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**Price stability: some costs and benefits  
in New Zealand**

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**Abstract**

Among the distortions generated by inflation, those caused by its interaction with taxation are particularly important. Due to the non-indexation of the tax system, inflation exacerbates the inefficiencies generated by taxation. The aim of this paper is to evaluate the welfare effects of these distortions in New Zealand. By using a stylised model of the New Zealand tax system, the tax burden on capital income is calculated for different values of the inflation rate. Following Feldstein (1997a, 1997b), the paper then estimates the welfare effects of going from 2 percent 'true' inflation (net of measurement bias) to price stability. The benefits turn out to be about 0.4 percent of GDP, approximately half the size of those calculated by Feldstein for the US, the difference being mainly due to a less distortionary tax system. The permanent benefits are then compared with the one-off output loss that would be involved. As for the US, the result is supportive of price stability, but it does not hold for plausible values of some key parameters.

## 1 Introduction<sup>1</sup>

For inflation-targeting central banks, the level of the target is a crucial part of the overall framework. The search for the optimal level has taken two main directions. One is concerned with estimating the measurement bias in the CPI so that the ‘true’ target can be identified. The other, which has proved elusive so far, tries to measure the costs and benefits of inflation.

Among the costs, those caused by the interaction of inflation with tax rules are particularly important. Due to the non-indexation of the tax system, inflation exacerbates the inefficiencies generated by taxation. The quantitative significance of these inefficiencies is likely to be particularly strong in the case of taxation of mobile factors of production, like capital.

In this paper, the analysis is focused on the distortions arising from the interaction between inflation and capital income taxation. Three types of distortions are considered: consumption timing, housing demand, and money demand. By using a simple model of the New Zealand tax system *à la* King and Fullerton (1984) in a small open economy framework, the paper calculates the tax burden for different values of the inflation rate (section 2). Following Feldstein (1997a, 1997b), the paper then estimates the welfare effects of going from 2 percent ‘true’ inflation (net of measurement bias) to price stability (section 3) and compares them with the output costs of disinflation (section 4). Some conclusions follow (section 5).

## 2 Inflation and capital income taxation

No tax system is completely neutral with respect to inflation for two main reasons. The first reason is that tax systems are generally progressive and tax brackets are rarely indexed to inflation. As nominal income rises with inflation, the average tax rate increases. The second reason is that most countries use nominal income as tax base because indexation is problematic. As a result, inflation affects the real tax burden through a number of different channels. New Zealand is certainly no exception to this. However, the New Zealand tax system is less progressive than in most other countries and the influence coming from this source is most likely negligible. Therefore, the paper concentrates on the second aspect: the nominal income tax base.

In order to estimate the tax burden both with and without inflation, we use a stylised model of the New Zealand tax system. As a measure of the tax burden, we focus on the wedge between the cost of capital (the pre-tax return required by savers) and the

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after-tax return to savers (King and Fullerton, 1984). Income from capital is taxed at both personal and corporate levels and the overall wedge is a function of both. However, the way the tax burden is shared between firms and savers, and thus how investment and savings are affected, depends on the equilibrium in capital markets. In a small open economy like New Zealand, international capital flows significantly influence the size and the composition of the tax wedge.

In the remainder of this section, we first set out the assumptions about capital market equilibrium for a small open economy. We then describe equilibrium for individual firms and savers. Lastly, we summarise the impact of inflation on the size and the composition of the tax burden.

## 2.1 Capital market equilibrium in a small open economy<sup>2</sup>

New Zealand is a small open economy, fully integrated in world capital markets, with a flexible exchange rate. In this situation, the world interest rate is exogenously determined and uncovered interest parity holds. We also assume that income from capital is taxed according to the residence principle<sup>3</sup>. These assumptions imply two arbitrage relationships, one for New Zealand and the other for the rest of the world:

$$(2.1.1) \quad i(1-m) = i^*(1-m) + \Delta e^e(1-g)$$

$$(2.1.2) \quad i(1-m^*) = i^*(1-m^*) + \Delta e^e(1-g^*)$$

where  $i$  and  $i^*$  are nominal interest rates in New Zealand and overseas,  $m$  and  $m^*$  are tax rates on interest income,  $g$  and  $g^*$  are tax rates on capital gains due to currency movements and  $\Delta e^e$  is the expected change in the exchange rate. For a risk-neutral investor, arbitrage at the margin implies 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. Under the residence principle, the home investor is taxed by the home country (equation (2.1.1)) and the foreign investor by the foreign country (equation (2.1.2)).

Exchange rate-related gains and losses are generally treated as ordinary income. When  $m = g$  and  $m^* = g^*$ , the international arbitrage relationships imply the equality of pre-tax interest rates, adjusted for the expected variation in the exchange rate. If we assume purchasing power parity, the arbitrage relationships guarantee the equality of real pre-tax interest rates and the traditional Fisher hypothesis obtains:

$$\Delta e^e = \pi - \pi^* \Rightarrow i - \pi = i^* - \pi^* \Rightarrow \frac{di}{d\pi} = \frac{di^*}{d\pi^*} = 1$$

<sup>2</sup> The argument developed in this section relies mostly on Desai and Hines (1997) and Cohen *et al* (1997).

<sup>3</sup> Under the residence principle, income is taxed by the country where the recipient resides, no matter where income has been generated. This principle is generally observed, at least as far as interest is concerned, in OECD countries, where bilateral treaties are in place in most cases.

As a result, the nominal interest rate is defined as:

$$(2.1.3) \quad i = r^* + \pi$$

where  $r^*$  may include a country risk premium.

Under the traditional Fisher hypothesis, real interest rates in the small open economy are unaffected by both taxes and inflation. One implication of this result is counterintuitive: when inflation rises, the real after-tax return to domestic savers increases less than proportionally. This result is explained by the asymmetric effects of inflation on domestic and foreign savers. If purchasing power parity holds, inflation in the home country will translate into a fall in the exchange rate of the home country. Foreign savers will be allowed to deduct currency losses as long as the losses are treated as ordinary income by the foreign tax system. Conversely, domestic savers will not be able to deduct the real losses caused by the interaction of inflation with the tax system.

## 2.2 Cost of capital

Initially, we assume a world with no inflation. Firms maximise the present discounted value of future cash flows over an infinite horizon, with no adjustment or installation costs. The cost of capital is derived from the solution to this maximisation problem.  $p$  is defined as the cost of capital net of depreciation:

$$(2.2.1) \quad p = \frac{(1 - z\tau)(\rho + \delta)}{1 - \tau} - \delta$$

where  $z$  is the present value of tax depreciation allowances,  $\tau$  is the corporate tax rate,  $\rho$  is the discount rate (or the financial cost of capital, *i.e.* the rate employed by the firm when discounting future cash-flows), and  $\delta$  is the rate of economic depreciation<sup>4</sup>.

