (Ottawa, Canada).
- James, Steven, Chris Matier, Humam Sakhnini, and Munir Sheik, 1995, “The Economics of Canada Pension Plan Reforms,” Working Paper 95-09, (Ottawa: Department of Finance).
- , Steven, 1996, “A Public Versus a Private Canada Pension Plan: A Survey of the Economics,” (unpublished; Ottawa: Department of Finance).
- Marchildon, Lori, Timothy C. Sargent, and Joe Ruggeri, 1996, “An Economic Analysis of Payroll Taxes,” (unpublished; Ottawa: Department of Finance).
- Office of the Superintendent of Financial Institutions, 1995, *Canada Pension Plan: Fifteenth Actuarial Report as at 31 December 1993*, (Ottawa: Office of the Superintendent of Financial Institutions).

Roseveare, Deborah, Willi Liebfriz, Douglas Fore and Eckhard Wurzel, 1996, "Ageing Populations, Pension Systems and Government Budgets: Simulations for 20 OECD Countries," Working Paper No. 168 (Paris: OECD).

Venti, Steven F., and David A. Wise, 1994, "RRSPs and Saving in Canada," (unpublished; Canada: Dartmouth College and Harvard University).

Table 1. Details of Policy Experiments

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Case A	Introduction of a public pension plan	Increase replacement rate from 0 to 25 percent over 10 years (constant thereafter)
Case B	Permanent increase in benefits	Increase replacement rate from 0 to 25 percent over 10 years, then increase to 30 percent over 30 years (constant thereafter)
Case C	Temporary increase in benefits	Increase replacement rate from 0 to 25 percent over 10 years; increase to 30 percent over 30 years; then gradually return to 25 percent in the long run.
Case D	Introduction of a public pension plan with contribution-benefit linkage	Increase replacement rate from 0 to 25 percent over 10 years (constant thereafter), with 1-1 linkage of contributions and benefits in present value
Case E	Permanent increase in benefits with contribution-benefit linkage	Increase replacement rate from 0 to 25 percent over 10 years, then increase to 30 percent over 30 years (constant thereafter), with 1-1 linkage of contributions and benefits in present value
Case F	Temporary increase in benefits with contribution-benefit linkage	Increase replacement rate from 0 to 25 percent over 10 years; increase to 30 percent over 30 years; then gradually return to 25 percent in the long run , with 1-1 linkage of contributions and benefits in present value

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Table 2. Effects of the Introduction of a PAYG Public Pension System 1/

(In percent)

Year	Income	Con- sumption	Labor Supply	Capital Stock	Average Wage	Interest Rate 2/	Tax Rate 3/
10	-4.17	-3.23	-3.93	-4.87	-0.25	0.06	1.80
20	-4.99	-6.35	-3.00	-10.71	-2.05	0.53	2.48
30	-5.52	-8.11	-2.50	-14.02	-3.09	0.82	2.90
50	-6.04	-9.76	-1.90	-17.44	-4.22	1.14	3.31
Long run steady state	-6.39	-10.87	-1.64	-19.33	-4.84	1.32	3.58

1/ Change relative to baseline simulation.

2/ Arithmetic difference in rate from baseline.

3/ Change in the tax rate on income required to maintain budget balance.

Table 3. Effects of a Permanent Increase in Benefits 1/

(In percent)

Year	Income	Con- sumption	Labor Supply	Capital Stock	Average Wage	Interest Rate 2/	Tax Rate 3/
10	-4.23	-3.27	-3.96	-5.05	-0.28	0.07	1.83
20	-5.31	-6.68	-3.27	-11.17	-2.11	0.54	2.64
30	-6.12	-8.85	-2.97	-14.98	-3.25	0.86	3.22
50	-7.12	-11.31	-2.47	-19.80	-4.77	1.30	3.92
Long run steady state	-7.72	-13.15	-1.98	-23.00	-5.85	1.64	4.39

1/ Change relative to baseline simulation.

2/ Arithmetic difference in rate from baseline.

3/ Change in the tax rate on income required to maintain budget balance.

