CANTER

DP 96-11

Department of Economics
UNIVERSITY OF CANTERBURY
CHRISTCHURCH, NEW ZEALAND

ISSN 1171-0705

OPTIMAL CURRENCY DENOMINATION OF PUBLIC DEBT IN NEW ZEALAND

Kerryn Fowlie and Julian Wright

Discussion Paper

No. 9611

Department of Economics, University of Canterbury
Christchurch, New Zealand

Discussion Paper No. 9611

November 1996

OPTIMAL CURRENCY DENOMINATION OF PUBLIC DEBT IN NEW ZEALAND

Kerryn Fowlie and Julian Wright

Optimal Currency Denomination of Public Debt in New Zealand

Kerryn Fowlie and Julian Wright[*]
j.wright@econ.canterbury.ac.nz

Abstract

This paper addresses the issue of whether New Zealand's debt obligations should be denominated in domestic or foreign currency. Using the tax smoothing approach of Bohn (1990) we estimate optimal debt portfolios and compare these to those obtained from a simple mean-variance approach. We find that contrary to current government policy as well as the results from the mean-variance approach, welfare maximising policy is for all public debt to be denominated in foreign currency.

I Introduction

Recently the New Zealand government has carried out an extensive program of asset sales in an attempt to reduce the ever increasing burden of public debt. Asset sales raised the issue of whether the proceeds should be used to redeem domestic or foreign denominated debt. Two principal policy makers in the New Zealand economy, the Reserve Bank (RBNZ) and the Debt Management Office (NZDMO) of Treasury, each have displayed unusually diverse perspectives on this issue[1].

The RBNZ is concerned with maintaining a credible monetary policy so as to achieve and maintain stability in prices. Issuing foreign currency debt removes the incentive for the government to inflate away the real value of nominal public debt, enhancing the credibility of monetary policy and thereby making it easier to achieve low inflation rates. Conversely high levels of nominal domestic currency debt lead to credibility problems for monetary policy. Through suprise inflation the government can reduce the real value of its debt obligations. These credibility problems become

[*] We are grateful to the NZIER for providing the relevant New Zealand data.

[1] When in 1989 the new Minister of Finance annouced proceeds of asset sales would be used to repay domestic debt the then manager of the NZDMO tendered his resignation in protest. In contrast the Governor of the RBNZ issued a statement strongly supporting the policy (National Business Review, 31 July, 1989, p1).

acute when a large fraction of the domestic denominated debt is owned by foreigners. Essentially inflation then becomes a way of raising tax revenue from foreigners.

In contrast the NZDMO's objective as cited by the Treasury in 1991, is to "*reduce the Crown's financial risks and to improve its net worth*". That is, the NZDMO is concerned with managing the public debt portfolio to control the Crown's financial risk. For this reason it displays a preference for avoiding foreign currency obligations which expose the government to exchange rate risk.

In this paper we set aside the Reserve Bank's time consistency concerns, which are the focus of Bohn (1991) and Dalziel and Wright (1993)[2] and instead re-examine the optimal currency denomination of government debt from Treasury's point of view. In doing so we recognise the NZDMO's case, as given above, is incomplete. It neglects to address issues of hedging that ensure consumer welfare is maximised and, as such, can not generally represent an optimal portfolio of public debt.

Bohn (1990) derives a formula for the socially optimal currency denomination of public debt ignoring time consistency issues. The key idea is that the government will prefer to issue debt for which repayments are low whenever the government's tax revenues are low. This will reduce the need for it to adjust tax rates, an action which is assumed to be costly. We apply Bohn's formula to New Zealand and contrast this to a simple mean-variance approach to debt management.

In Bohn's tax smoothing approach, optimal public debt management involves issuing securities which provide natural hedges against fluctuations in tax revenues. Domestic currency debt can be desirable in this regard if low inflation is associated with high output growth. Conversely, if low inflation is associated with low output growth foreign currency debt will generally be optimal. Clearly then the optimal currency composition of public debt becomes an empirical question.

We use data on the post-float period for New Zealand to calculate the optimal currency compostion of government debt using pairwise comparisons with three countries (Germany, Japan and the United States)[3]. In each case we find that when

[2] Dalziel and Wright (1993) establish that the socially optimal proportion of foreign debt lies between the objective functions of the RBNZ and the NZDMO.

[3] These three countries correspond to the currencies which NZ has its three largest debt obligations with. According to the Treasury's statement of borrowings in June 1993, 48% of foreign currency debt was in U.S dollars, 28% in Japanese yen and 8% in German marks.

using the tax smoothing approach, the New Zealand government should issue only foreign currency debt. This contrasts with the recent policy of the government to pay back all foreign currency debt, leaving only domestic currency obligations. Perhaps a motivation for Treasury's domestic debt bias is the NZDMO's objective to eliminate currency risk. Using a simple mean-variance framework we indeed find that Treasury should issue only domestic debt. However recall that a mean-variance approach to Government debt management is flawed. More variance in the value of the governments debt obligations may well be appropriate if such fluctuations are negatively correlated with the need for the government to raise taxes.