The cost of capital may vary according to the type of asset because of differences in the tax treatment. Two types of assets are considered: durables (buildings and machinery) and inventories. The overall cost of capital  $p$  is assumed to be a weighted average of the two:

$$(2.2.2) \quad p = \xi p_{BM} + (1 - \xi) p_I$$

Consider first inventories. For assets that are short-lived, the depreciation terms drop out of (2.2.1), which reduces to:

<sup>4</sup> This expression is slightly different from the traditional user-cost-of-capital formula developed by Hall and Jorgenson (1967). For notational convenience, we consider the cost of capital net of depreciation and add the additional assumption of no change in the relative price of capital goods.

$$(2.2.3) \quad p_I = \frac{\rho}{1-\tau}$$

Next consider buildings and machinery. For simplicity, it is assumed that all firms apply the declining balance method to calculate their tax depreciation allowance.<sup>5</sup> In this case,  $z$  is equal to:

$$(2.2.4) \quad z = \int_0^{\infty} (e^{-\rho t} d e^{-dt}) dt = \frac{d}{\rho + d}$$

where  $d$  is the rate of tax depreciation.

Assuming  $d = \delta$ <sup>6</sup>, we substitute back into (2.2.4) and (2.2.1), to get:

$$(2.2.5) \quad p_{BM} = \frac{\rho}{1-\tau}$$

which is the same as (2.2.3). When inflation is zero, the cost of capital turns out to be the same for all assets.

What is the discount rate? It should reflect the financial cost of capital that firms face when deciding about an investment project. Let us first assume that firms finance the project by issuing debt. Because firms are allowed to deduct nominal interest payments from their taxable income, the net cost of funds is given by the after-tax nominal interest rate:

$$(2.2.6) \quad \rho = i(1-\tau)$$

Alternatively, firms may finance their projects either by using retained earnings or by issuing new shares. In the former case, reinvested profits will translate into capital gains, which will be taxed at the shareholders' personal rate  $m_g$ , and the shareholder will get  $(1-m_g)$ . In the case of new shares, firms will distribute dividends, which will be taxed at the rate  $m_d$ . Also, in the imputation system, shareholders will receive a credit  $c$  for the tax paid on profits at the corporate level, and the shareholder will get  $(1-m_d)/(1-c)$ . In any case, shareholders will require a post-tax return on their investment equal to what they could earn on bonds, which is  $i(1-m_i)$ , where  $m_i$  is the personal tax rate on interest income. The no-arbitrage conditions imply:

$$(2.2.7) \quad \frac{(1-m_i)}{(1-m_g)} = \frac{(1-c)(1-m_i)}{(1-m_d)}$$

<sup>5</sup> In New Zealand, firms are allowed to choose between straight-line and declining-balance depreciation.

<sup>6</sup> Tax depreciation appears to be close to economic depreciation in New Zealand. Typical rates for the declining balance method are: buildings, 4 percent; machinery, 12 percent. The simple average of 8 percent turns out to be equal to the rate of economic depreciation used in the Reserve Bank Forecasting and Policy System (FPS: see Black *et al.*, 1997).

In New Zealand there is full imputation, or  $c = \tau$ , and no capital gains tax at the personal level, *i.e.*  $m_g = 0$ . The marginal effective tax rate (METR) of investors is likely to be very similar, whether they hold debt or equity. In turn, the personal tax rate is mostly equal to the corporate tax rate<sup>7</sup>. Under these circumstances, there is no difference between the after-tax returns on different investments and the cost of different sources of finance for the firm is the same. (2.2.6) is likely to be a good approximation of the cost of funds for New Zealand firms.

Substituting (2.2.6) back into (2.2.3) and (2.2.5), we get:

$$(2.2.8) \quad p = i = r^*$$

At zero inflation, the cost of capital (net of depreciation) equals the real pre-tax interest rate and the tax system does not affect either the level or the composition of business investment.

This neutrality result does not generally hold when inflation is positive. The first reason is that nominal, rather than real, interest payments are tax deductible. In real terms, (2.2.6) becomes:

$$(2.2.9) \quad \rho - \pi = (r^* + \pi)(1 - \tau) - \pi = r^*(1 - \tau) - \pi\tau$$

The real cost of financing is now lower because firms are allowed to deduct the inflation-induced component of the increase in nominal interest rates,  $\pi\tau$ .

A second channel through which inflation affects the cost of capital is the valuation of inventories for tax purposes. When firms use FIFO, as they do in New Zealand, (2.2.3) becomes:

$$(2.2.10) \quad p_I = \frac{(\rho - \pi) + \pi\tau}{1 - \tau} = r^*$$

Inflation increases the value of taxable profits because inventories are evaluated at historic cost. The cost of capital increases as a result of higher taxation, as it is shown by the additional term  $\pi\tau$  at the numerator of (2.2.10). However, firms can deduct the inflation-induced component of interest rates. This reduces the cost of capital by the same amount, completely offsetting the initial increase. By substituting (2.2.9) into (2.2.10), we can see that the cost of capital for inventories is not at all affected by inflation. In other words, the neutrality result holds for inventories even when inflation is positive.

<sup>7</sup> The corporate rate, which is flat, equals the top personal tax rate of 33 percent. This rate cuts in at a relatively low level of income (NZ\$ 38,000). Below this threshold, METRs may be very high due to a number of welfare provisions. These factors bring the METR very close to the top statutory rate on average: according to unofficial estimates from the NZ Treasury, the income-weighted average METR is 32.1 percent.

The same is not true for durable assets. When inflation is positive, (2.2.5) becomes:

$$(2.2.11) \quad p_{BM} = \frac{\rho}{1-\tau} - \pi \frac{\rho + \delta(1-\tau)}{(\rho + \delta)(1-\tau)} = r^* - \pi \frac{i\tau}{i(1-\tau) + \delta}$$

By comparing (2.2.11) with (2.2.5), we can see that inflation has a small negative effect on the cost of capital. The term associated with inflation in the second part of (2.2.11) is positive and smaller than one (at current tax rates). It is increasing in the corporate tax rate and decreasing in the depreciation rate. Also, the relationship between  $p$  and  $\pi$  is non-linear and the inflation effect depends on the level of nominal interest rates. In particular, at current tax rates, it is decreasing in the nominal interest rate.

The inflation term summarises how different channels operate. Inflation reduces the present value of depreciation allowances, which are calculated on historic cost capital. As a result, taxable profits increase in present value, with a positive impact on the cost of capital. This effect can be represented by the use of nominal, rather than real, discount rate in (2.2.4). While  $\rho$  goes up with inflation,  $z$  falls, pushing up the cost of capital. On the other hand, inflation reduces the real cost of financing, as shown in (2.2.8), due to the deductibility of the inflation-induced component of interest rates. The latter channel is more powerful than the former and the overall impact of inflation on the cost of capital turns out to be negative.

