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Inflation and the Tax System in Canada: An Exploratory Partial-Equilibrium Analysis

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Abstract

This paper reports on an exploratory application to Canadian data of an approach pioneered by Martin Feldstein (1997, 1999). Feldstein finds that even at low inflation rates there are costs arising from the distortions introduced by the interaction of inflation with the taxation of income from capital (capital gains, dividends, and interest) in a less-than-perfectly-indexed tax system. Given the exploratory nature of our work, only the main aspects of the conceptual basis of this approach are sketched, and very rough-and-ready estimates for inputs and outputs reported. The economically significant welfare costs of inflation obtained when this approach is applied to Canada arise mainly from distortions in the timing of consumption and saving. However, our reservations about the approach have not led us to refine the estimates or to indicate a preferred estimate.

JEL classification: E5, E6
Bank classification: Inflation: costs and benefits

Résumé

L'étude présente les résultats de l'application aux données canadiennes, à titre expérimental, d'une approche proposée initialement par Feldstein (1997 et 1999). Ce dernier constate que, même à de bas taux d'inflation, l'interaction de l'inflation et de l'imposition des revenus tirés de placements (gains en capital, dividendes et intérêts) dans un régime fiscal imparfaitement indexé entraîne des distorsions coûteuses. Compte tenu du caractère exploratoire de leur recherche, les auteurs se contentent d'esquisser à grands traits le fondement conceptuel de la démarche de Feldstein et de présenter des estimations rudimentaires pour les données utilisées et les résultats obtenus. Les effets négatifs de l'inflation sur le bien-être, qui se révèlent importants du point de vue économique lorsque cette approche est appliquée au cas canadien, découlent surtout des distorsions liées à l'absence de synchronisme entre les activités de consommation et d'épargne. Toutefois, en raison de leurs réserves au sujet de l'approche de Feldstein, les auteurs se sont abstenus de peaufiner leurs estimations ou d'indiquer lesquelles leur semblent les plus plausibles.

Classification JEL : E5, E6
Classification de la Banque : Inflation : Coûts et avantages

1. Introduction

This paper reports on an exploratory application to Canadian data of an approach pioneered by Martin Feldstein. Using a partial-equilibrium framework, Feldstein (1997, 1999) shows that even at low inflation rates there are costs arising from the distortions introduced by the interaction of inflation with the taxation of income from capital (capital gains, dividends, and interest) in a less-than-perfectly-indexed tax system. This approach has been applied by other researchers to Germany (Tödter and Ziebarth (1999)), Spain (Dolado et al. (1999)), the United Kingdom (Bakhshi et al. (1999)), and New Zealand (Bonato (1998)).

The work reported in this paper was performed to better understand the strengths and weaknesses of Feldstein's partial-equilibrium approach. We consider only the main aspects of the conceptual basis of this approach, and accept very rough-and-ready estimates for inputs and outputs. The estimates do not reflect the latest tax changes (for example, the reduced proportion of capital gains subject to tax) or data. However, given the sensitivity analysis, we are confident that the broad conclusions would not change.

The results of the exploratory analysis suggest that there are likely to be economically significant welfare costs of inflation even at Canada's current low inflation rate. The bulk of those costs arise from distortions in the timing of consumption and saving. While believing that the results are qualitatively correct, we have several reservations about the approach. Further work, perhaps using general-equilibrium approaches, would be required to get a clear sense of the robustness of the results to the use of different assumptions and techniques.

Sections 2 to 7, inclusive, sketch the elements of the approach, ranging from an overview to showing how key prices are obtained, to outlining the main elements in deriving estimates for the benefits of moving from low inflation to zero inflation for: saving for retirement, owning versus renting housing, holding money, and government debt service. Section 8 summarizes the tentative empirical estimates of the overall benefits, compares them to those obtained for other countries, and provides some sensitivity analysis. Section 9 discusses some issues identified in the course of this work, and Section 10 concludes. The appendices provide more detail on the analysis or data used in this work.

2. What is Involved in the Feldstein Approach?

The Feldstein approach is explained using a diagram based on the implications of inflation and taxation for the intertemporal allocation of consumption. We point out the key parameters and relationships, and what affects them. Previous papers on this subject give more detail on the conceptual basis. Tödter and Ziebarth (1999) provide a relatively complete exposition of each of the steps.

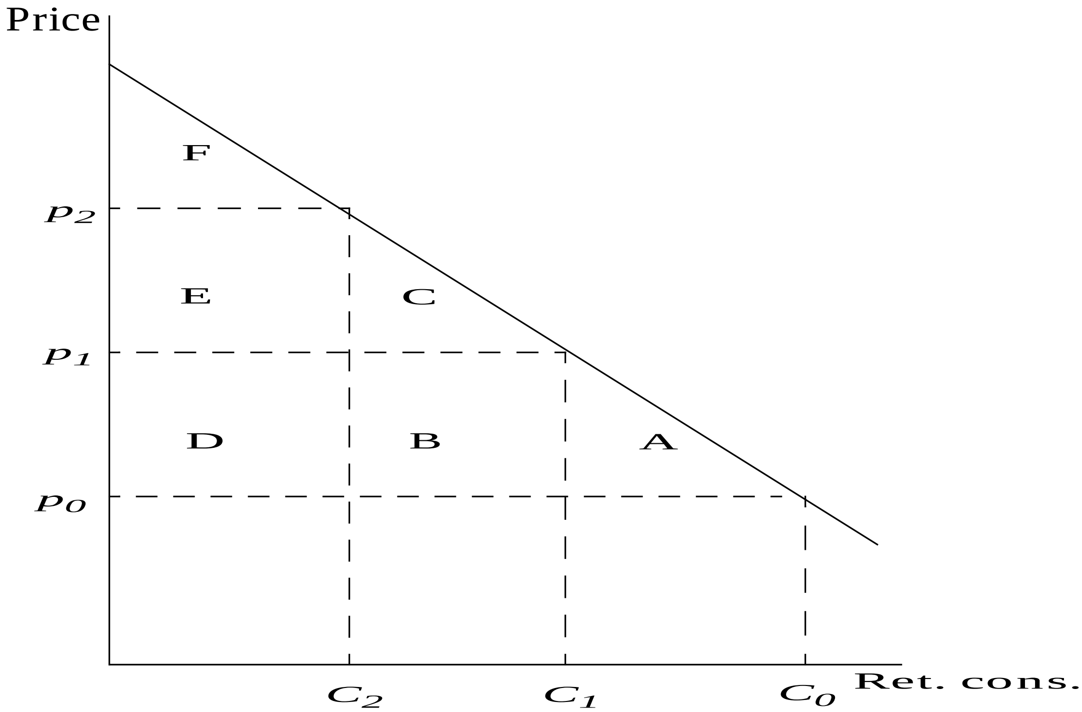
Feldstein (1997, 1999) argues that inflation reduces the after-tax real return to savers, and distorts the allocation of consumption between the early years in life and later years. As a result, young people (our term for period-one economic agents) might decide to save less than they would otherwise. Even if there is no change in saving, there will be a dead-weight cost for the economy, since the fall in the after-tax return to savings implies fewer resources for future consumption. Feldstein derives an estimate of the gain in welfare from reducing inflation in a two-period consumption model.

Individuals are given an initial endowment and they decide how much to save in the first period in order to consume when they retire in the second period. Agents' first-period saving earns a real rate of return. Hence, the period-one price of retirement consumption is inversely related to this rate of return, in that the higher the return on saving, the cheaper the effective price of retirement consumption. Taxes drive a wedge between the pre-tax rate of return—which is assumed to be invariant to inflation—and the post-tax return that households earn. Higher inflation increases the tax wedge and reduces the effective real post-tax return to saving. This lowers retirement consumption from its optimum level (zero-tax, zero-inflation), with corresponding welfare implications.

Demand curves are usually drawn on the assumption that nominal income and the price of other goods are held constant. However, a "compensated" demand curve is more appropriate to measure the dead-weight cost, because it represents the change caused by the substitution effect. When the price of a good increases, the purchasing power (real income) of consumers is reduced, as they can now buy only a smaller quantity of the same good (because of the "income" effect). The effect of a price change on consumers' utility is correctly measured holding real income constant; i.e., compensating for the "income effect."

The negatively sloping compensated demand curve in Figure 1 shows that the amount of retirement consumption (C) purchased by individuals becomes lower when its price rises. Because inflation interacts with the tax system to increase the effective tax rate on capital income and thus to reduce the real net-of-tax return to individual savers, the higher the inflation rate, the higher the price of retirement consumption ($p_2 > p_1$), and the lower the demand for retirement consumption ($C_2 < C_1$) relative to the optimal situation of no inflation and no taxes (p_0,C_0).