The paper is organised as follows. Section II reviews the tax smoothing approach as developed in Bohn (1990) and dervies its implications for the optimal currency composition of public debt. Section III details the data used for this analysis. Section IV presents the empirical results, comparing optimal debt portfolios under tax smoothing with those calculated from a mean-variance approach. Section V discusses other factors which might influence the debt denomination decision and section VI concludes.

II Tax Smoothing

As stated in Bohn (1990), the principle idea governing tax smoothing theories is that government liabilities should provide a hedge against any macroeconomic shocks that affect the governments budget so as to minimize fluctuations in tax rates. Bohn begins by assuming that consumers are only interested in maximizing the utility they can derive from all future consumption subject to an individual budget constraint. Each individual has a given set of endowments and is able to trade a given set of assets (K of them). In addition, endowments are taxed at a rate T_t. Such taxes are considered distortionary due to the collection costs and misallocation costs that are imposed on the private economy. As remarked by Barro (1979) "*the production of government revenue involves the using up of some resources in the sense of costs that are often referred to as deadweight losses or excess burdens*".

The government will choose tax rates and debt structure so as to optimize the objective function of the consumer given its own policy constraints. The government uses tax revenues to finance government expenditure and to service its public debt. It can buy and sell securities at the market price. By assuming a quadratic excess burden, Bohn establishes that an optimal policy requires that

$$\operatorname{cov}_t(\hat{T}_{t+1}, \hat{r}_{t+1,i}) = 0 \quad i = 1,\ldots,K \tag{1}$$

where $\hat{T}_{t+1}$ is the innovation in the tax rate and $\hat{r}_{t+1,i}$ is the innovation in the real return to asset i.

If this covariance term is negative it would suggest that when tax rates are high, the rate of repayment required on the form of debt in question is low. This being the case, it would be optimal for the government to issue more of this form of debt as it would reduce the need to alter tax rates. The converse is true if the covariance is positive. If no relationship exists between tax rates and debt repayment requirements then the debt portfolio outstanding at that point in time could not be altered so as to improve levels of tax smoothing.

The innovation in tax rates is determined by the governments budget constraint to equal

$$T_{t+1} - E_t T_{t+1} = (1-\psi)e^{-\bar{y}}\Big(\sum_i \hat{r}_{t+1,i} d_{t,i} + \sum_{j\geq 0} \rho^j \hat{g}_{t+1+j}\Big) - T_t \sum_{j\geq 0} \psi^j \hat{y}_{t+1+j} \tag{2}$$

where y_t is the growth rate of real GDP and $\bar{y}$ is its mean. The new information about period (t+1+j) output growth is denoted by $\hat{y}_{t+1+j} = E_{t+1} y_{t+1+j} - E_t y_{t+1+j}$. The term g_t represents government spending as a ratio to GDP. Innovations in g_{t+1+j} can be expressed as $\hat{g}_{t+1+j} = E_{t+1} g_{t+1+j} - E_t g_{t+1+j}$. The ratio of security i debt to output is defined as $d_{t,i} = p_{t,i} D_{t,i} / Y_t$ where $p_{t,i}$ is the price of asset i in terms of consumption goods. The present value expression for unexpected innovations in output is discounted at a rate $\psi = \rho \exp(-\bar{y})$ where ρ is the discount factor associated with one period ahead consumption.

The intuition behind this formula is that the present value of tax revenues must cover initial debt plus the present value of government spending. Any innovations in government spending will have an effect on the state of the budget and will therefore cause a change in the value of government debt. If these changes are permanent, the government must adjust tax revenues eventually. A proportion $(1-\psi)$ of this will take place immediately due to tax smoothing. In addition, since tax revenues depend on the path of output, tax rates will be adjusted whenever new information about current and future output is received. The result of this process is that taxes will be adjusted whenever there are:

unexpected changes in the value of government debt;
estimates of government spending are revised; and
output growth differs from what is expected.

Substituting equation (2) into equation (1) gives the following optimality condition for each government security i. i=1,...,K.

$$\sum_k \mathrm{cov}_t(\hat{r}_{t+1,k}, \hat{r}_{t+1,i}) d_{t,k} + \mathrm{cov}_t(\hat{r}_{t+1,i}, \sum_{j\geq 0} \rho^j \hat{g}_{t+1+j}) - w_t \mathrm{cov}_t(\hat{r}_{t+1,i}, \sum_{j\geq 0} \psi^j \hat{y}_{t+1+j}) = 0 \quad (3)$$

where $w_t = [\exp(\bar{y}/(1-\psi)]T_t$ is a weighting factor.