### 2.3 Return to savers

Inflation does not affect the real pre-tax interest rate, which is determined on international financial markets, but the nominal interest rate increases one-to-one with inflation. Personal taxes are levied at the rate  $m$  on nominal returns on financial assets. As a consequence, the tax burden on savings increases with inflation.

The real after-tax rate of return on savings,  $s$ , is defined as:

$$(2.3.1) \quad s = i(1-m) - \pi$$

### 2.4 Tax burden

In the stylised model presented above, four parameters describe the whole tax system:  $\tau$ ,  $d$ ,  $\xi$ ,  $m$ . The corporate tax rate,  $\tau$ , is equal to 0.33 and so is the personal tax rate,  $m$ . The rate of depreciation,  $d$ , is 0.08 and the weight of durable assets,  $\xi$ , 0.78 (OECD, 1991). As a starting point for  $p$ , we take 0.12, the average real rate of return experienced by New Zealand's business sector over the period 1988-96 (OECD, 1997). Then we simulate the model for different levels of the inflation rate and the results are presented in Table 1.

**Table 1 - The effect of inflation on the tax burden on capital income**  
(percentages)

Inflation Rate (%)	Real pre-tax required rate of return on investment (%) ( $p$ )	% METR on investment ( $(p-r^*)/r^*$ )	Real after-tax rate of return on savings (%) ( $s$ )	% METR on savings ( $(r^*-s)/r^*$ )
0	12.0	0.0	8.0	33.0
1	11.8	-1.7	7.7	35.8
2	11.6	-3.5	7.4	38.5
3	11.4	-5.4	7.1	41.3
4	11.1	-7.3	6.7	44.0
5	10.9	-9.4	6.4	46.8
6	10.6	-11.6	6.1	49.5
7	10.4	-13.8	5.7	52.3
8	10.1	-16.0	5.4	55.0
9	9.8	-18.4	5.1	57.8
10	9.5	-20.8	4.7	60.5

The effect of inflation is significant, even when it is low. Let us concentrate on the change between zero and 2 percent inflation, which will be the focus of the rest of the paper. Over this interval, the marginal effective tax rate (METR) on savings increases from 33 percent to 38.5 percent and the real after-tax return on savings drops from 8.0 to 7.4 percent as a result. On the other hand, the tax system, originally neutral, provides a net subsidy to investment equal to 3.5 percent. Consequently, the cost of capital declines from 12 percent to 11.6 percent. The overall impact of inflation is to increase the tax burden, because higher taxes on savings are only partially offset by the subsidy to investment. At the same time, the tax burden shifts from investors to savers<sup>8</sup>.

### 3 The benefits of price stability

Feldstein (1997a, 1997b) looks at three types of inflation-induced distortions: consumption timing, housing demand, and money demand. In calculating the benefits of going from 2 percent to zero ‘true’ (net of measurement bias) inflation, we explicitly consider the loss of tax revenue that would be involved. In traditional welfare economics the tax revenue loss is normally assumed to be offset by lump-sum taxes. This assumption may not be very realistic: thus we follow Feldstein in assuming that other distortionary taxes will be needed to compensate for the loss in tax revenue. Also, the negative effect of disinflation on the cost of servicing government debt is considered.

The results are reported in Table 2, where we make a distinction between the direct effect on welfare and the indirect effect due to the loss of tax revenue. The distortionary effect of offsetting taxation is summarised by the parameter  $\lambda$

<sup>8</sup> Under this tax system, inflation increases the size of the current account deficit. This hypothesis has been empirically explored by Bayoumi and Gagnon (1996), who show that inflation rates are good predictors of net foreign assets.

(corresponding to the deadweight loss per one dollar of additional taxes). The estimates of this parameter for New Zealand range from 0.14 (Diewert and Lawrence, 1994) to 0.65 (McKeown and Woodfield, 1995). Due to the uncertainty surrounding this parameter, we present two sets of results for each of these values. Significant uncertainty also surrounds the parameter  $\eta$ , the interest elasticity of savings, for which we do not have any reliable estimate for New Zealand. This parameter is important in determining the welfare effect relative to consumption timing. Therefore we present the results for three different values of  $\eta$ , for both consumption timing and the total.

**Table 2 - Net welfare effect of reducing “true” inflation from 2 percent to zero**  
(as a percentage of GDP)

		Direct	Indirect		Total effect	
			$\lambda=0.14$	$\lambda=0.65$	$\lambda=0.14$	$\lambda=0.65$
Consumption timing	$\eta=0.4$	0.46	-0.07	-0.32	0.39	0.14
	$\eta=0.0$	0.36	-0.09	-0.42	0.27	-0.06
	$\eta=1.0$	0.60	-0.04	-0.17	0.56	0.43
Housing demand		0.03	0.01	0.02	0.04	0.06
Money demand		0.00	-0.01	-0.04	-0.01	-0.03
Debt service			-0.03	-0.13	-0.03	-0.13
Total	$\eta=0.4$	0.49	-0.10	-0.46	0.39	0.03
	$\eta=0.0$	0.40	-0.12	-0.56	0.28	-0.16
	$\eta=1.0$	0.63	-0.07	-0.31	0.57	0.32

The overall results, presented in Table 2, show that the benefits of inflation going from 2 percent to zero vary between -0.16 and 0.57 percent of GDP. For the base case ( $\eta = 0.4$  and  $\lambda = 0.14$ ), our estimate of 0.39 percent compares with Feldstein’s estimate of 0.76 percent of GDP for the United States<sup>9</sup>.

The main reason for this difference seems to lie in the tax system. Statutory tax rates are broadly similar in the United States and in New Zealand, but the New Zealand system appears to be less distortionary overall. One important distinction relates to the integration of corporate and personal income taxation. The full imputation system adopted in New Zealand eliminates the double taxation of dividends that characterises the United States ‘classical’ system. Also, New Zealand does not tax capital gains at the personal level and this narrows the tax wedge on savings. Finally, the tax advantage of owner-occupied housing in New Zealand is reduced by the fact that mortgage payments are not tax deductible.

<sup>9</sup> Feldstein (1997b), table 2, p. 28. This corrects downward the previous estimate of 1.01 percent (Feldstein, 1997a). For countries like Germany (Tödter and Ziebarth, 1997) and Spain (Dolado *et al.*, 1997) benefits are even larger. The result for New Zealand compares with that obtained for the UK by Bakhshi *et al* (1998).

### 3.1 Reducing distortions to consumption timing

By reducing the after-tax return to savers, inflation magnifies the tax distortion to the timing of consumption. The incentive to save for retirement is further reduced below optimum and young people may save less than they would like to. Even with no change in savings, the dead-weight loss arises from the reduction in future consumption that is caused by the fall in the return to savings.