Figure 1: Demand for retirement consumption



In a world with no tax and no inflation (p_0,C_0) the consumers' surplus is the sum of the areas A to F. At price p_0, the intersection of supply and demand curves, consumers can acquire quantity C_0 of the good. However, at that price, only the marginal buyers pay exactly what they want. All other consumers pay less, enjoying a "consumer surplus." Recall that the consumer surplus is the excess that consumers would be willing to pay for a given quantity of retirement consumption over the amount that they have to pay. This is represented in Figure 1 by the difference between the area below the demand curve for the quantity C_0 and the quantity p_0C_0.

In a world with taxes but no inflation (p_1,C_1) the equilibrium point moves from (p_0,C_0) to (p_1,C_1) with less retirement consumption at a higher price. The consumers' surplus shrinks to the area C+E+F and tax revenues (TR) of B+D are created. The difference, the triangle A, is a dead-weight loss (DWL); it is the reduction of consumers' surplus which is not compensated by higher tax revenues.

In a world with taxes and inflation, the equilibrium point moves to (p_2, C_2) with a reduced consumption level at a higher price. The remaining consumers' surplus is the area F, whereas tax revenues correspond to the rectangle D+E. The DWL relative to a world with no taxes and no inflation increases to the triangle A+B+C.

The gross welfare gain, G_G (in Sections 4 to 7, inclusive, denoted as the direct effect), associated with a reduction in inflation (and hence with a reduction in the retirement price $p_2 - p_1$), is the area under the compensated demand curve. This area is the trapezium C+B (an increase in consumer surplus of C+E plus the change in tax revenues, B-E ((B+D) - (D+E) = (B-E)), gives C+B). In equation form this can be represented as:

$$G_G = (B + C)$$

Assuming that the government would want to offset any change in tax revenues arising from lower inflation, the net gain, G_N, of a move to price stability would be different from that given by the area B+C. Denoting the dead-weight effect of a dollar change of an alternative tax by λ, the change in the dead-weight burden arising from imposing or removing alternative taxes is given by $\lambda(B - E)$ (denoted henceforth as the indirect effect). Then the net gain of price stability is the direct effect plus the indirect effect:

$$G_N = (B + C) + \lambda(B - E).$$

Note that the sign of the difference between the areas B and E depends on the nature of the distortions in the market being considered. It is negative under reasonable assumptions in the case of the intertemporal allocation of consumption.

Although we do not systematically show every step to go from the areas in the diagram to the algebraic relationships needed to make the empirical estimates, the following areas are relevant to quantifying the benefits of price stability:

$$A = \frac{1}{2}(p_1 - p_0)(C_0 - C_1)$$

$$B = (p_1 - p_0)(C_1 - C_2)$$

$$C = \frac{1}{2}(p_2 - p_1)(C_1 - C_2)$$

$$D = (p_1 - p_0)C_2$$

$$E = (p_2 - p_1)C_2$$

3. Derivation of Prices (p_0, p_1, and p_2)

This section defines some of the basic concepts, provides an overview of the experiment, including some caveats, and derives the prices used for the calculations in the remainder of the paper. Because the focus is on the distortions arising from the interaction of inflation and the taxes on income from capital, recall that income from capital is what persons receive in the form of capital gains, dividends, and interest.

Table 1 provides rough-and-ready estimates of the relevant rates of return for different inflation rates. The rates can be used along with an assumption about the length of an agent's working life to arrive at estimates of the prices shown in Figure 1. (Appendix 1 discusses the issues involved in choosing an estimate of the base rate of return required to do the calculations.)

Table 1: The effect of inflation on the tax burden on capital income (per cent)

Inflation rate π	Real after-tax return on savings s	METR on savings $\frac{r^* - s}{r^*}$
0	5.8	42
1	5.4	46.2
1.5	5.2	48.3
2	5	50.4

Boadway and Kitchen (1999) note that, if capital markets in Canada are open, then taxes levied on firms will cause the before-tax rate of return on investment to rise, distorting investment decisions. They argue that the after-tax return to shareholders must conform with the rate of return on international markets. At the same time, personal taxes levied on capital income will cause the after-tax rate of return on savings to fall and discourage saving. Boadway and Kitchen suggest that, while "capital markets in Canada may not be fully open, they are nonetheless "quite" open" (p. 276). For another perspective, see OECD (1991, p. 269, Annex 3), which argues that, with interest income taxed according to the residence principle (countries levy taxes on interest income from home and abroad earned by their residents) in the OECD area, free capital mobility "implies a tendency for the pre-tax rates of interest to be equalised across countries and hence the rate of interest before tax will tend to be given from abroad in an open economy which is small relative to the world economy."

In the baseline calculations, we assume that true inflation, π, is reduced from 2 to 0 per cent. This can be considered to be lowering the upper band of the inflation control target to a measured inflation rate of 1 per cent from a measured inflation rate of 3 per cent to allow for a measurement error of between 0.5 and 1 percentage points in the year-to-year inflation rate. Crawford et al. (1998, 68–9) suggested that the mean bias was 0.5 percentage point with a maximum bias of 0.7 percentage point.

As in Feldstein's work, the calculations in this paper use aggregate estimates of saving and tax rates, and other parameters, to derive the results. The cautions of Ruggeri et al. (1997) about summarizing tax structures with single indicators of tax rates in general-equilibrium simulations extend to partial-equilibrium analysis. Other work (Boadway et al. (1984), OECD (1991), and *The Report of the Technical Committee on Business Taxation* (Canada 1997)) demonstrates that representing the implications of major aspects of the Canadian tax system can be quite complex, very time-consuming, not easily done with single parameters, and provides results that are often only indicative.

Following the approach used by other researchers, we obtain 0.10 (10 per cent) for the initial value of the real pre-tax return to capital, *r*, roughly the average real rate of return experienced by Canada's business sector over the period 1971 to date (see Appendix 2). Nominal returns on financial assets, *i* (a combination of a real return and inflation à la the Fisher equation), are taxed at the rate m_i, so that the tax burden on savings increases with inflation, π. To be consistent with the terminology used in this literature, *s* is defined as the real after-tax rate of interest received by savers:

$$s = i(1 - m_i) - \pi \tag{3.1}$$

In Canada, personal income is taxed by two different levels of government (federal and provincial), and the tax burden is affected by changes in tax rates and brackets, individual incomes, and compositional changes in income. With the removal in 1994 of the $100 thousand exemption on capital gains available to individuals, the effective marginal tax rate on capital gains in Canada has increased from its low value prior to that change (OECD 1991). To obtain our initial estimate (0.42) of the marginal tax rate on all capital income (m), we took the top marginal tax rates on the different types of capital income (capital gains, dividends, and interest) and weighted them by an estimate of their relative share as determined from Revenue Canada reports on individual incomes and taxes. Recall that capital gains are taxed on realization, not on accrual, allowing for taxes to be deferred. Active use of this option, particularly by high-income earners, could lower the marginal tax rate on capital gains relative to what is assumed here.

The estimates in Table 1, though approximate, suggest that even a low inflation rate can have sizable costs. For example, the results presented in the table show that reducing true inflation by 2 percentage points to zero lowers the marginal effective tax rate (METR) on savings from 50.4 to 42 per cent, and increases the real after-tax return to saving from 5 to 5.8 per cent. A higher marginal personal tax rate than assumed would lead to a higher METR on savings for any given rate of inflation. This conclusion and the implications of focusing on the change in the net return to savers seems to be consistent with Boadway et al. (1984). In their analysis of the impact of inflation, they concluded that "Under the open economy assumption, corporate taxes have no influence on the net return to savers . . . . Analogous to the corporate tax, personal taxes influence only the net return to savers, not the gross return to investment, under the open economy assumption, since they have no effect on the market cost of finance" (p. 77–8). We report the results of using sensitivity analysis to explore the implications of making different assumptions about data and parameters in Section 8.3.

4. Estimate of Effect on the Intertemporal Allocation of Consumption (Or on Savings for Retirement)

This section and the three that follow describe the key relationships for deriving the results and indicate how estimates for unobserved or ambiguous parameters are obtained. The foregoing diagrammatic analysis is repeated in each of the following sections to give some intuition about the perceived distortion. The algebraic analysis is presented in subsections 4.1 and 4.2, respectively, on direct effects (the gains from reducing inflation) and indirect effects (the gains/losses from replacing the inflation tax with an alternative one). Results from our initial assumptions (called base-case results) are presented for the direct, indirect, and net effects (the sum of the direct and indirect effects).

4.1 Direct effects of reducing distortions to consumption timing

In a simple 2-period model, young people earn income in period 1 and save S out of their income to provide for their retirement. If the period for work is T periods long, S is invested at the real after-tax rate of return s for T years. In period 2, retired people consume out of their wealth (equation (4.1)).

$$C = (1 + s)^T S \qquad (4.1)$$

Then, the price at which savings S can buy retirement consumption C is given by:

$$p_i = (1 + s_i)^{-T} \qquad (4.2)$$

The welfare loss caused by inflation can be estimated as:

$$\Delta DWL = [(p_1 - p_0) + 0.5(p_2 - p_1)](C_1 - C_2) \tag{4.3}$$

The prices, p_0, p_1, p_2, can be calculated from (4.2) where s_0, s_1, and s_2 are the estimates derived in Section 3 (respectively, 0.10, 0.058, and 0.05).