Equation (3) identifies innovations in the present value of government spending and output as two situations that require adjustments in tax rates which the government would like to smooth through issuance of state contingent debt. These innovations appear as the last two terms in equation (3). By solving these K equations the optimal level of debt for each asset can be expressed as the sum of these two covariance terms. A priori, it is likely that output variation is quantitatively important in equation (3) as the cyclical volatility of budget deficits is well documented. The same cannot be said for the second term. Bohn(1990) showed for the United States that the second term is small and insignificant. For the calculations in this paper we will therefore ignore the covariance between innovations in the present value of government spending and innovations in returns on the assets[4].

To focus on the choice between domestic and foreign denominated debt we assume d_t contains only two elements, domestic debt (d_D) and foreign debt (d_F)[5].

[4] We will return to this issue in section VI.

[5] Thus we only consider pair-wise comparisons. That is we compare domestic currency debt with each type of foreign currency debt, one country at a time.

Equation (3) implies

$$\begin{bmatrix} d_D \\ d_F \end{bmatrix} = \frac{w_t}{\Delta} \begin{bmatrix} \text{cov}(\hat{r}_{t+1,2}, \hat{r}_{t+1,2}) & -\text{cov}(\hat{r}_{t+1,2}, \hat{r}_{t+1,1}) \\ -\text{cov}(\hat{r}_{t+1,1}, \hat{r}_{t+1,2}) & \text{cov}(\hat{r}_{t+1,1}, \hat{r}_{t+1,1}) \end{bmatrix} \begin{bmatrix} \text{cov}(\hat{r}_{t+1,1}, \sum_{j\geq 0} \psi^j \hat{y}_{t+1+j}) \\ \text{cov}(\hat{r}_{t+1,2}, \sum_{j\geq 0} \psi^j \hat{y}_{t+1+j}) \end{bmatrix} \tag{4}$$

where

$$\begin{aligned} \hat{r}_{t+1,1} &= (i_{1,t+1} - \pi_{t+1}) - E_t(i_{1,t+1} - \pi_{t+1}) \\ &= -(\pi_{t+1} - E_t\pi_{t+1}) \\ \hat{r}_{t+1,2} &= (i_{2,t+1} + \Delta s_{t+1} - \pi_{t+1}) - E_t(i_{2,t+1} + \Delta s_{t+1} - \pi_{t+1}) \\ &= (\Delta s_{t+1} - E_t\Delta s_{t+1}) - (\pi_{t+1} - E_t\pi_{t+1}) \\ \hat{y}_{t+1+j} &= E_{t+1} y_{t+1+j} - E_t y_{t+1+j} \end{aligned} \tag{5}$$

and $i_{1,t+1}$ is the nominal interest rate in the domestic country (between t and t+1, known at time t) and $i_{2,t+1}$ is the nominal interest rate in the foreign country (between t and t+1, known at time t). π is defined as the rate of inflation and s_t represents the log of the spot exchange rate, defined as the New Zealand dollar price of one unit of foreign currency. Δ is the determinant of the variance covariance matrix of innovations in the returns to domestic and foreign denominated debt. That is, $\Delta = \begin{vmatrix} \text{cov}(\hat{r}_{t+1,1}, \hat{r}_{t+1,1}) & \text{cov}(\hat{r}_{t+1,1}, \hat{r}_{t+1,2}) \\ \text{cov}(\hat{r}_{t+1,1}, \hat{r}_{t+1,2}) & \text{cov}(\hat{r}_{t+1,2}, \hat{r}_{t+1,2}) \end{vmatrix}$.

In equation (4) the present value expression for unexpected innovations in output is discounted at a rate ψ. Bohn determined that differing discount rates had only a negligible effect on the estimates achieved for the US. For the purposes of this analysis a value of 0.99 will be used throughout. The summation term is calculated over 8 periods (*i.e.* a total length of 2 years)[6]. VAR regressions (6)-(8) are used to calculate expectations of inflation, exchange rate changes and read GDP growth, needed in equation (5). The VAR used includes 3 variables with four lags and a constant.