The positive welfare effect resulting from disinflation is partially offset by the loss of tax revenue, to be compensated for by distortionary taxes. The estimates of the combined effect range from -0.06 percent to 0.56 percent of GDP, depending on the values of  $\eta$  and  $\lambda$ .

#### 3.1.1 Direct effect

In a simple two-period model, young people receive income in period 1 and save  $S$  out of their income to provide for their retirement.  $S$  is invested at the real after-tax rate of return  $s$  for  $T$  years. In period 2, old people consume out of their wealth. Their retirement consumption is given by

$$(3.1.1.1) \quad C = (1 + s)^T S$$

and

$$(3.1.1.2) \quad P^C = (1 + s)^{-T}$$

can be thought as the price at which savings  $S$  buy retirement consumption  $C$ .

Figure 2

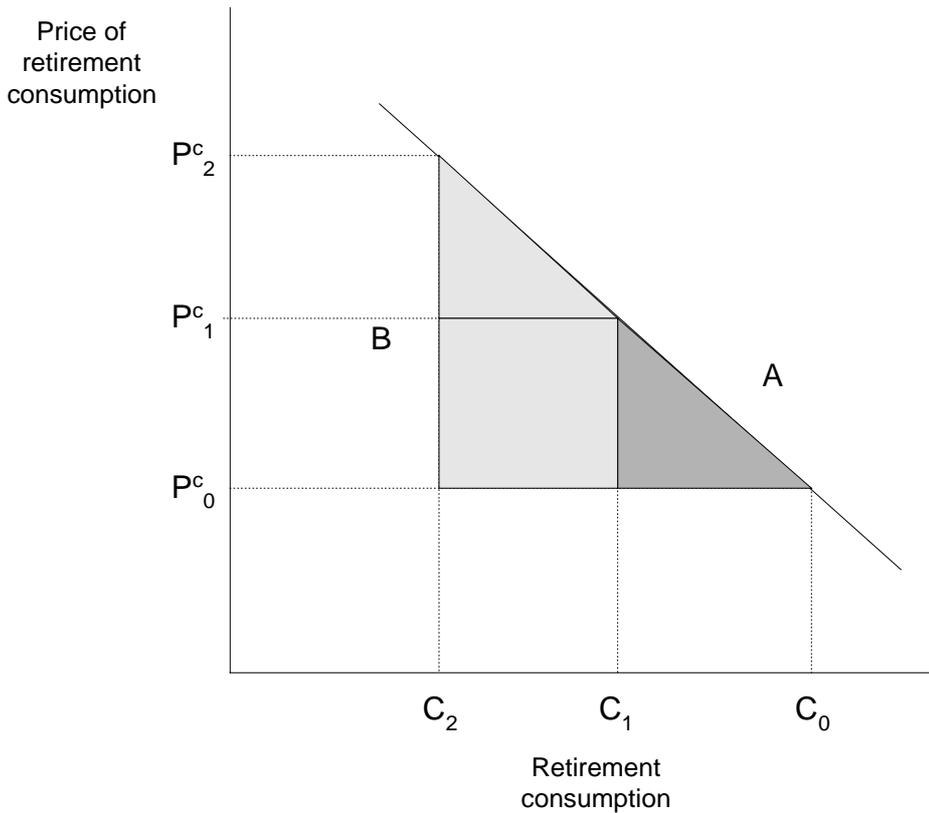


Figure 2 presents the individual's compensated demand curve for retirement consumption. In a world with no taxes and no inflation, young people demand  $C_0$  at price  $P_0^c$ . Taxes increase the price of future consumption to  $P_1^c$ , causing a dead-weight loss equal to the area of triangle A. The additional effect of inflation is to increase the price of future consumption to  $P_2^c$ , and to reduce the quantity of the same to  $C_2$ , with a dead-weight loss equal to the area of the trapezoid B. The welfare effect caused by inflation can thus be estimated as:

$$(3.1.1.3) \quad \Delta DWL = [(P_1^c - P_0^c) + 0.5(P_2^c - P_1^c)](C_1 - C_2)$$

$P_0^c$ ,  $P_1^c$ , and  $P_2^c$  can all be calculated from (3.1.1.2) where  $s_0$ ,  $s_1$ , and  $s_2$  are the estimates derived in section 2 (respectively 0.12, 0.08, and 0.074). Assuming  $T = 30$ ,<sup>10</sup> the price of retirement consumption increases from 0.033 to 0.098 due to taxation and to 0.118 as a result of inflation.

<sup>10</sup> This is equivalent to assuming that all saving occurs in the middle of the working life at age 45 and dissaving takes place in the middle of the retirement years at age 75.

$(C_1 - C_2)$  cannot be calculated directly. It can be rewritten as<sup>11</sup>:

$$\frac{(P_1^C - P_2^C)}{P_2^C} C_2 \varepsilon_{C_p}$$

where  $\varepsilon_{C_p} < 0$  is the compensated elasticity of net retirement consumption with respect to its price. Thus (3.1.1.3) can be expressed as:

$$(3.1.1.4) \quad \Delta DWL = \left( \frac{(P_1^C - P_0^C)}{P_2^C} + \frac{0.5(P_2^C - P_1^C)}{P_2^C} \right) \frac{(P_1^C - P_2^C)}{P_2^C} P_2^C C_2 \varepsilon_{C_p}$$

We can now substitute in  $S_2 = P_2^C C_2$ , evaluate the first part of (3.1.1.4), and rewrite it as:

$$(3.1.1.5) \quad \Delta DWL = -0.106 S_2 \varepsilon_{C_p}$$

$S_2$  and  $\varepsilon_{C_p}$  are not directly observable.  $S_2$  is the value of savings during pre-retirement years at 2 percent inflation. It does not correspond to the national account measure of savings, which is directly observable. But the relationship between the two can be approximated by using the simple overlapping generations model described above. 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 rate of income growth per capita. Savings of young people are then  $(1 + n + g)^T$  times the dissaving of old people and net personal savings in the economy ( $S_N$ ) are related to the savings of young people ( $S_Y$ ) according to:

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

$S_Y$  is conceptually equivalent to  $S_2$  and can be calculated from the above expression. For  $S_N$  we take the average of personal savings between 1978 and 1996, equal to 0.045 of GDP. For  $(n + g)$  we use the steady-state value of GDP growth in FPS, 0.025. For  $T = 30$ ,  $S_2$  is equivalent to 0.086 GDP. (3.1.1.5) becomes:

$$(3.1.1.6) \quad \Delta DWL = -0.009(GDP) \varepsilon_{C_p}$$

Let us now turn to  $\varepsilon_{C_p}$ , the compensated elasticity of retirement consumption with respect to its price. The first step is to express it in terms of the uncompensated elasticity  $\eta_{C_p}$  and of the propensity to save out of exogenous income  $\sigma$ :<sup>12</sup>

<sup>11</sup>  $(C_1 - C_2) = (dC/dP^c)(P_1^c - P_2^c)$   
 $= (dC/dP^c)(P_2^c / C_2)(C_2 / P_2^c)(P_1^c - P_2^c)$   
 $= \varepsilon_{C_p} C_2 (P_1^c - P_2^c) / P_2^c$

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

We assume that the propensity to consume out of exogenous income is equal to the propensity to consume out of wage income. Thus

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

With  $\alpha=0.66$  (the steady-state value of labour income share in FPS),  $\sigma=0.13$ .