Assuming an uninterrupted working life of thirty years, *T*=30, the price of retirement consumption increases as the economy moves from a no-inflation, no-taxation world to a world with taxation and then to a world with inflation and taxation.

The difference, $(C_1 - C_2)$, cannot be calculated directly. It can be rewritten as:

$$\frac{(p_1 - p_2)}{p_2} C_2 \varepsilon_{C_p}$$

where ε_{C_p} is the compensated elasticity of net retirement consumption with respect to its price. Thus, (4.3) can be expressed as:

$$\Delta DWL = \left(\left(\frac{p_1 - p_0}{p_2}\right) + 0.5\left(\frac{p_2 - p_1}{p_2}\right)\right)\left(\frac{p_1 - p_2}{p_2}\right) p_2 C_2 \varepsilon_{C_p} \tag{4.4}$$

After substituting in $S_2 = p_2 C_2$ and doing some calculations, (4.4) can be rewritten as:

$$\Delta DWL = a S_2 \varepsilon_{C_p} \tag{4.5}$$

where *a* depends on the elements determining the s_i and the assumption about the length of working life. The measurement of the distortions associated with consumption timing depends upon how long a saving period is assumed. For example, a saving period half as long as assumed here would roughly reduce the wedge created by inflation (estimated from the ratios of the relevant prices) by more than half.

The variables S_2 and ε_{C_p} are not directly observable. The term S_2 represents the value of savings during pre-retirement years, assuming 2 per cent inflation. It does not correspond to the average savings rate, but the relationship between the two can be derived from a simple overlapping generations (OLG) model. In that model, savings are proportional to income and grow at the rate $(n + g)$, where n is the rate of population growth and g is the growth rate of real income per capita. Savings of young people are then $(l + n + g)^T$ times the dissaving of old people; see Tödter and Ziebarth in Feldstein (1999, 83). Average personal savings in the economy (S_n) are related to the savings of young people S_Y according to:

$$S_Y = S_n[1 - (1 + n + g)^{-T}]^{-1}.$$

The term S_Y is conceptually equivalent to S_2 and can be calculated from the above expression. For S_n an estimate of average savings is used.[1] For $(n + g)$ an obvious source for an estimate is the steady-state value of GDP growth from a model; for example, the Bank's Quarterly Projection Model (QPM). Given values for these components and the preferred assumption about the length of working life, the value of S_2 can be calculated. Equation (4.5) then becomes:

$$\Delta DWL = b(GDP)\varepsilon_{C_p} \tag{4.6}$$

where *b* depends on *a* and the assumptions used to determine S_2.

ε_{C_p}, the compensated elasticity of net retirement consumption with respect to its price, can be expressed initially in terms of the uncompensated elasticity η_{C_p} and of the propensity to save out of exogenous income (income from an unfunded social security system), σ:

$$\varepsilon_{C_p} = \eta_{C_p} + \sigma$$

One assumption is that the propensity to save out of exogenous income is equal to the propensity to save out of wage income. Thus,

$$\sigma = \frac{S_2}{\alpha(GDP)}$$

where α is the wage share of GDP.

Given a value for σ, it is then necessary to transform the elasticity of net retirement consumption into that of an observable variable, like savings. When doing this, it must be taken into account that old people receive a certain amount of exogenous income during their retirement years (see Appendix 2). For those who live only on this form of income, the welfare loss induced by inflation affecting savings behaviour is virtually nil.

The budget constraint of retired people is given by $C = (S/p) + E$, where E is exogenous income. Taking logarithms of both sides and rearranging gives

1. In recent years, the national accounts measure of personal savings has been low, but there is some debate about whether this estimate reflects the true savings behaviour of Canadians. For example, the national accounts are based on the concept of current production, so the national accounts personal savings measure does not include capital gains and losses. As a result, the economic agents' savings rate in the recent period may have been higher than that shown in the national accounts measure. For the implications of a lower and higher savings rate on the estimates of the welfare cost of low inflation, see the results of the sensitivity analysis.

$\eta_{C_p} = (1 - E/C)(\eta_{S_p} - 1)$, where E/C is the ratio of exogenous income to retirement consumption. Other things being equal, the higher this ratio the lower the gain from reducing inflation.

Another step is to express the uncompensated elasticity of savings with respect to the price of retirement consumption, η_{S_p}, in terms of the elasticity with respect to the real rate of return, η_{S_s}:

$$\eta_{S_p} = -\frac{(1+s)}{sT}\eta_{S_s}$$

where s, the real after-tax return on savings, is evaluated at 2 per cent inflation.

With no reliable estimate of the interest elasticity of saving in Canada, we follow the lead of other researchers who have applied this approach and use three different values for η_{S_s} (0, 0.4, and 1) to get a range of values for η_{S_p}.[2] When these values are used in the relevant equations and an assumption made for the value of E/C, three different values can be obtained for η_{C_p} and for ε_{C_p}.

Given our base-case assumptions and different values for ε_{C_p}, the resulting estimates of the direct welfare effect of reducing distortions to consumption/saving are 0.50, 0.70, and 1.05 per cent of GDP, respectively.

4.2 Indirect effects

With disinflation there is a reduction of the tax burden on capital income and a loss of tax revenue. The latter is equal to the difference between the two rectangles, E and B, in Figure 1. This difference can be expressed in algebraic form as

$$\Delta Rev = (p_1 - p_0)(C_1 - C_2) - (p_2 - p_1)C_2$$

It is appropriate to look at the compensated demand curve for retirement consumption when calculating the direct effect, since price movements cause changes in consumers' real income that should be taken into account when considering welfare implications. However, an uncompensated demand curve is more appropriate for evaluating the

2. See Bérubé and Côté (2000) for a recent discussion of work on the interest elasticity of saving and an estimate of the long-term effect of the real interest rate on savings in Canada. Their results indicate the difficulty of getting reliable estimates of this elasticity.

government revenue impact, since it takes into account the actual behaviour in the market. Then $(C_1 - C_2)$ can be expressed as:

$$\frac{(p_1 - p_2)}{p_2} C_2 \eta_{C_p}$$

Recall that $S_2 = p_2 C_2$ and $\eta_{C_p} = \eta_{S_p} - 1$. Rearranging terms gives:

$$\Delta Rev = \left[\left(\frac{p_1 - p_0}{p_2}\right)\left(\frac{p_2 - p_1}{p_2}\right)(1 - \eta_{S_p}) - \left(\frac{p_2 - p_1}{p_2}\right)\right] S_2$$

Given values for p_0, p_1, and p_2, respectively, and for S_2, they can be substituted into the equation to get:

$$\Delta Rev = [c(1 - \eta_{S_p}) - d](S_2)$$

where c and d depend on estimates for the p_i, and S_2 on the elements noted above.

Depending on the values of η_{S_p}, different values for the loss in tax revenue are obtained. To get the welfare effect of this tax revenue loss, these values must be scaled by some estimate of the dead-weight cost of taxation.

Since we are unaware of a consensus estimate of the dead-weight cost of taxation, we follow Tödter and Ziebarth and assume that the computed tax loss in the case of price stability can be calculated as $\lambda = A/(B + D)$. Using this approach, and given the range of estimates for ε_{C_p}, a range of values for λ is obtained. Taking these values for λ, the resulting welfare effect of the tax revenue loss varies from just above 0 per cent to just above 0.25 per cent of GDP.

4.3 Net effect

Combining the direct estimates of the positive welfare gain of moving from 2 to 0 per cent inflation with the estimates of the indirect costs under base-case assumptions gives an estimate of the overall net welfare gain ranging from around 0.20 to just over 1 per cent of GDP, depending on the value of λ used. This result assumes that there are more efficient ways of raising government revenues than the inflation tax. As a result, it uses a general estimate of the dead-weight cost of raising these revenues, rather than one that would equalize the cost of raising revenues to the benefit of reducing inflation. Sensitivity analysis of the implications of different values of this estimate is discussed later.