Table 4. Effects of a Temporary Increase in Benefits 1/

(In percent)

Year	Income	Con- sumption	Labor Supply	Capital Stock	Average Wage	Interest Rate 2/	Tax Rate 3/
10	-4.23	-3.27	-3.96	-5.05	-0.28	0.07	1.83
20	-5.30	-6.68	-3.27	-11.15	-2.10	0.54	2.64
30	-6.11	-8.84	-2.96	-14.94	-3.24	0.86	3.21
50	-7.03	-11.21	-2.39	-19.66	-4.75	1.30	3.87
Long run steady state	-6.38	-10.86	-1.64	-19.29	-4.82	1.32	3.58

1/ Change relative to baseline simulation.

2/ Arithmetic difference in rate from baseline.

3/ Change in the tax rate on income required to maintain budget balance.

Table 5. Effects of Introduction of PAYG Pension Scheme  
with Linkage of Contributions and Benefits

(In percent)

Year	Income	Con- sumption	Labor Supply	Capital Stock	Average Wage	Interest Rate 2/	Tax Rate 3/
10	-1.90	-0.32	-0.66	-5.54	-1.25	0.32	0.66
20	-2.49	-2.51	-0.07	-9.40	-2.42	0.63	1.13
30	-2.86	-3.70	0.23	-11.55	-3.08	0.81	1.40
50	-3.24	-4.80	0.59	-13.87	-3.81	1.02	1.67
Long run steady state	-3.45	-5.54	0.80	-15.17	-4.22	1.14	1.83

1/ Change relative to baseline simulation.

2/ Arithmetic difference in rate from baseline.

3/ Change in the tax rate on income required to maintain budget balance.



Table 6. Effects of a Permanent Increase in Benefits  
with Linkage of Contributions and Benefits

(In percent)

Year	Income	Con- sumption	Labor Supply	Capital Stock	Average Wage	Interest Rate 2/	Tax Rate 3/
10	-2.05	-0.36	-0.75	-5.83	-1.30	0.33	0.71
20	-2.73	-2.67	-0.15	-10.10	-2.59	0.68	1.23
30	-3.22	-4.04	0.17	-12.72	-3.39	0.90	1.57
50	-3.77	-5.48	0.65	-15.88	-4.39	1.19	1.94
Long run steady state	-4.13	-6.64	0.98	-17.96	-5.06	1.39	2.21

1/ Change relative to baseline simulation.

2/ Arithmetic difference in rate from baseline.

3/ Change in the tax rate on income required to maintain budget balance.

Table 7. Effects of a Temporary Increase in Benefits  
with Linkage of Contributions and Benefits

(In percent)