The second step is to transform the elasticity of retirement consumption into that of an observable variable, like savings. When doing this, we have to consider the fact that old people receive a certain amount of exogenous income, like State superannuation, during their retirement years. For those who live only on this form of income, the welfare loss induced by inflation is virtually nil.

Therefore, the budget constraint of old people is given by  $C = S/P^C + E$ , where  $E$  is exogenous income. Taking logs of both sides and rearranging, we get:

$$\eta_{Cp} = (1 - E/C)(\eta_{Sp} - 1)$$

where  $E/C$  is the ratio of exogenous income to retirement consumption. For this parameter, Feldstein (1997b) uses a value equal to 0.25. My estimate for New Zealand is much larger and is equal to 0.47<sup>13</sup>.

The third step is to express the uncompensated elasticity of savings with respect to the price of retirement consumption,  $\eta_{Sp}$ , in terms of the elasticity with respect to the real rate of return,  $\eta_{Ss}$ :<sup>14</sup>

$$\eta_{Sp} = -\frac{(1+s)}{sT} \eta_{Ss}$$

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

Short of a reliable estimate of the interest elasticity of saving in New Zealand, we follow Feldstein (1997a, 1997b) and use three different values for  $\eta_{Ss}$  (0, 0.4, and 1) to get, respectively, 0, -0.19 and -0.49 for  $\eta_{Sp}$ ; -0.40, -0.50, and -0.65 for  $\varepsilon_{Cp}$ . The

<sup>12</sup> This can be obtained by using the Slutsky decomposition  $(dC/dP^C) = (dC/dP^C)_{comp} - C(dC/dY)$  and multiplying both sides by  $P^C/C$ .

<sup>13</sup> The ratio should be thought as a weighted average, with the weights given by the amount of savings. For New Zealand,  $C$  is estimated as the annuity flow from the stock of net worth for people aged 60+ from the Westpac-FPG (1996) survey, while  $E$  is derived by applying the yearly value of Government superannuation payments for single persons.

<sup>14</sup> This can be done by differencing (3.1.1.2) with respect to  $s$  and multiplying the result by  $s/P^C$ .

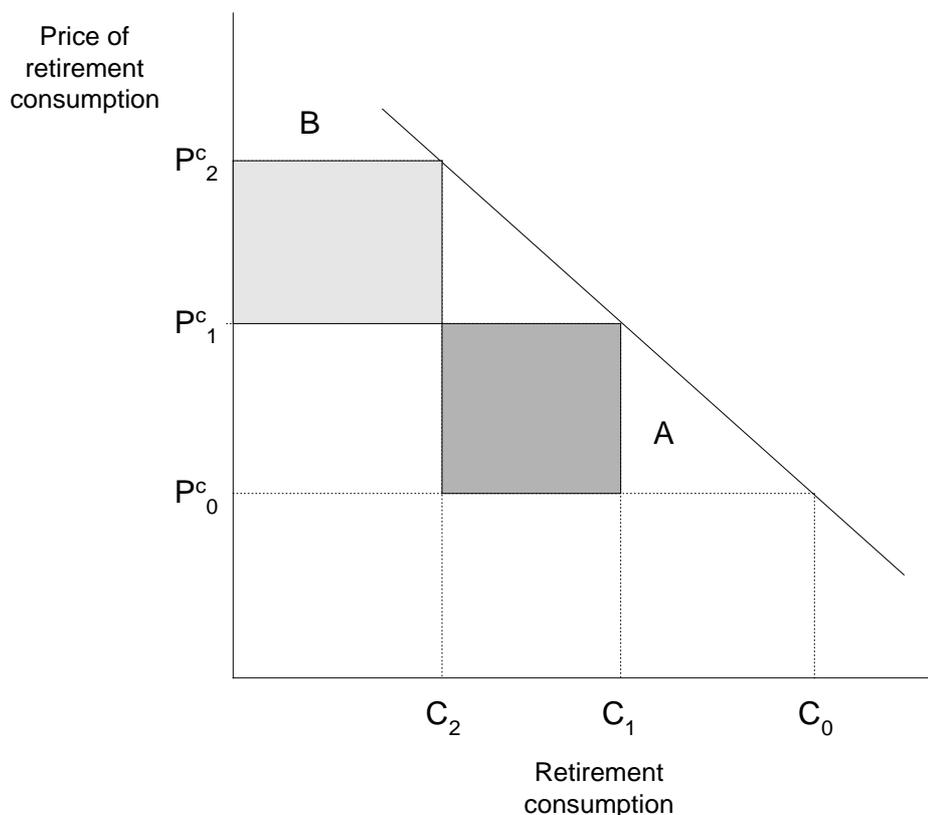
resulting estimates of the welfare effect are: 0.36 percent, 0.46 percent, and 0.60 percent of GDP respectively.

### 3.1.2 Indirect effect

Disinflation implies 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, *A* and *B*, in Figure 3. This difference can be expressed as

$$(3.1.2.1) \quad \Delta REV = (P_1^c - P_0^c)(C_1 - C_2) - (P_2^c - P_1^c)C_2$$

**Figure 3**



Price movements cause changes in consumers' real income that should be taken into account when considering welfare implications. This is why it is appropriate to look at the compensated demand curve for retirement consumption when calculating the direct effect. For the indirect effect, however, the story is quite different. Individuals are very unlikely to take into account the loss in government revenue due to disinflation and fully recognise it will imply more taxes in the future. The uncompensated demand curve is therefore more appropriate.  $(C_1 - C_2)$  can be expressed as:<sup>15</sup>

<sup>15</sup> By substituting  $\epsilon_{cp}$  with  $\eta_{cp}$  in footnote 10.

$$\frac{(P_1^C - P_2^C)}{P_2^C} C_2 \eta_{cp}$$

Recalling that  $S_2 = P_2^C C_2$  and  $\eta_{cp} = \eta_{sp} - 1$ , and rearranging:

$$\Delta REV = \left[ \frac{(P_1^C - P_0^C)}{P_2^C} \frac{(P_2^C - P_1^C)}{P_2^C} (1 - \eta_{sp}) - \frac{(P_2^C - P_1^C)}{P_2^C} \right] S_2$$