5. Inflation and Residential Investment

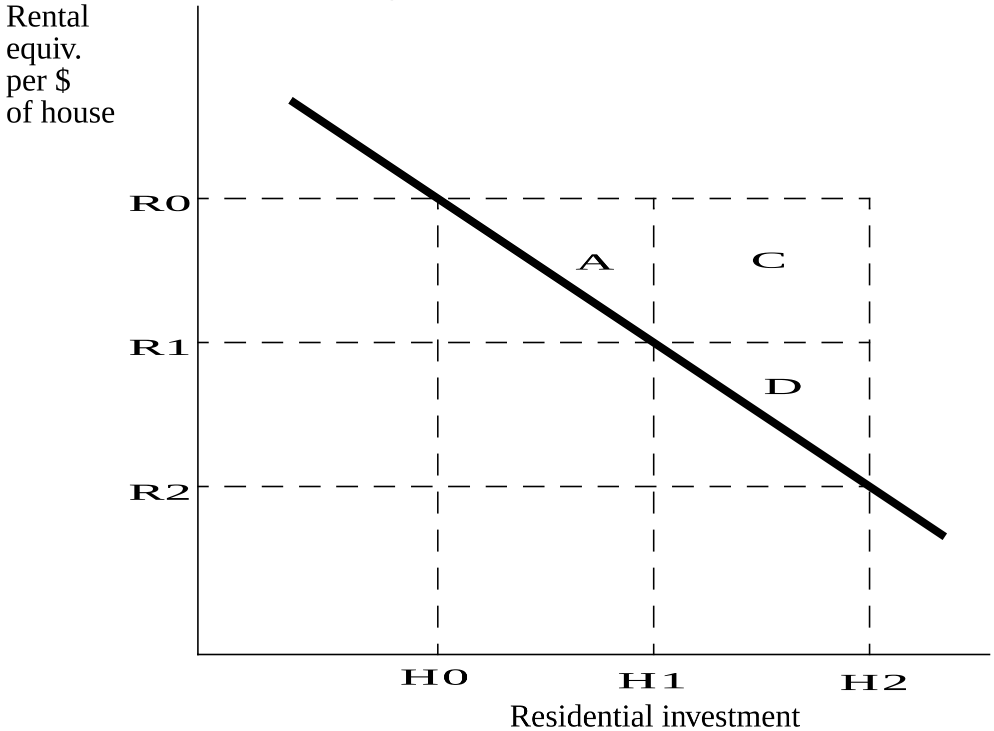
The tax system in most industrial countries favours owner-occupied housing over other capital investments because no tax is imposed on the implicit rent on the property that the owners earn. This distortion is exacerbated in some countries because homeowners are allowed to deduct mortgage interest and property taxes from their taxable income. As a result, analysis such as that done here usually assumes that investment in housing is probably above its optimal level under these conditions. Then, the associated welfare loss is the opportunity cost of the resources that could be used otherwise. Inflation adds to the distortion by reducing the net-of-tax real return on alternative assets.

The tax distortion arising from not taxing imputed rental income reduces the opportunity cost of the equity invested in owner-occupied houses, since the implicit income from the investment in housing remains tax-free, while returns on alternative assets are subject to tax (outside of tax-deferred or tax-exempt vehicles).[3] Inflation adds to the distortion because it reduces net-of-tax real returns on alternative financial and business assets. Disinflation increases the after-tax return on alternative assets and pushes capital out of housing into the business sector, potentially generating two opposite changes in tax revenues: (1) income-tax revenues increase because the effective tax rate in the business sector is higher, and (2) revenues from local government property tax are reduced as the housing stock falls. It seems likely that (1) would exceed (2), and as a result the indirect effect should be positive. To the extent that revenues raised from property taxes are determined by local expenditure needs, an increase in property tax rates may prevent a decline in revenues from local property tax.

The dark line in Figure 2 describes the compensated demand for housing services. The horizontal line at R_0 is the undistorted cost of housing; at R_1 it is the cost of housing with taxes included; at R_2 it is the cost of housing with taxes and inflation included. Triangle A represents the dead-weight cost of taxation, while that caused by the interaction of inflation and taxation is represented by the trapezoid C+D.

3. See Boadway and Kitchen (1999, 159), for an example of how this violates the economic principle of neutrality.

Figure 2: Residential investment



Owner-occupied housing is favoured by personal income taxation in Canada; no taxes are imposed on the implicit “rental” return earned by the owner from the capital invested in the property. In addition, no taxes are imposed on capital gains realized from the sale of a principal dwelling. The implication of the non-taxation of the implicit rent is that inflation affects the demand for housing indirectly, by cutting the return on alternative assets. With price stability this distortion is minimized, and the loss of tax revenue is reduced by moving capital from owner-occupied housing to the business sector.

5.1 Direct effect

With no taxation and no inflation, the implied rental cost of housing per dollar of housing capital is:

$$R_0 = s_0 + \delta_H$$

where s_0 is the rate of return on capital in the business sector with no taxes and no inflation, and δ_H represents the rate of depreciation and maintenance. However, this is not the way that the rental cost of housing per dollar of housing capital is calculated below, since we want to include property taxes and the real interest cost of mortgages.

With taxation and inflation,

$$R_2 = \mu(r_m + \pi) + (1 - \mu)(s_2 + \pi) + \tau_p + \delta_H - \pi$$

where μ is the loan-to-value ratio, r_m is the real mortgage interest rate, Π is the rate of inflation, s_2 is the rate of return on capital in the business sector assuming taxation and inflation, and τ_p is the local property tax rate.

Given the values for each of the parameters, a range of values for the implied rental rate can be obtained. This rate first declines from its value in a world with no taxation and no inflation; it declines more as a world with taxation is considered, and then somewhat more as a world with inflation and taxation is assumed.

Using the area of trapezoid C+D, the dead-weight cost of inflation and taxation, the measure of the welfare effect of inflation can be represented as:

$$\Delta DWL = [(R_0 - R_1) + 0.5(R_1 - R_2)](H_2 - H_1). \tag{5.1}$$

Making use of the following:

$$\begin{aligned} H_2 - H_1 &= (dH/dR)(R_2 - R_1) \\ &= (dH/dR)(R_2/H_2)(H_2/R_2)(R_2 - R_1) \\ &= \varepsilon_{H_R} H_2 (R_2 - R_1)/R_2 \end{aligned}$$

equation (5.1) can be rewritten as:

$$\Delta DWL = -\varepsilon_{H_R} R_2 H_2 \left\{ \left[\frac{(R_0 - R_1)}{R_2} \frac{(R_1 - R_2)}{R_2} \right] + 0.5 \left[\frac{(R_1 - R_2)}{R_2} \right]^2 \right\} \tag{5.2}$$

where ε_{H_R} is the compensated elasticity of housing demand with respect to the rental rate. In the absence of an estimate for ε_{H_R} a range of values (0.1, 0.4, and 1) is used, as in other studies (for example, Bakhshi et al. (1999)), which encompass those obtained for the other countries involved in this exercise. Given an estimate of the ratio between the value of the owner-occupied housing stock and GDP, and taking each possibility for ε_{H_R}, the ΔDWL is 0.01, 0.04, or 0.10 per cent of GDP.

5.2 Indirect revenue effect

In the case of owner-occupied housing, elimination of inflation would lead to higher tax revenues. The increase in business capital resulting from the release of capital from owner-occupied housing generates additional revenue equal to:

$$\Delta Rev = \varepsilon_{H_R} \frac{R_1 - R_2}{R_2} H_2 (s_0 - s_1)$$

and gives a range of values as a per cent of GDP, depending on whether ε_{H_R} is taken to be equal to 0.1, 0.4, or 1.

This increase in tax revenue is partly offset by a loss in revenue from property taxes (although see the earlier observation), due to the reduction of the housing stock. This loss can be estimated from:

$$\Delta Rev = \varepsilon_{H_R} \frac{R_1 - R_2}{R_2} H_2 \tau_p$$

again giving a range of values as a per cent of GDP, depending on whether ε_{H_R} is taken to be equal to 0.1, 0.4, or 1.

The welfare effect of the net change in revenue, applying the maximum value of λ, is at most 0.02 per cent of GDP.

5.3 Net effect

Under the base-case assumptions, the maximum overall welfare gain of the effect of lower inflation on the housing sector is 0.12 per cent of GDP. This effect would likely be larger if we had factored into the calculation the exemption from taxes of capital gains on a principal residence.

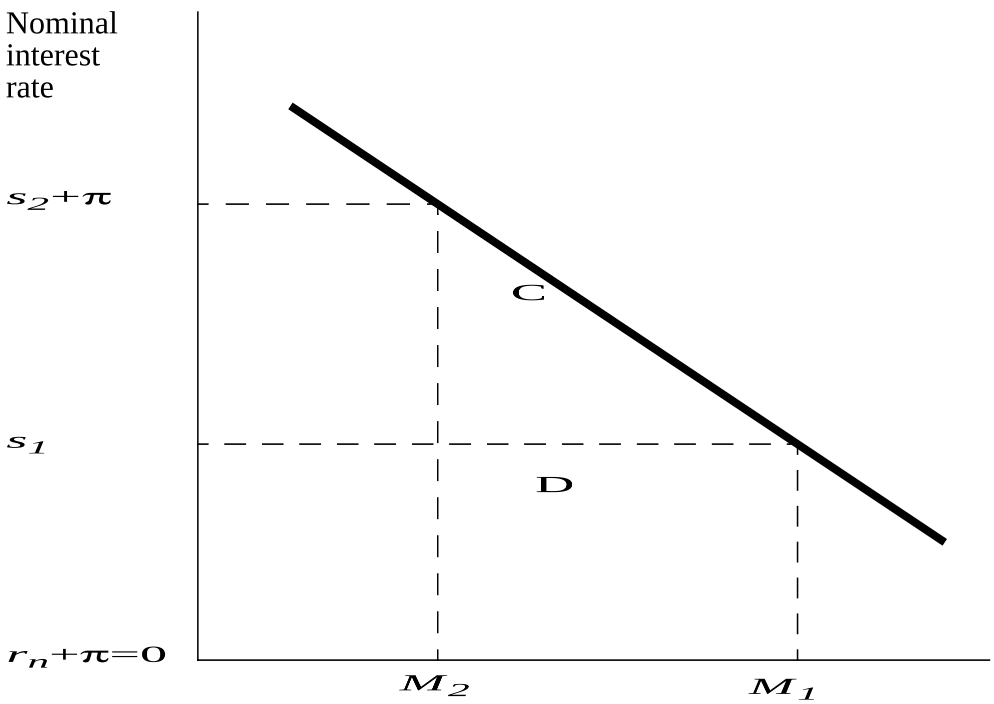
6. Inflation and Money Demand

With inflation, the cost of holding non-interest-bearing money is higher, leading agents to hold less than an optimal level of money balances. This distortion is eliminated in a world with price stability, but at the cost of lower seigniorage revenue. A lower opportunity cost from holding money balances results in a transfer of capital out of the business sector into money, and thus into a lower amount of tax revenue from business profits.