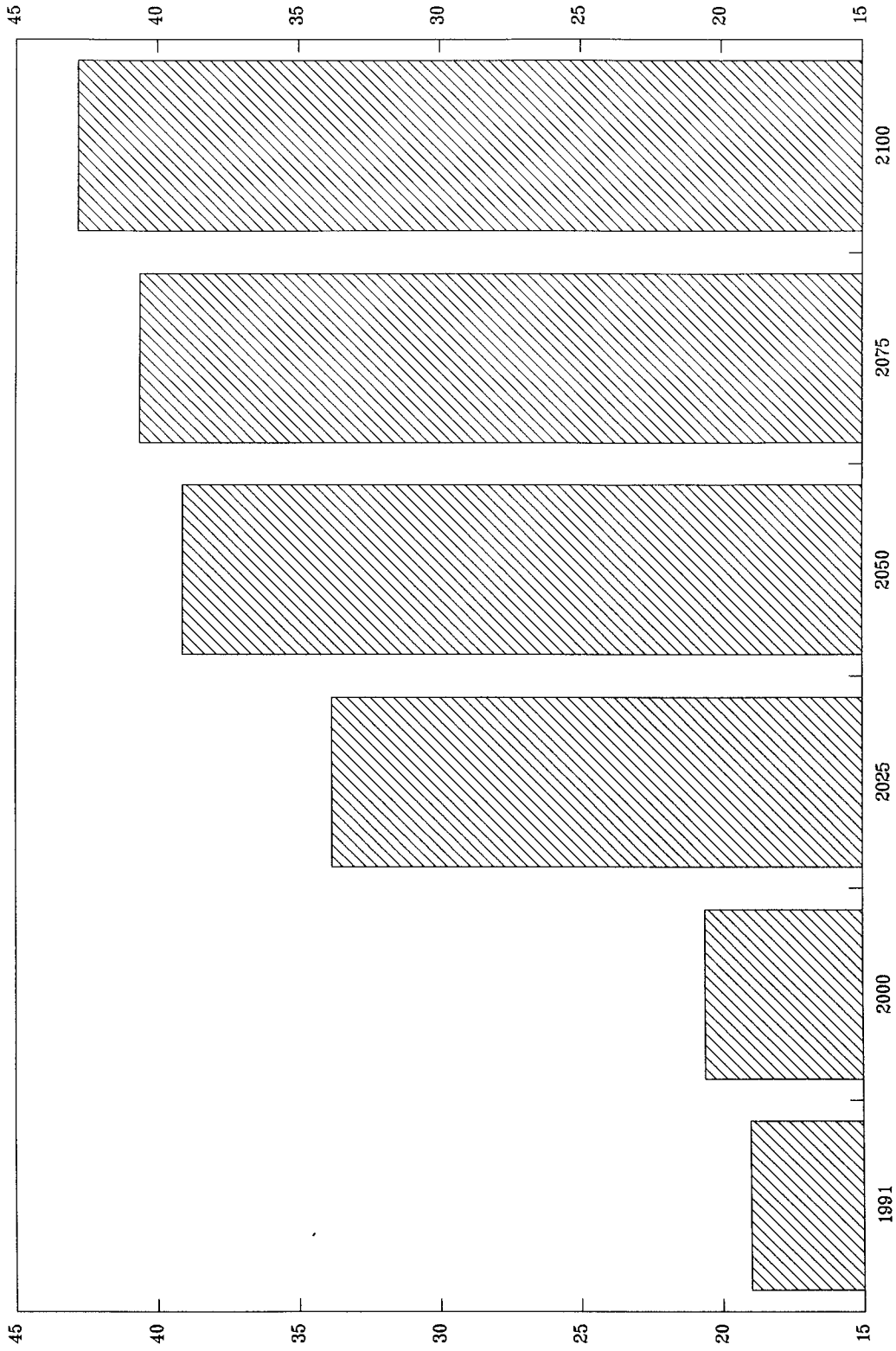
Year	Income	Con- sumption	Labor Supply	Capital Stock	Average Wage	Interest Rate 2/	Tax Rate 3/
10	-2.05	-0.36	-0.75	-5.83	-1.30	0.33	0.71
20	-2.73	-2.67	-0.14	-10.09	-2.59	0.68	1.23
30	-3.20	-4.03	0.18	-12.68	-3.38	0.89	1.56
50	-3.69	-5.42	0.67	-15.67	-4.33	1.17	1.90
Long run steady state	-3.45	-5.55	0.80	-15.17	-4.22	1.14	1.84

1/ Change relative to baseline simulation.

2/ Arithmetic difference in rate from baseline.

3/ Change in the tax rate on income required to maintain budget balance.