Recall that the values of  $P_0^C$ ,  $P_1^C$ , and  $P_2^C$  are equal to 0.033, 0.098, and 0.118, respectively, and  $S_2$  is equal to 0.086(GDP). Substituting in, we get:

$$\Delta REV = [0.09(1 - \eta_{sp}) - 0.17]0.086(GDP)$$

The values obtained for the loss in tax revenue are, respectively, 0.65 percent, 0.50 percent and 0.27 percent of GDP, depending on the value of  $\eta_{sp}$  (0, -0.19, and -0.49) employed. To obtain the welfare effect of this tax revenue loss, we need to multiply these values by some estimates of the dead-weight cost of taxation. As already anticipated, we use two values of  $\lambda$ : 0.14 from Diewert and Lawrence (1994) and 0.65 from McKeown and Woodfield (1995). The resulting welfare effect varies from -0.04 percent to -0.42 percent of GDP.

### 3.2 Reducing distortions to housing demand

Owner-occupied housing is generally favoured by personal income taxation. The main reason for the tax advantage is the fact that no tax is imposed on the implicit 'rental' return of the capital invested in the property. Moreover, in many countries – but not in New Zealand – mortgage interest payments and local property rates are tax deductible.

When mortgage interest payments are not tax deductible, as in New Zealand, inflation affects demand for housing only indirectly, by cutting the return on alternative assets. Price stability minimises this distortion and reduces the loss of tax revenue by moving capital from housing to the business sector. The combined welfare effect is between 0.04 and 0.06 percent of GDP for a reduction of inflation from 2 percent to zero.

#### 3.2.1 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;  $\delta_H$  represents the rate of depreciation and maintenance.

With taxation and inflation,

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

where  $\mu$  is the loan-to-value ratio,  $r_m$  is the real mortgage interest rate,  $s_2$  is the rate of return on capital in the business sector with taxes and 2 percent inflation, and  $\tau_p$  is the local property tax rate.

The value of the housing stock is estimated at around \$130,000 million in 1996 (Breece and Cassino, 1998), of which roughly 75 percent is owner-occupied. By comparing this figure with expenditure items as detailed by the Household Expenditure Survey, we estimate  $\delta_H = 0.05$  and  $\tau_p = 0.01$ .  $r_m$  (equal to 0.068) is the average first mortgage rate over the June 1987- July 1997 period.  $\mu$  (0.2) is taken from Bourassa (1998). The implied rental rate, which equals 0.16 with no inflation and no taxation, drops to 0.138 with taxation and further down to 0.132 at 2 percent inflation.

**Figure 5**

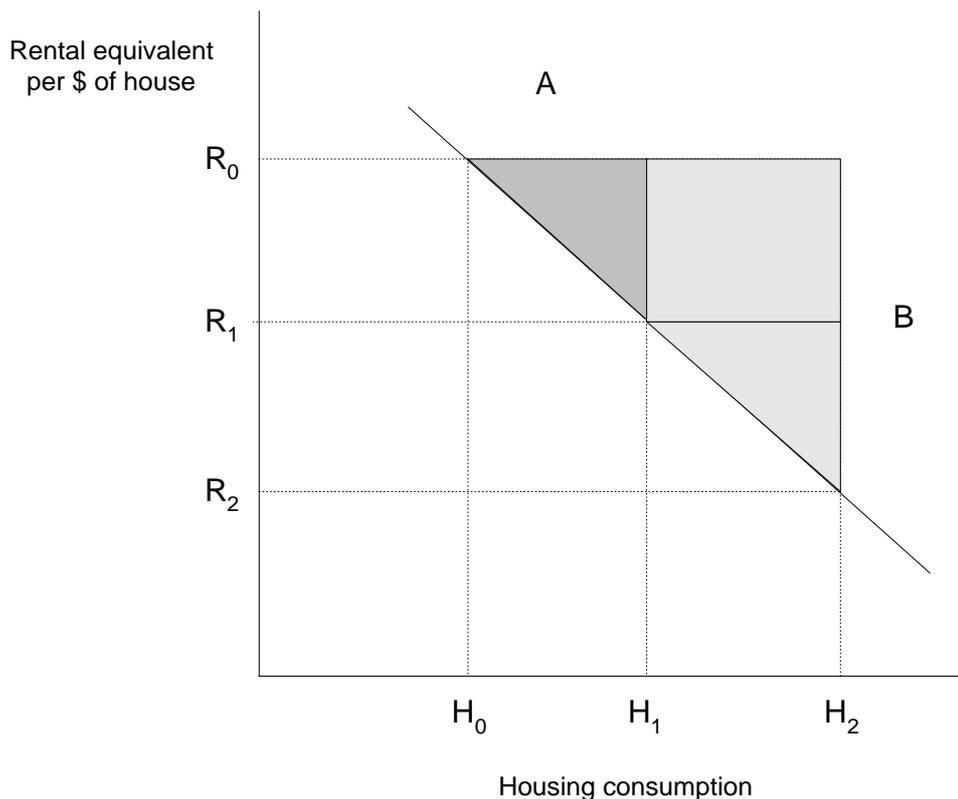


Figure 5 describes the compensated demand for housing services. The horizontal line at  $R_0$  represents the undistorted cost of housing - the 'true' supply curve. The dead-weight cost of taxation is represented by triangle *A*, while the dead-weight cost of inflation is represented by the area of trapezoid *B*.

The measure of the welfare effect of inflation is thus

$$(3.3.1.1) \quad \Delta DWL = [(R_0 - R_1) + 0.5(R_1 - R_2)](H_2 - H_1)$$

With a linear approximation<sup>16</sup>, (3.3.1.1) becomes

$$(3.3.1.2) \quad \Delta DWL = -\varepsilon_{HR} R_2 H_2 \left\{ \left[ \frac{(R_0 - R_1)}{R_2} \frac{(R_1 - R_2)}{R_2} \right] + 0.5 \left[ \frac{(R_1 - R_2)}{R_2} \right]^2 \right\}$$

where  $\varepsilon_{HR}$  is the compensated elasticity of housing demand with respect to the rental rate.  $H_2$  is based on our estimate of the value of the housing stock outlined above and is equal to 1.08 percent of GDP. We then use a value of 0.3 for  $\varepsilon_{HR}$  taken from Diewert and Lawrence (1994). The welfare effect obtained as a result is equal to 0.03 percent of GDP.

### 3.2.2 Indirect effect

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

$$\Delta REV_1 = \varepsilon_{HR} \frac{R_1 - R_2}{R_2} H_2 (s_0 - s_1)$$

equivalent to 0.05 percent of GDP.