There is a partial offset to these two negative indirect effects from the larger amount of monetary financing available to lower the cost of servicing government debt.

Figure 3 shows the reduction in DWL that results if the inflation rate is reduced from $\pi = 2$ to 0, thereby reducing the opportunity costs of holding money balances from $s_2 + \pi$ to s_1. Since the opportunity cost of supplying money is zero, the welfare gain from reducing inflation is the area C+D between the money-demand curve and the zero-cost line.

Figure 3: Money demand and seigniorage



6.1 Direct effect

As noted above, the Friedman-Bailey effect should be measured by the trapezoid, C+D, in Figure 3, where the money-demand curve is displayed. Its area is measured by

$$\Delta DWL = s_1(M_1 - M_2) + 0.5(s_2 + \pi - s_1)(M_1 - M_2)$$

where $(M_1 - M_2) = \left(\left(\frac{s_2 + \pi - s_1}{s_2 + \pi}\right) M \varepsilon_m\right)$

with ε_m representing the elasticity of money demand with respect to the nominal opportunity cost of holding money balances. In Canada, a recent estimate for this is 0.26, while the quantity of non-interest-bearing money (essentially currency) is between 3 and 4 per cent of GDP. Given the small size of these numbers, the direct effect of inflation on money demand is insignificant using base-case numbers.

6.2 Indirect effect

The net revenue effect is the sum of three different effects: the reduction of seigniorage, the tax revenue loss in the business sector, and the reduction of the cost of servicing government debt.

The loss in seigniorage of lower inflation can be calculated as

$$\Delta Rev_1 = -M\left[1 - \varepsilon_m \frac{(s_2 + \pi - s_1)}{s_2 + \pi}\right]$$

and is small.

The revenue loss effect is measured by

$$\Delta Rev_2 = (-(s_0 - s_1)(M_1 - M_2))$$

and it is very small.

Similarly, the effect arising from reducing interest-bearing debt instruments, and hence the government's debt service, is very small. It can be expressed as:

$$\Delta Rev_3 = r_{ng}(M_1 - M_2),$$

where r_{ng} is the real interest paid by government on its debt net of the taxes it collects on those interest payments. Tödter and Ziebarth (1999, 72), note that r_{ng} is a function of the ratio of debt service to public debt, the tax rate, and inflation. In algebraic form the relationship is:

$$r_{ng} = (1 - m)\gamma - \pi$$

where γ is the ratio of debt service to public debt expressed as a percentage.

6.3 Net effect

When the DWL coefficient is applied to the sum of the above, the net effect using base-case assumptions is very small.

7. Government Debt Service

With no inflation, the real cost of servicing the government debt would be higher, because nominal interest payments would no longer include an element of inflation compensation to be taxed. This loss in revenue is calculated as

$$\Delta GDP = \left(-m\frac{B}{GDP}\right)(\Delta\pi)$$

where m is the personal tax rate and B is the outstanding government debt. The lost revenue using the base-case numbers is estimated to equal -0.53 per cent of GDP.

7.1 Net effect

In terms of the welfare cost of reducing inflation from 2 per cent to zero, the effect is between -0.06 and -0.12 per cent of GDP.

8. The Reasonableness and Robustness of the Overall Result

8.1 Overall result

As Table 2 shows, reducing true inflation from 2 to 0 per cent is estimated to result in a benefit ranging from 0.11 to 1.08 per cent of GDP year by year, with the interval reflecting the choice of assumptions used for the elasticity of savings with respect to the real rate of return, the compensated elasticity of housing demand with respect to the rental rate, and the dead-weight cost of taxation. Whatever estimate of the benefit used, the main part is due to preventing inflation-induced distortions in the intertemporal allocation of consumption and saving (0.24 to 1.03 per cent of GDP). The correction of the distortions in the demand for owner-occupied housing makes a net contribution amounting to as much as 0.12, and as little as 0.01, per cent of GDP. The impact on money demand and the associated government income of reduced inflation lead to little or no net cost. Without the moderating effect of inflation on the costs of servicing the public debt, the overall benefits from lower inflation are reduced by between 0.06 and 0.12 per cent of GDP.

Table 2: Net welfare effect of reducing "true" inflation from 2 to 0 per cent

		Direct	Indirect		Net effect	
			λ=0.11	λ=0.24	λ=0.11	λ=0.24
Consumption timing	$\eta_{S_s}=0.0$	0.50	-0.12	-0.26	0.38	0.24
	$\eta_{S_s}=0.4$	0.70	-0.09	-0.18	0.61	0.52
	$\eta_{S_s}=1.0$	1.05	-0.02	-0.04	1.03	1.01
Housing demand	$\varepsilon_{H_R}=0.1$	0.01	0.00	0.00	0.01	0.01
	$\varepsilon_{H_R}=0.4$	0.04	0.00	0.01	0.04	0.05
	$\varepsilon_{H_R}=1.0$	0.10	0.01	0.02	0.11	0.12
Money demand		0.00	0.00	-0.02	0.00	-0.02
Debt service			-0.06	-0.12	-0.06	-0.12
Total	Maximum	1.15	-0.07	-0.16	1.08	0.99
	Minimum	0.51	-0.18	-0.40	0.33	0.11

Note: Numbers may not add exactly because of rounding.

8.2 Comparisons with other countries

One way of assessing the base-case results obtained for Canada is to compare them with those obtained for other countries. Studying the assumptions and key parameters used in those studies and analysing the reasons given for the differences in their results relative to those obtained by Feldstein for the United States may suggest where to revisit specific assumptions. It may also allow perspective on which set of results is more reasonable than others, given the differences between Canada's tax systems and those of other countries.

Appendix 3 compares the base-case parameters used in our study with those used in the studies employing the Feldstein framework that were undertaken for Germany, New Zealand, Spain, the United Kingdom, and the United States. We can compare selected parameters in each of the major blocks (fiscal policy parameters, financial parameters, macroeconomic relations, and behavioural coefficients).

With respect to fiscal policy parameters, the estimated marginal tax rates on the distributed profits of corporations are very similar across the countries, with the exception of Germany. On the other hand, the estimate of the marginal tax rate on capital income is higher in Canada than in the other countries, partly because of the much higher effective marginal tax rate on capital gains. Combined with the relatively low estimate of the marginal excess burden of taxation, the net effect of the assumptions about fiscal policy parameters should be to increase the estimated benefits of reducing inflation in Canada relative to those of other countries, *ceteris paribus*.

For the financial parameters, the data on the housing sector differ most from those of the other countries. In part, this difference may reflect the difficulty in obtaining estimates for some of the data and parameters. For example, the depreciation and maintenance number for Canada relates only to the depreciation rate. In part, differences may occur because some of the countries provide more incentives to home ownership than does Canada. For example, Germany, Spain, the United Kingdom, and the United States allow some form of substantive tax relief on owner-occupied housing.

For the macroeconomic relations and behavioural coefficient blocks, money-related variables stand out. The ratio of non-interest-bearing money as a percentage of GDP may seem to be low relative to other countries, but it probably reflects well the alternatives to Canadians for holding excess cash. Recall that a substantial portion of the currency issued in the United States is held outside the country.

If we examine the overall results obtained by applying the Feldstein framework to the assumptions for each country (Table 3), we see differences among them that seem to be consistent with the different tax and institutional frameworks. The results listed in Table 3 are for only one of the assumptions on the marginal excess burden of taxation. The range of estimates for the welfare effect, where provided, reflect different assumptions on the elasticity of saving or housing demand with respect to the relevant price.