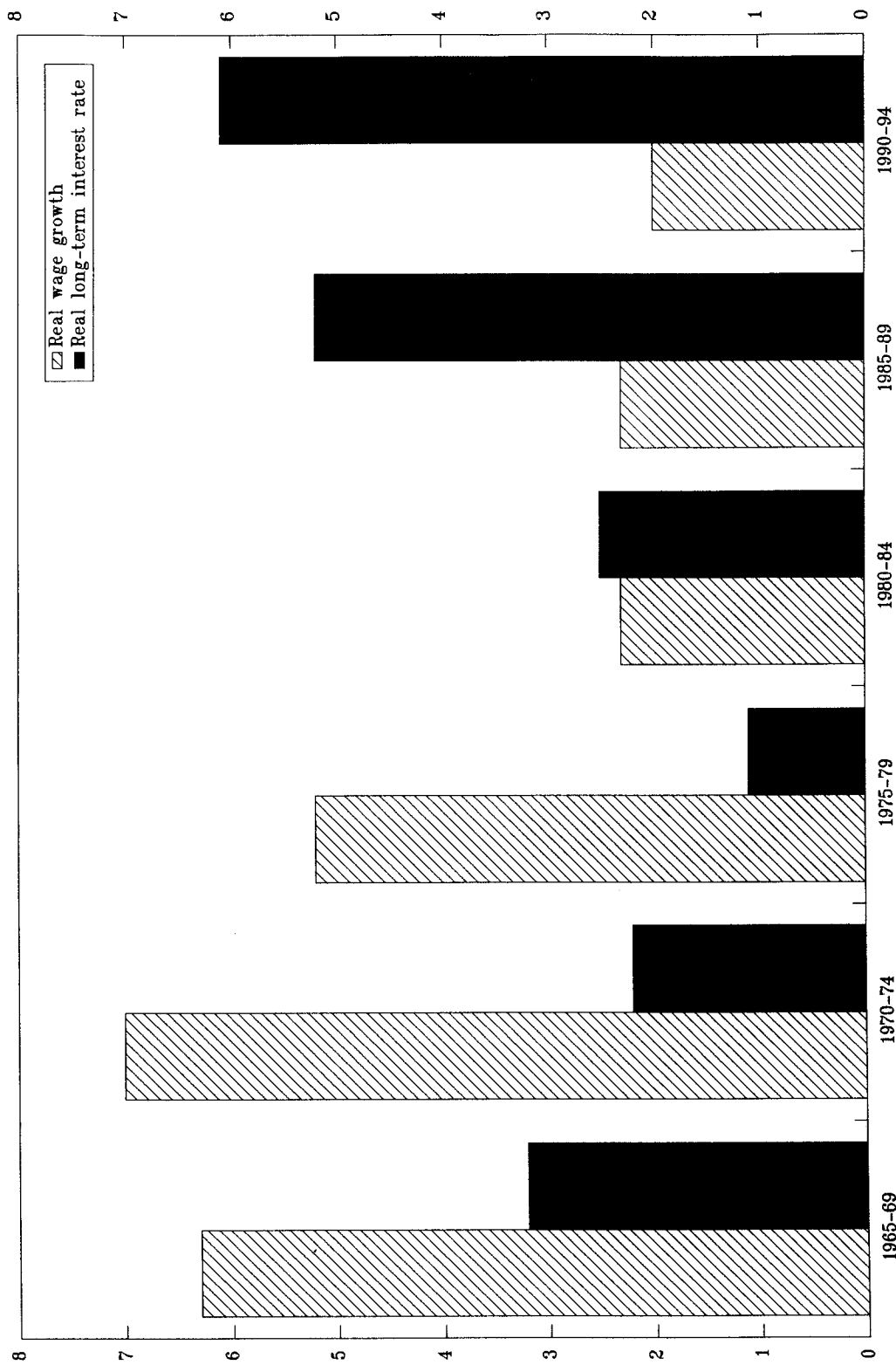
CHART 1  
CANADA  
HISTORICAL AND PROJECTED ELDERLY DEPENDENCY RATIO (EXCLUDING QUEBEC) 1/  
(in percent)



Source: The Canada Pension Plan Fifteenth Actuarial Report.

1/ Elderly dependency ratio: population aged 65 and over as a percentage of population 20-64.