This increase in tax revenues is partly offset by a loss in the revenue from property taxes due to reduction of the housing stock. This loss can be estimated from

$$\Delta REV_2 = \varepsilon_{HR} \frac{R_1 - R_2}{R_2} H_2 \tau_P$$

equivalent to 0.01 percent of GDP.

The overall effect on tax revenue is about 0.03 percent of GDP and the welfare effect turns out to be between 0.01 and 0.02 percent of GDP.

### 3.3 Reducing distortions to money demand

Inflation raises the cost of holding non-interest bearing money and reduces money balances below the optimal level. Price stability eliminates this distortion, but at the same time reduces seigniorage revenue. The lower opportunity cost from holding money balances results in a transfer of capital out of the business sector into money,

<sup>16</sup>  $(H_1 - H_2) = (dH/dR)(R_2 - R_1)$   
 $= (dH/dR)(R_2/H_2)(H_2/R_2)(R_2 - R_1)$   
 $= \varepsilon_{HR} H_2 (R_2 - R_1) / R_2$

and thus in a lower amount of tax revenue from business profits. These two negative indirect effects would be partly offset by the lower service cost of government debt as the result of the larger amount of monetary financing. In New Zealand, the negative tax revenue effects are estimated to dominate the positive welfare effect and the overall result is between -0.01 and -0.03 percent of GDP.

### 3.3.1 Direct effect

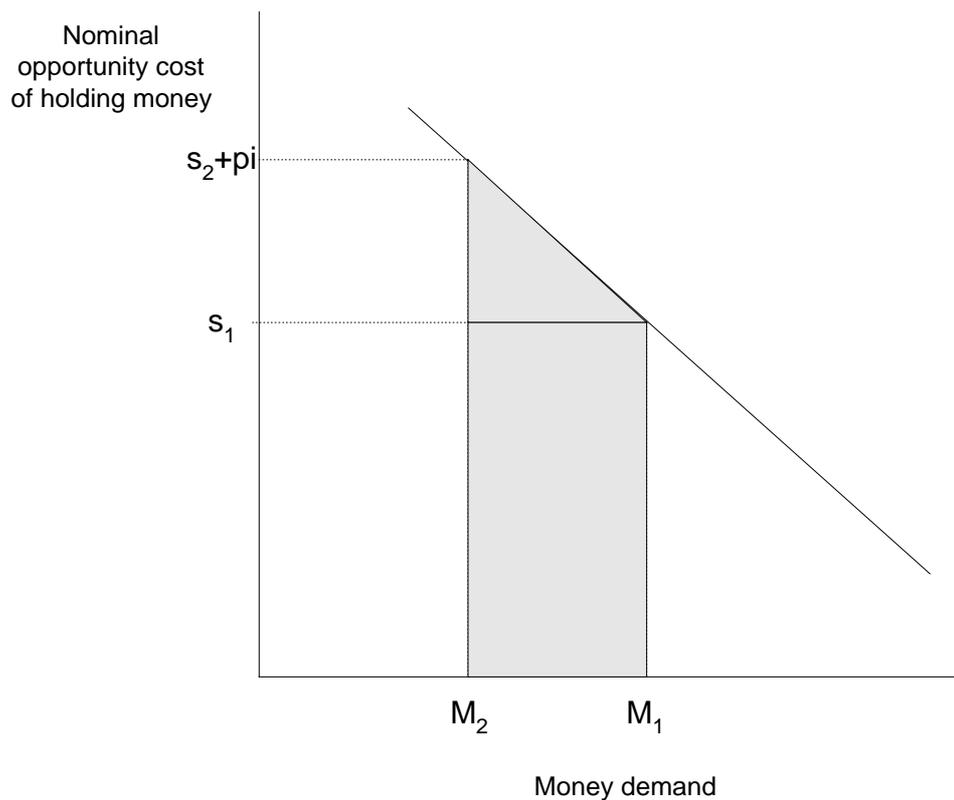
The Friedman-Bailey effect should be measured by the trapezoid in Figure 6, where the money demand curve is portrayed. Its area is measured by

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

$$\text{where } (M_1 - M_2) = (s_2 + \pi - s_1) \frac{M}{s_2 + \pi} \varepsilon_M$$

with  $\varepsilon_M$  representing the elasticity of money demand with respect to the nominal opportunity cost of holding money.

**Figure 6**



The estimates of money demand elasticity in New Zealand are generally very low. The one that we use (0.036) is the simple average of the results obtained by Siklos (1995). The quantity of non-interest bearing money is also very small in New

Zealand: according to our own estimates, only 0.027 percent of GDP. As a result, the direct effect of inflation on money demand is insignificant.

### 3.3.2 Indirect effect

The net revenue effect is negative, but small (about 0.05 percent of GDP). Its distortionary effect is within the range -0.1/-0.4 percent of GDP. It 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 seigniorage effect can be calculated as

$$\Delta REV_1 = -M \left[ 1 - \varepsilon_M \frac{(s_2 + \pi - s_1)}{(s_2 + \pi)} \right]$$

equivalent to -0.05 percent of GDP.

The revenue loss effect is measured by

$$\Delta REV_2 = -(s_0 - s_1)(M_1 - M_2)$$

and it turns out to be insignificant. The same can be said about the debt service effect:

$$\Delta REV_3 = -r_{ng} (M_1 - M_2)$$

where  $r_{ng}$  is the real interest paid by government on its debt net of the taxes it collects on those interest payments. Our estimate of  $r_{ng}$  (0.0335) is based on the relevant steady-state interest rate from FPS, net of taxes.

### 3.4 Government debt service

Eliminating inflation would increase the real cost of servicing the government debt because tax assessable interest payments would no longer include an element of inflation compensation. This loss in revenue is calculated as

$$\Delta GDS = -m \frac{B}{GDP} \Delta \pi$$

where  $m$  is the personal tax rate and  $B$  is the outstanding government debt. With  $B=0.3(\text{GDP})$ , the lost revenue is equal to -0.2 percent of GDP. In terms of welfare, the effect is between -0.03 and -0.13 percent of GDP.

## 4 Costs and benefits compared

The main cost of eliminating inflation would be the output loss involved in getting to price stability. This cost is measured by using the ‘sacrifice ratio’, which tells us by how much output would have to be reduced to cut inflation by one percentage point. The estimates of this ratio are typically very uncertain and show substantial variation over time. For New Zealand, we have values ranging from 0.5 (Ball, 1994) to 8.5

(Mayes and Chapple, 1994). A more recent estimate by Hutchison and Walsh (1998) points at a value of 4, increasing from the pre-reform period. It is not clear which estimate would be more appropriate for a low-inflation regime. We thus resort to a value drawn from a calibrated model, FPS, which has embedded a sacrifice ratio of 2.