Table 3: Findings when the Feldstein framework is applied to different countries

Effect as a percentage of GDP	Canada	United States	Germany	New Zealand	Spain	United Kingdom
Non-housing capital channel	0.24–1.01	0.95	1.48	0.27–0.56	0.55–0.88	0.21–0.37
Housing channel	0.01–0.12	0.22	0.09	0.04	1.33	0.11
Money demand	-0.02	-0.03	-0.04	-0.01	-0.07	-0.02
Overall[a]	0.11–0.99	1.04	1.41	0.28–0.57	1.71–2.04	0.21–0.37

Notes: λ = 0.4 for Spain, the United Kingdom, and the United States, 0.14 for New Zealand, and 0.24 for Canada. For all countries estimates relate to a 2-percentage-point reduction in inflation.

a. Includes debt service.

Major potential reasons for differences in estimates of the non-housing capital channel are the relative size of tax wedges and savings rates, and the sensitivity of tax rates to inflation. The former seem to be lowering the welfare benefit of moving to zero inflation relative to that in the United States for the United Kingdom, New Zealand, and Spain. Some offset occurs in the United Kingdom from its higher savings rate. For Germany, Tödter and Ziebarth (1999) state that the higher savings rate and taxes on income from capital explain the large costs of even moderate rates of inflation. The estimate used for the savings rate in Canada does not differ much from those in the other countries (except for Germany), so any difference among estimates for non-housing capital channels would seem to hinge on the assumption made about the marginal tax rate on capital income.

Mortgage interest deductibility is an obvious reason why some countries have a larger effect from the housing channel. It is the main reason for the difference in channel between the estimates obtained for the United States and Spain, and all of the other countries, including Canada, where the main benefit, abstracting from the exemption of capital gains on owner-occupied housing, is the non-taxation of the imputed rent of owner-occupied homes. In addition, Spain provides a large subsidy to owner-occupied housing and has a relatively large owner-occupied housing stock; the adjusted share for owner-occupied housing in the housing stock in 1995, according to Dolado et al. (1999, 114), was close to 81 per cent.

We will now explore the sensitivity of the estimated welfare results for Canada to the assumptions made about different parameters and the key data used.

8.3 Sensitivity analysis

We have calculated results for different starting-point inflation rates (the base-case 2 per cent measure, 1 1/2 per cent, and 1 per cent) using the benchmark assumptions for all other parameters. We have varied each of the other parameters in turn, to generate what the results would have been for each starting-point inflation rate scenario, but we initially report only those for a starting-point inflation rate of 2 per cent.

We provide the minimum and maximum estimates as a percentage of GDP only for where the dead-weight cost of taxation is taken to be 0.24, except for the sensitivity scenarios that involve looking at the implications of higher and lower values for this estimate. In Appendix 4, columns 2, 3, and 4, we report results for the base case, for higher and lower values of the relevant input, and the results obtained, assuming everything else remains as in the base case. Ideally, the range of the values associated with any particular variable would correspond to two standard deviations around the most likely estimate. However, in the absence of an estimate of the standard deviation of the parameter, we cannot follow this approach.

Changing the assumptions about different parameters causes the results to vary significantly. In most cases, the results indicate a positive benefit of reducing already low inflation, except for when we increase the parameter for the marginal excess burden of taxation.

Table 4 lists the results obtained when a different starting-point inflation rate (2, 1.5, and 1 per cent, respectively) is used in turn with the full set of parameter assumptions, including different assumptions for the dead-weight cost of taxation, λ, from the base-case, upper-band, and lower-band choice set (see the relevant columns of Appendix 4). As might be expected, the estimates of the overall benefits decrease with a lower starting-point inflation rate and using the lower band of the range for the parameter estimates. The value for λ is important to the range obtained for the estimates. When λ is as high as 0.5 (50 per cent), negative values emerge for the lower band of the range of estimates, despite the tendency of most of the other assumptions in the upper-band scenario to increase the estimates of the benefit of low inflation.

Table 4: Sensitivity of results to alternative inflation and parameter assumptions

Starting-point inflation rate (per cent)	Net welfare gain of moving to zero inflation (as % of GDP)		
	Lower band of parameter assumptions λ =0.15	Base-case parameter assumptions λ =0.24	Upper band of parameter assumptions λ =0.5
2	0.12 to 0.58	0.12 to 0.99	-0.36 to 1.09
1.5	0.10 to 0.44	0.12 to 0.78	-0.20 to 0.93
1	0.07 to 0.29	0.05 to 0.54	-0.08 to 0.70

9. Outstanding Issues

Although we have learned a great deal in this exercise, many gaps remain. Rather than perform an exhaustive review, we classify the gaps as first-order and second-order issues. First-order issues raise questions about the usefulness of the whole approach. Second-order issues arise from uncertainty about the true model or key data and parameters, most of which can be addressed by sensitivity analysis.

For first-order issues on methodology, a number of questions arise, such as whether for Canada it is the most effective way to calculate the wedges in a small or almost-small open economy. An obvious question is the extent to which savers, looking ahead to their retirement years and living in an open economy, focus on after-tax or before-tax rates of return determined on world financial markets. A case can be made for both possibilities depending, among other things, on whether taxes in a country are source- or residence-based.[4] Because there is a mixture of these bases, the interaction between inflation and the tax system is likely to create investment and savings wedges even in a world with high capital mobility. Additional reasons for this likelihood include the existence of fixed capital, irreversibilities, incomplete information, and restrictions on the holdings of foreign assets for some types of savings. Even if such wedges exist, it does not mean that Feldstein's approach is the best way to estimate them.

4. Under the residence principle, income, no matter where generated, is taxed by the country of residence of the recipient. Under the source principle, a government taxes all income originating within its jurisdiction. In practice, both the source and residence principles are applied to the taxation of income from corporate investments in the OECD.

Another problem that appears to be first-order arises from the assumption that most savings decisions are marginal ones. Behaviour at the margin has been well analyzed, but most of the research uses average data at a highly aggregated level. Empirical evidence suggests that tax-deferred and forced savings have become relatively more important in Canada.[5] Boadway and Kitchen (1999) argue that, more and more, savings in Canada are done in ways that take advantage of tax savings (see Table 5). Their views on the composition of savings are supported by various Statistics Canada publications (for example, see Catalogue 74F0002XIB). The implications of fewer savings subject to discretionary decisions are shown in Appendix 4 in the column labelled "Assumption A." Relative to the base case, with everything else staying the same, a savings rate of just under half that assumed in the base case implies a benefit from reducing inflation by 2 percentage points that is half that in the base case.

Table 5: Total personal savings and savings components as percentages of personal disposable income, selected years from 1971 to 1995

	1971	1980	1988	1993	1995
CPP/QPP	0.9	0.9	1.0	1.2	1.3
RRSPs	0.5	1.8	2.7	3.6	4.1
RPPs	1.3	1.5	1.3	1.4	1.4
RHOSPs	na	0.3	na	na	na
Other	4.1	8.8	4.9	3.2	1.4
Total	6.8	13.3	9.9	9.3	8.2

Source: Table 3.2.1 in Boadway and Kitchen (1999, 150). They use the table to show the relative importance of various savings vehicles over the period considered. The total personal savings rate is from the National Income and Expenditure Accounts, and the components are deflated by personal disposable income, as is the rate.

A range of other issues are related to various types of uncertainty (model, parameter, data). They are commonly encountered in policy formulation and can be addressed by looking for robustness in results in various ways.

Model uncertainty pertains to: reliance on a two-period, OLG model when a continuous time model with more than one agent might be more relevant; the assumption of a fixed return on capital as opposed to a supply curve for capital; and the assumption of

5. The tension between a concept and its implementation may have been what Mervyn King was puzzling over when he reportedly said, "What are marginal savings and what are inframarginal savings? This is a very hard issue to determine" (Feldstein 1999, 197).

certainty about income. The simplicity of Feldstein's model is one of its major strengths but also its major weakness, since it fixes certain key parameters that are likely to vary as agents' circumstances, including future prospects and their perceptions of them, change.[6] For example, the work/out-of-work time frames are likely much more flexible than is implied by the fixed time horizon assumed in Feldstein's approach. The rate of return on capital probably varies substantially, depending on a number of factors, not all of them cyclical. Finally, uncertainty about earned and other income would seem to be a useful extension, since people cannot be certain about their average future earned income.

Parameter and data uncertainty pertain to the value of certain key parameters, such as the interest elasticity of savings. It is uncertain whether a more detailed calculation of the various wedges between different rates of return would have been useful. We made no substantive effort to account for the different tax status of various holders of some assets, or to address foreign holdings of domestic assets (and vice versa), and their different tax implications. These issues could mean that even the low estimate in the sensitivity analysis for the marginal tax rate on capital income is too high for the representative individual taxpayer in Canada.

10. Conclusions

An exploratory application to Canada of the Feldstein partial-equilibrium framework to estimate the costs of low inflation suggests that there could be economically significant benefits of moving to zero inflation from the current low-inflation rate. However, reservations about making policy decisions based on this approach are justified, because of the approach's combination of "sweeping statements and complicated calculations" (Fischer 1999, 42), and questions about its relevance in the context of a small, open economy. Some of the assumptions could be considered to be controversial, at least in the way they are implemented. Because of these reservations, no effort was made to convert our estimates to present value terms and to net them against estimates of the present value of disinflating to zero.