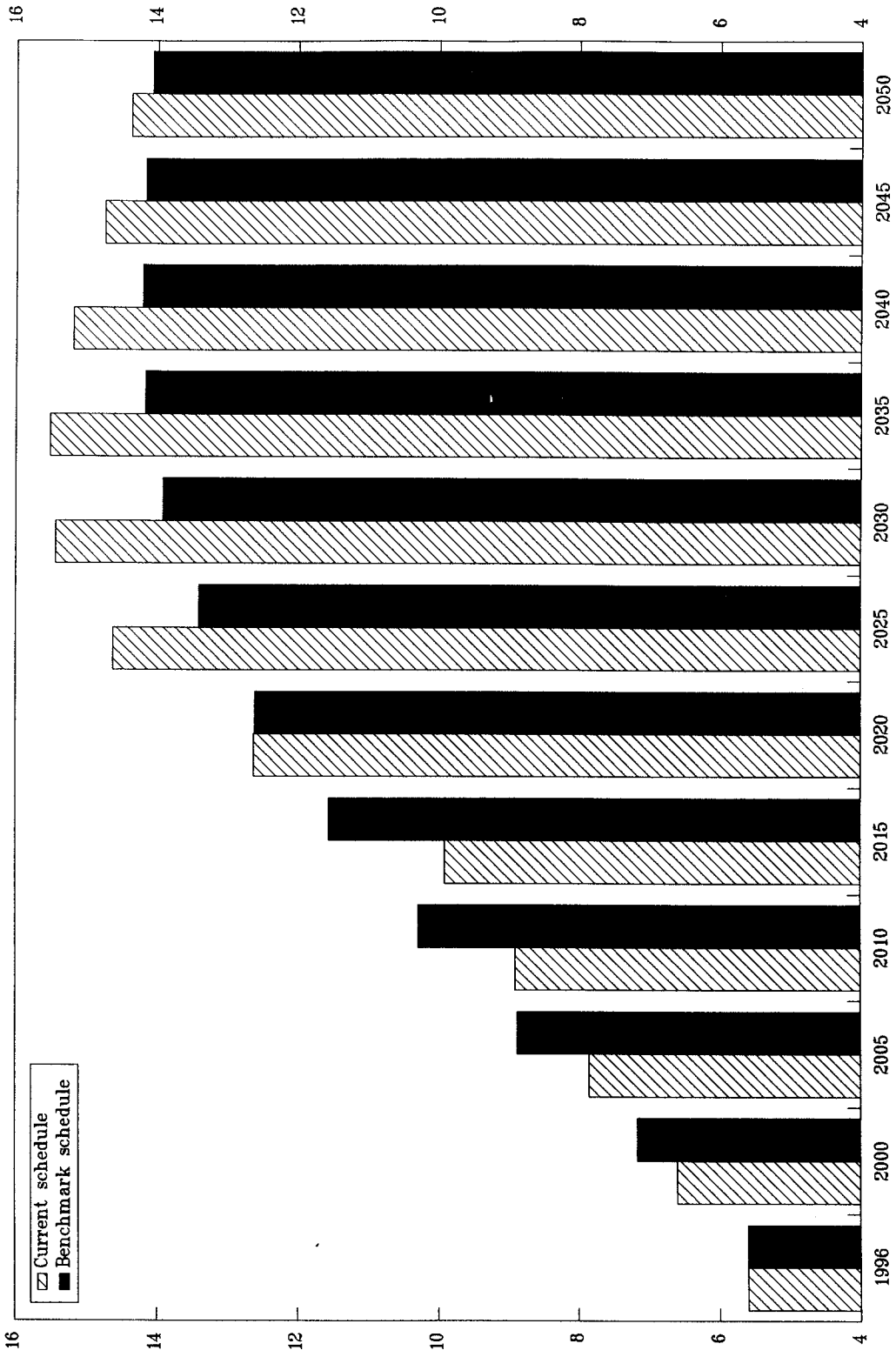
CHART 2  
CANADA  
REAL WAGE RATE AND INTEREST RATE 1/  
(in percent)



Source: Statistics Canada.

1/ Deflated by CPI.

CHART 3  
CANADA  
CURRENTLY LEGISLATED AND BENCHMARK SCHEDULE OF CONTRIBUTION RATES  
(In percent)