A key point of the analysis is how to compare costs and benefits. Following Feldstein (1997a, 1997b), we argue that the costs of disinflation are temporary while the benefits are permanent. The implication of this argument is that the one-off output costs must be compared with the discounted stream of future benefits.

The choice of the discount rate is extremely important in determining the final result. A very small discount rate produces a strong magnifying effect on the estimated benefits. In our case, the discount rate should be represented by market rate  $s_2$ , the after-tax rate of return to savers when inflation is 2 percent, which is equal to 0.0738. Because benefits grow at the same rate  $g$  as GDP, the relevant discount rate is  $(d-g)$ , where  $d$  is equal to  $s_2$  and  $g$  is assumed to be 0.025, equal to the steady-state value in FPS.

The choice of the discount rate determines the break-even point for benefits. If the total costs of going from 2 percent to zero inflation is 4 percent of GDP, as implied by a sacrifice ratio of 2, the break-even point turns out to be  $B^* = C(d - g) = 0.20$  percent in New Zealand. When comparing this figure with those in Table 2, four out of six values of the estimated benefits clearly exceed the break-even point. The result is robust to different values of the savings elasticity provided the lower value of  $\lambda$  (0.14) is employed. When the high value of  $\lambda$  (0.65) is used instead, the same result could be obtained only for an unitary savings elasticity.

However, this result depends heavily on the values of two parameters, the discount rate and the sacrifice ratio, for both of which there is significant uncertainty. The conclusions reached could be reversed for plausible values of the same parameters. If we concentrate on the base case ( $\eta=0.4$ ;  $\lambda=0.14$ ), a discount rate of 12 percent and a sacrifice ratio of 4 percent would be enough to completely offset the estimated benefits. This discount rate (which would imply an after-tax rate of return of 14.5 percent) may be too high, but the sacrifice ratio is certainly within the range of plausible estimates.

## 5 Conclusions

The monetary policy implications of this work may not seem obvious. In principle, the costs of inflation analysed in this paper would be eliminated by fully indexing the tax system or shifting from direct to indirect taxation. Nevertheless, there are practical difficulties associated with these options. Indexation has been attempted by many countries, but the problems are such that no satisfactory solution has been reached. More developments are possible on the second option, but the consequences of such a dramatic change are still far from being understood and it will probably take some time before any significant progress is made.

Given these difficulties, the alternative option is to reduce inflation. By doing so, monetary policy significantly reduces welfare costs, but it generates other costs in terms of output and unemployment. The results presented in this paper show that going from 2 percent to zero 'true' inflation would most likely have a positive net welfare effect. However, this result is nowhere as strong as that obtained by Feldstein for the United States and is not robust to plausible values of some key parameters.

The analysis is necessarily incomplete. It does not consider other costs of inflation, like those associated with uncertainty, which are certainly most relevant. Some complications, relative to the possibility of persistent effects of disinflation on output, are also not taken into account. Finally, the analysis completely ignores general equilibrium effects, which are likely to magnify the welfare impact of inflation. Overall, the results support the notion that inflation, even when it is low, has significant costs that can hardly be neglected.

## References

- Bakhshi, H, Haldane, A G and N Hatch (1998) 'Some costs and benefits of price stability in the United Kingdom', *NBER Working Paper* No. 6660
- Ball, L (1994) 'What Determines the Sacrifice Ratio?', in *Monetary Policy*, N.G. Mankiw (ed.), The University of Chicago Press
- Bayoumi, T and J Gagnon (1996) 'Taxation and inflation: A new explanation for capital flows', *Journal of Monetary Economics*, 38, 303-330
- Black, R, Cassino, V, Drew, A, Hansen, E, Hunt, B, Rose, D, and A Scott (1997) 'The Forecasting and Policy System: the core model', *Reserve Bank of New Zealand Research Paper* No. 43
- Bourassa, S C (1998) 'Owner-Occupied Housing Costs and the Consumer Price Index,' *New Zealand Economic Papers*, 32(1), 71-82
- Breece, J and V Cassino (1998) 'The Forecasting and Policy System: Demand-Side Satellite Models', *Reserve Bank of New Zealand Discussion Paper* G98/3
- Cohen, D, Hassett, K A and R G Hubbard (1997) 'Inflation and the User Cost of Capital: Does Inflation Still Matter?', *NBER Working Paper* No. 6046
- Desai, M A and J R Hines (1997) 'Excess Capital Flows and the Burden of Inflation in Open Economies', *NBER Working Paper* No. 6064
- Diewert, W E and D Lawrence (1994) 'The Marginal Costs of Taxation in New Zealand', report prepared for the New Zealand Business Roundtable, Swan Consultants, Canberra
- Dolado, J J, Gonzalez-Paramo, J M and J Viñals (1997) 'A cost-benefit analysis of going from low inflation to price stability', paper presented at the NBER Conference on *The costs and benefits of achieving price stability*, Federal Reserve Bank of New York, February
- Feldstein, M (1997a) 'The Costs and Benefits of Going from Low Inflation to Price Stability', in Romer, C.H. and D.H. Romer (eds.) *Reducing Inflation*, The University of Chicago Press
- Feldstein, M (1997b) 'Capital Income Taxes and the Benefit of Price Stability', *NBER Working Paper* No. 6200
- Hall, R E and D W Jorgenson (1967) 'Tax Policy and Investment Behavior', *American Economic Review*, 57, June, 391-414

- Hutchison, M H and C E Walsh (1998) 'The Output-Inflation Tradeoff and Central Bank Reform: Evidence from New Zealand', *The Economic Journal*, 108, May, 703-725
- King, M A and D Fullerton (eds.) (1984) 'The Taxation of Income from Capital: A Comparative Study of the United States, the United Kingdom, Sweden and West Germany', University of Chicago Press
- Mayes, D and B Chapple (1994) 'The Costs and Benefits of Disinflation: A Critique of the Sacrifice Ratio', *Reserve Bank of New Zealand Bulletin*, 57(4), 9-21
- McKeown, P C and A E Woodfield (1995) 'The Welfare Cost of Taxation in New Zealand Following Major Tax Reforms', *New Zealand Economic Papers*, 29(1), 41-62
- OECD (1991) *Taxing Profits in a Global Economy*, Paris
- OECD (1997) *Economic Outlook*, December, Paris
- Siklos, P L (1995), 'The Demand for Money in New Zealand in an Era of Institutional Change: Evidence from the 1981-1994 Period', *New Zealand Economic Papers*, 29(1), 21-40
- Tödter, K H and G Ziebarth (1997), 'Price Stability vs. Low Inflation in Germany: An Analysis of Costs and Benefits', *NBER Working Paper* No. 6170
- Westpac-FPG (1996) 'New Zealand Savings Profile – Review of Selected Findings', July, Wellington