6. In his original comment on Feldstein's work and in his comment on the work applying Feldstein's framework to Germany, Spain, and the United Kingdom, Andrew Abel used a variant of Sidrauski's (1967) model (which introduced two types of capital: a government budget constraint integrating monetary and fiscal policy, and endogenized labour supply) to compute the welfare effects of low inflation. His conclusions were broadly in line with those achieved in each of the partial-equilibrium studies.

The interaction of inflation and the tax system likely imposes costs on the economy, not all of which are easy to identify and represent. Despite the potential difficulties, any attempt to assess such costs should be considered in a broader context than partial-equilibrium analysis. It can only identify some of the costs to the economy arising from the interaction of inflation and the tax system; it may exaggerate some of them and completely miss others. As Harberger (1998, 21) has noted, "policies that impede the accurate perception of real costs are inimical to growth. *Inflation* is the most obvious, probably the most pervasive, and *almost certainly the most noxious of such policies*."

While not minimizing the design and calibration efforts required, it would seem that dynamic general-equilibrium models have a comparative advantage in capturing the implications of such pervasive effects: all benefits and costs are identified within a unified framework, where all sectors are specified with an objective function and budget or technology constraints; the interdependence among the various distortions can be studied; and variables of interest are endogenously determined. In recent work, Leung and Zhang (2000) use a dynamic general-equilibrium, life-cycle model of a small open economy to show that the co-existence of inflation and a capital gains tax increases distortions to the consumption path relative to those arising from an inflationary environment alone.

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Appendix 1

A.1 Issues Involved in Choosing the Required Rate of Return

As noted in an OECD report (1991, 89 and 90), there are three rates of interest relevant to the King-Fullerton (1984) approach: the real pre-tax required rate of return on investment (p); the real post-tax return received by savers, the providers of finance, (s); and an intermediate return reflecting the real pre-personal-tax rate of return paid by corporations to savers (r*). To calculate the difference between them, and hence the impact of taxation, one of them must be chosen so that the implied values of the other two can be calculated.

A fixed-r approach can be rationalized by arguing that investors require a return from the company at least as high as that which they could earn elsewhere. This rate would be the same irrespective of the form in which the investment in the company is made. However, the pre-tax rate of return would then depend on the source of finance used. In the open economy case, it may be more realistic to assume that r is fixed, because it can be assumed to be determined on world markets.

In the text an estimate is obtained of the historical required real pre-tax return on investment. At zero inflation, this rate is equal to the pre-tax return paid by corporations to savers (r*). This estimate of r* is then used to calculate the variables and METRs at the different inflation rates considered. This implementation is much more of a fixed-r approach, in the sense of OECD (1991), than anything else, even though it begins with an estimate of p at zero inflation. While the actual value chosen for r* may seem to be high, sensitivity analysis suggests that the overall estimates of the welfare costs of low inflation are not changed much if a lower or higher estimate is used (see Appendix 4).

Boadway and Kitchen (1999) argue that the after-tax return to shareholders, suitably adjusted for risk *and expected exchange rate movements* (added by us), must conform with the rate of return on international markets. They note that, if capital markets in Canada are open, then taxes levied on firms will cause the before-tax rate of return on investment to rise, distorting investment decisions. At the same time, personal taxes levied on capital income will cause the after-tax rate of return on savings to fall and discourage saving. They suggest that while “capital markets in Canada may not be fully open, they are nonetheless “quite” open” (p. 276).

Section A.2 shows one way that the approach used in the text might be linked to the condition described by Boadway and Kitchen. However, their main point and that of this paper is that there are distortions introduced by the interaction of inflation and the tax system that affect both investment and savings decisions.

A.2 Existence of Savings Wedges Assuming Capital Market Equilibrium

Canada is a small open economy with a flexible exchange rate and no capital controls.[7] As a result, to assume that uncovered interest parity holds (which is assumed by QPM, the Bank of Canada model), might seem to be reasonable, despite the lack of evidence. Another assumption is that income from capital is taxed according to the residence principle. This leads to two arbitrage conditions, one for Canada and the other for the rest of the world[8]:

$$i(1-m) = i^*(1-m) + \Delta e^e(1-g) \qquad \text{(A.1)}$$

$$i(1-m^*) = i^*(1-m^*) + \Delta e^e(1-g^*) \qquad \text{(A.2)}$$

where i and i^* are nominal interest rates in Canada and elsewhere, m and m^* are tax rates on interest income, g and g^* are tax rates on capital gains due to currency movements, and Δe^e is the expected change in the exchange rate. As is well known, for a marginal risk-neutral investor, arbitrage ensures that the after-tax return on a domestic investment equals the exogenous after-tax return on a foreign asset plus the expected rate of depreciation of the home currency net of tax. With the residence principle, the home investor is taxed by the home country (A.1) and the foreign investor by the foreign country (A.2).

Gains and losses due to exchange rate changes are generally treated as ordinary income. When $m = g$ and $m^* = g^*$, the arbitrage relationships above imply the equality of pre-tax interest rates, adjusted for the expected change in the exchange rate. Assuming purchasing-power parity, these relationships imply the equality of real pre-tax interest rates. Although this does not imply the Fisher hypothesis, it is consistent with it, holding

$$\Delta e^e = \pi - \pi^* \Rightarrow i - \pi = i^* - \pi^*$$

One can say that $d(i - i^*) = d(\pi - \pi^*)$ so that

7. There is a constraint on foreign content in registered retirement savings plans.

8. In financial markets the arbitrage condition is $i = i^* + \Delta e^e$, because taxes are on profits, not individually on i, i^*, and Δe^e. For other markets, nothing guarantees m = g or $m^* = g^*$. Equilibrium would likely occur in reality through heterogeneous Δe_i^e across investors, i.

$$\frac{d(i - i^*)}{d\pi} = 1 - \frac{d\pi^*}{d\pi}.$$

This implies that $\frac{di}{d\pi} = 1 + \frac{d(i^* - \pi^*)}{d\pi}$. So if changes in domestic inflation do not affect the foreign real interest rate, the Fisher hypothesis holds, in which case the nominal interest rate can be defined as:

$$i = r^* + \pi \tag{A.3}$$

where r^* is the world real interest rate and may include a risk premium.

Even if real interest rates in the small open economy are unaffected by either taxes or inflation, the asymmetric effects of inflation on domestic and foreign savers remain. If relative purchasing-power parity holds, inflation in the home country translates into a depreciation of its exchange rate. Any resultant currency losses on the assets held in the home country incurred by foreign savers can be deducted as long as they are treated like ordinary income by the foreign tax system. On the other hand, domestic savers will not be able to deduct the real losses caused by the interaction of inflation with the tax system, leaving a distortion that would still affect savings and investment decisions.

Appendix 2: Source of Information for Assumptions for Canada

(Note that not all of the information below was required for the exploratory analysis)

Effective inflation rate (%)	Begin with midpoint of inflation target range
Fiscal policy parameters	
Marginal tax rate on capital income (capital gains, dividends, and interest) of individuals	Source is KPMG web page "Combined Federal and Provincial Top Marginal Tax Rates for Individuals - 1998." Information is presented by province. To get a weighted average, Revenue Canada data for recent years on taxable interest, capital gain, and dividend income for all tax filers except those who had pensions as their main source of income was used. These ratios vary from one year to the next, especially for the shares of dividends and capital gains, but interest income is consistently around 45% of total taxable capital income and the top MTRs for dividends and capital gains are not so different that small changes in their shares should affect the overall estimate of the MTR on capital income. This estimate is then 0.45*0.50 + 0.275*0.34+0.275*0.38 to give 0.42 as an estimate for the overall top MTR on capital income.
Effective marginal tax on capital gains	An earlier source is the OECD (1991, p. 80, Table 3.21), "Taxing Profits in a Global Economy," which would give 10.5%. However, with the elimination of the $100 thousand capital gains exemption it is likely to be no longer relevant. Likely to be closer to the KPMG estimate is essentially three-quarters of the MTR on salary and interest income.
Property tax rate (%)	Canadian Tax Foundation Web page: "Impossible Comparisons." Looks at property tax bills on three representative residential properties in each province using the winter 1997 Survey of Canadian House prices compiled by Royal LePage. A range of 0.8–3, depending on the city and type of unit, was shown.
Tax concessions on owner-occupied housing	Treated these as too small to matter for the purposes of this paper.
Marginal excess burden of taxation	The parameter used to adjust to changes in revenue into a DWL measure. We follow the Tödter and Ziebarth approach to calculate it directly.
Financial parameters	
Real gross rate of return (%)	OECD Economic Outlook Dec. 1998, Annex Tables 25 and 14. (Average rate of return on capital in the business sector, 1971–98 inclusive, deflated by the growth in the GDP deflator over this period).