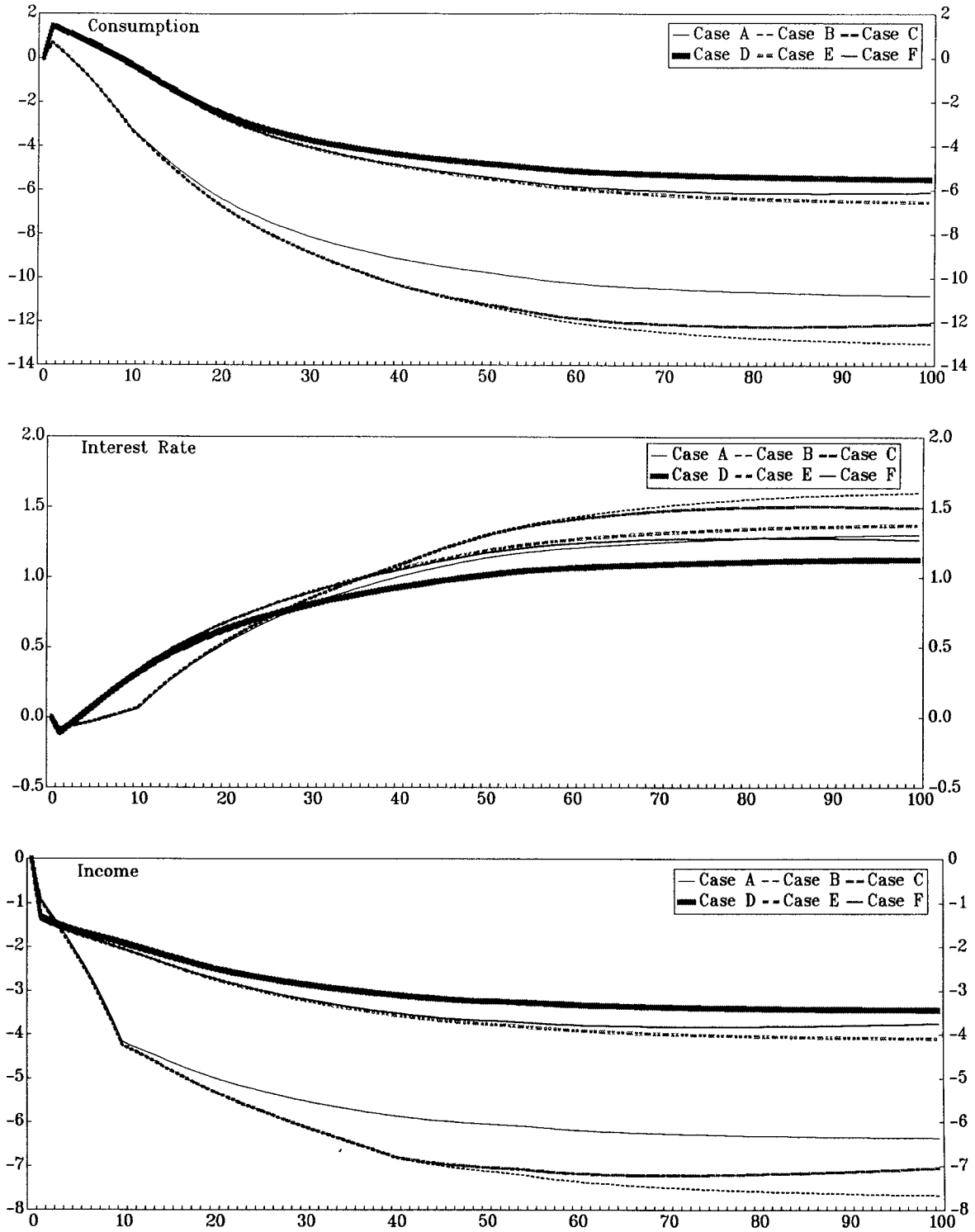
Source: The Canada Pension Plan Fifteenth Actuarial Report.

CHART 4

CANADA

EFFECTS OF DIFFERENT CPP POLICIES

(Deviation from baseline in percent)