(continued)

Appendix 2 (continued): Source of Information for Assumptions for Canada

(Note that not all of the information below was required for the exploratory analysis)

Financial parameters (continued)	
Discounting period (years)	Assume that people retire on average after 30 years of work.
Ratio of exogenous income to retirement consumption (%)	E = exogenous income received by an unattached elderly person; the measure includes retirement, disability, and surviving spouse benefits under CPP and QPP, and Old Age Supplement and Guaranteed Income Supplement benefits. The estimate is an average of the total of these benefits over the 1993 to 1998 period. The data are from HRDC. Retirement consumption is calculated in the text.
Depreciation and maintenance costs of housing (%)	Depreciation assumption from Statistics Canada (National Accounts Division) via Gerald Stuber. No adjustment made for maintenance.
Nominal mortgage rate (%)	See effective mortgage rate series in “The Financial Situation of the Personal Sector in Canada,” by the Economic Analysis and Forecasting Division of the Department of Finance.
Mortgage loan to value of owner-occupied houses (%)	Source: Statistics Canada (balance sheet accounts).
Value of owner-occupied housing as a % of GDP	Source: Statistics Canada (balance sheet accounts). (Note that a better source is the 1996 Census data on housing.)
Debt services as a % of public debt	NIA basis, 1997 prior to reallocation of government-sponsored pension plans.
Public debt as a % of GDP	NIA basis, 1997 prior to reallocation of government-sponsored pension plans.
Macroeconomic relations	
(n+g) (%)	Steady-state growth of GDP growth in QPM.
Ratio of wages to GDP (%)	Steady-state share of labour income in QPM.
Ratio of savings to GDP (%)	Household saving as a per cent of GDP.
Saving of the young as a per cent of GDP	Calculated as reported in text.
Ratio of non-interest-bearing money to GDP (%).	Estimate.

(continued)

Appendix 2 (concluded): Source of Information for Assumptions for Canada
(Note that not all of the information below was required for the exploratory analysis)

Behavioural coefficients	
Interest rate elasticity of savings (uncompensated)	Used same range that Feldstein used for the United States.
Compensated interest elasticity of investment in housing capital	Used same range as Bakhshi et al. (1999) used for the United Kingdom.
Interest rate elasticity of money demand	See System 10a) in Table 6a, the preferred equation, in Hendry (1995, 73). This gives the semi-elasticity in coefficient form. The elasticity is calculated as in Feldstein (1999, p. 34, footnote 39).
Propensity to save (%)	Savings of young as a per cent of GDP divided by the wage share.

Appendix 3: Assumptions for Calculating the Benefits: Cross-Country Comparison

	Canada	Germany	United Kingdom	United States	Spain	New Zealand
Effective inflation rate (%)	**2.00**	**2.00**	**2.00**	**2.00**		**2.00**
Fiscal policy parameters						
Marginal tax rate on capital income (capital gains, dividends, and interest) of individuals (%)	42	37.60	23.00	25.00	26.00	33.00
Effective marginal tax rate on capital gains	38	-	14.10	10.00	11.00	
Property tax rate (%)	2.0	-	0.8	2.50	1.00	
Tax concessions on owner-occupied housing	?	2.00	-	-	15.00	
Marginal excess burden of taxation	0.11–0.24	0.34	(0.4;1.5)	(0.4;1.5)	(0.4;1.5)	(0.14;0.65)
Financial parameters						
Average pretax real gross rate of return (%)	10.00	10.80	8.20	9.20	11.9	12.0
Discounting period (years)	30	27	30	30	30	30
Ratio of exogenous income to retirement consumption (%)	47			25		47
Depreciation and maintenance costs of housing (%)	2.0	4.00	0.80	4.00	4.2	5.0
Nominal mortgage rate (%)	8.7	8.5	7.9	7.2	10.8	6.8
Mortgage loan to value of owner-occupied houses (%)	35	60	60	20–50	50	20
Value of owner-occupied housing as a % of GDP	84	170	130	105	184	108
Debt services as a % of public debt	8.1	7.80	?	8.50		
Public debt as a % of GDP	62.6	48.00	35.5	50.00	40.00	

(continued)

Appendix 3 (concluded): Assumptions for Calculating the Benefits: Cross-Country Comparison

	Canada	Germany	United Kingdom	United States	Spain	New Zealand
Effective inflation rate (%)	**2.00**	**2.00**	**2.00**	**2.00**		**2.00**
Macroeconomic relations						
(n+g) (%)	2.3	2.2	2.0	2.6	2.8	2.5
Ratio of wages to GDP (%)	66.0	56.00	63.00	75.00	66.00	66.00
Ratio of savings to GDP (%)	5.5	9.30	9.2	5.00	5.00	4.50
Saving of the young as a % of GDP	11.10	20.90	11.00	9.00	14.00	
Non-interest-bearing money as a % of GDP	3.5	9.00	4.9 (non-interest M1)	6.1	12.8	2.7
Behavioural coefficients						
Interest rate elasticity of savings (uncompensated)	(0;0.4;1)	0.25	(0;0.2;0.4)	(0;0.4;1)	(0;0.2;0.4)	(0;0.4;1)
Compensated interest elasticity of investment in housing capital	(0.1; 0.4; 1)	0.25	(0.1;0.4;1)	0.80	0.9	
Interest rate elasticity of money demand	0.26	0.25	0.30	0.20	0.20	0.036
Propensity to save (%)	17	37	17	12	21	

Appendix 4: Alternative Assumptions to Explore Sensitivity of Results for Canada

(Everything as in base case except for identified change**)**

	Base case	Assumption A	Assumption B	Net welfare gain (λ =0.24) (as % of GDP)		
				Base case	**A**	**B**
Effective inflation rate (%)	**2.0**	1.5	1.0	0.12 to 1.0	0.13 to 0.78	0.05 to 0.54
Fiscal policy parameters						
Marginal tax rate on capital income (capital gains, dividends, and interest) of individuals (%)	**42**	38	46	0.12 to 1.0	0.09 to 0.79	0.17 to 1.25
Effective marginal tax on capital gains	38	?	?	-	-	-
Property tax rate (%)	**2.0**	1.5	2.5	0.12 to 1.0	0.14 to 1.04	0.13 to 0.97
Tax concessions on owner-occupied housing	?	?	?	-	-	-
Marginal excess burden of taxation	**0.11–0.24**	0.15	0.50	0.12 to 1.0	0.28 to 1.06	-0.30 to 0.84
Financial parameters						
Real gross rate of return (%)	**10.00**	8.0	12.0	0.12 to 1.0	0.05 to 1.00	0.22 to 1.02
Discounting period (years)	**30**	27	33	0.12 to 1.0	0.08 to 1.00	0.18 to 1.03
Ratio of exogenous income to retirement consumption (%)	**47**	40	55	0.12 to 1.0	0.29 to 1.25	0.06 to 0.89
Depreciation and maintenance of housing (%)	**2.0**	1.5	2.5	0.12 to 1.0	0.14 to 1.04	0.13 to 0.96
Real mortgage rate (%)	**6.7**	6.0	10	0.12 to 1.0	0.13 to 1.02	0.13 to 0.94
Mortgage loan to value of owner-occupied houses (%)	**35**	30	40	0.12 to 1.0	0.13 to 1.02	0.13 to 0.99

(continued)

Appendix 4 (concluded): Alternative Assumptions to Explore Sensitivity of Results for Canada
(Everything as in base case except for identified change**)**

	Base case	Assumption A	Assumption B	Net welfare gain (λ =0.24) (as % of GDP)		
				Base case	**A**	**B**
Financial parameters (continued)						
Value of owner-occupied housing as a % of GDP	**84**	75	100	0.12 to 1.0	0.13 to 0.99	0.13 to 1.03
Debt services as a % of public debt	8.1			-	-	-
Public debt as a % of GDP	62.6			-	-	-
Macroeconomic relations						
(n+g) (%)	**2.3**	2.0	2.6	0.12 to 1.0	0.13 to 1.08	0.13 to 0.94
Ratio of wages to GDP (%)	**66.0**	58.0	70.0	0.12 to 1.0	0.10 to 0.97	0.15 to 1.02
Ratio of savings to GDP (%)	**5.5**	2.5	8.0	0.12 to 1.0	0.06 to 0.52	0.08 to 1.30
Saving of the young as a per cent of GDP	**11.1**	Derived	Derived	-	-	-
Non-interest-bearing money as a % of GDP	**3.5**	2.0	5.0	0.12 to 1.0	0.14 to 1.01	0.13 to 1.01
Behavioural coefficients						
Interest rate elasticity of savings	(**0;0.4;1**)	(0;0.4;1)	(0;0.4;1)	-	-	-
Compensated interest elasticity of investment in housing capital	(**0.1; 0.4; 1**)	(0.1; 0.4; 1)	(0.1; 0.4; 1)	-	-	-
Interest rate elasticity of money demand	**0.26**	0.00	0.70	0.11 to 0.99	0.13 to 1.0	0.12 to 0.99
Propensity to save (%)	**16.8**	Derived	Derived	-	-	-

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