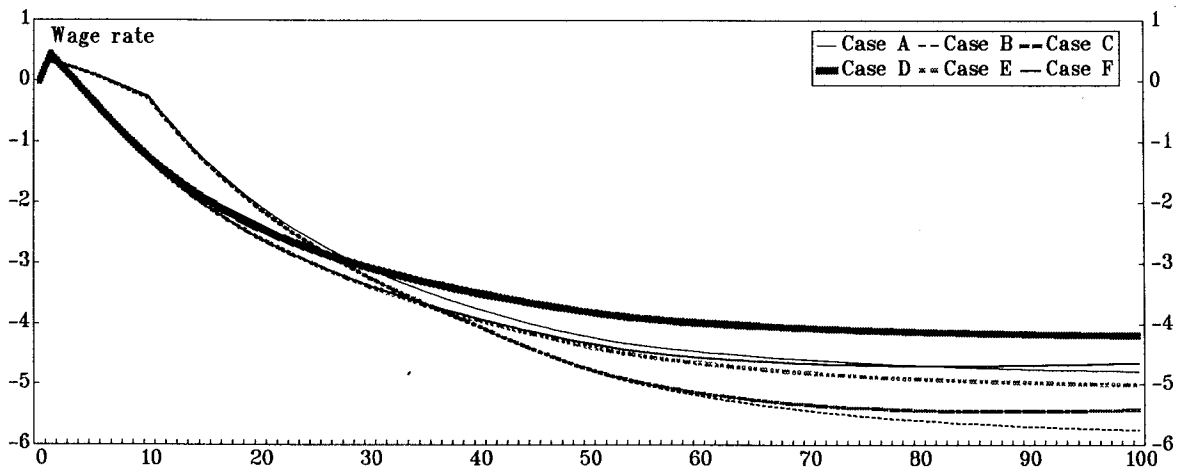
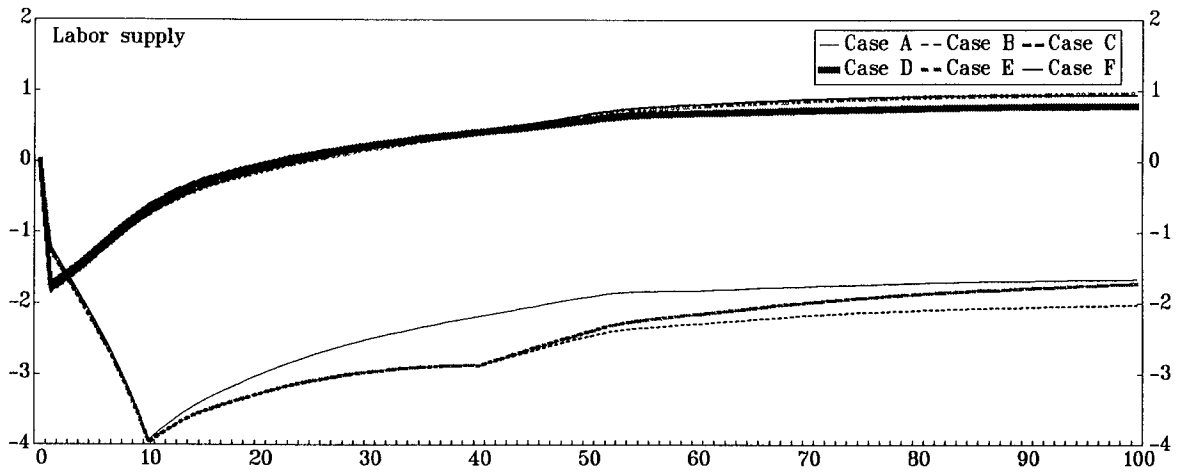
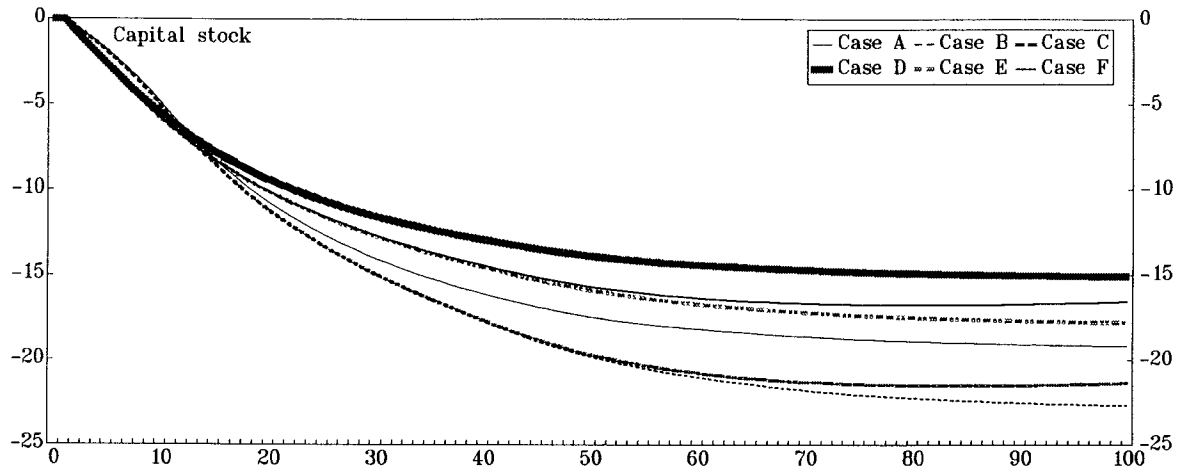
Source: Staff estimates.

CHART 5

CANADA

### EFFECTS OF DIFFERENT CPP POLICIES

(Deviation from baseline in percent)



Source: Staff estimates.