[6] Eight quarters was thought to be long enough for convergence in forecasted GDP growth to its long run rate.

$$r_{t,1} = \alpha_0 + \alpha_{11}r_{t-1,1} + \alpha_{12}r_{t-2,2} + \alpha_{13}r_{t-3,3} + \alpha_{14}r_{t-4,4} + \alpha_{21}r_{t-1,2} + \alpha_{22}r_{t-2,2} + \alpha_{23}r_{t-3,2} + \alpha_{24}r_{t-4,2} + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \beta_3 y_{t-3} + \beta_4 y_{t-4} + u_{t,1} \tag{6}$$

$$r_{t,2} = \delta_0 + \delta_{11}r_{t-1,1} + \delta_{12}r_{t-2,2} + \delta_{13}r_{t-3,3} + \delta_{14}r_{t-4,4} + \delta_{21}r_{t-1,2} + \delta_{22}r_{t-2,2} + \delta_{23}r_{t-3,2} + \delta_{24}r_{t-4,2} + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \phi_3 y_{t-3} + \phi_4 y_{t-4} + u_{t,2} \tag{7}$$

$$y_t = \theta_0 + \theta_{11}r_{t-1,1} + \theta_{12}r_{t-2,2} + \theta_{13}r_{t-3,3} + \theta_{14}r_{t-4,4} + \theta_{21}r_{t-1,2} + \theta_{22}r_{t-2,2} + \theta_{23}r_{t-3,2} + \theta_{24}r_{t-4,2} + \varphi_1 y_{t-1} + \varphi_2 y_{t-2} + \varphi_3 y_{t-3} + \varphi_4 y_{t-4} + u_{t,3} \tag{8}$$

where $r_{t,1} = -\pi_t$

$r_{t,2} = -\pi_t + \Delta s_t$

In contrast to the tax smoothing approach it is simple to calculate the optimal debt structure using the mean-variance approach to debt management. The real repayment required on a debt portfolio consisting both of a domestic and foreign currency bond is equal to:

$$r_{t+1}{}^P = (1-\omega)(\, i_{1,t+1} - \pi_{t+1}\,) + \omega(\, i_{2,t+1} + (\Delta s_{t+1} - \pi_{t+1}) \tag{9}$$

where ω is defined as the proportion of foreign currency debt in the portfolio. Assuming uncovered interest parity, the best the government can do according to this theory is to choose ω so as to minimize the variance of real debt repayments. The variance of debt re-payments is equal to

$$V(r_{t+1}{}^P) = V(\pi_{t+1}) + \omega^2 V(\Delta s_{t+1}) - 2\omega \mathrm{cov}(\Delta s_{t+1}, \pi_{t+1}) \tag{10}$$

which implies the optimal proportion of foreign currency debt is

$$\omega = \mathrm{cov}(\Delta s_{t+1}, \pi_{t+1}) \,/\, V(\Delta s_{t+1}) \tag{11}$$

III. Data

All data used is quarterly. We analyse our results over the flexible exchange rate period for New Zealand from 1985Q3 to 1996Q1. The exchange rate is the end of quarter New Zealand price of one unit of foreign currency (US, Germany, and Japan) and is taken from the International Financial Statistics. The New Zealand price of one Yen or one Deutschmark is calculated from triangular arbitrage using the NZ/US and US/YEN or US/DM rates. Information on New Zealand growth rates and inflation was provided courtesy of the New Zealand Institute of Economic Research. As no seasonally adjusted current price production based GDP series exists, it has been calculated by deriving the implicit actual price deflator and applying this to the seasonally adjusted real GDP series. This assumes that the seasonal pattern does not alter the implicit aggregate price series.

IV Results

The following section outlines the results of the tax smoothing approach and compares these to those obtained using a simple mean variance approach. It also dicusses how these results compare to the actual debt portfolio of the New Zealand government. Table 1 presents the main results of the paper. Using the tax smoothing approach, (equation (4) with innovations calculated using the VAR system (6)-(8) above), we find that the optimal debt policy for New Zealand requires all debt to be denominated in foreign currency. This is true regardless of which of the three foreign currencies are considered. In fact the unconstrained solution to equation (4) is for New Zealand to purchase securities denominated in New Zealand dollars and fund this plus government spending through issuance of foreign currency debt[7]. Although not addressed in the analysis, this would have the additional benefit of not only reducing the Reserve Bank's credibility problem but potentially even eliminating it altogether. However large scale government purchases of New Zealand dollar financial assets are probably not politically feasible and so the constrained optimum is for the government to denote all its obligations in foreign currency.

[7] That is d_D is negative and d_F is positive.

Table 1: Optimal Proportions of Foreign Debt in New Zealand

(% of total public debt which is denoted in foreign currency)

	\$US	Yen	Deutschmark
Tax Smoothing	100%	100%	100%
Mean-Variance	0.1%	0%	0%
Corr (π , y)	0.46917	0.19305	0.37106

Note: Each column represents the analysis with respect to a specific currency.

The mean-variance approach ignores the implications of the type of debt finance on the government's budget contraint. Rather it seeks simply to minimize the variance in debt repayments. In this case the high volatility of exchange rates (under flexible exchange rate systems) implies that the government should elimate foreign currency debt altogether. This is bourne out in table 1 where the results for the mean-variance approach suggest the government should only issue domestic currency debt.

However the results from tax smoothing imply this is not optimal. While foreign currency debt indeed induces more volatility in the value of the governments liabilities, this volatility is not necessary harmful. With foreign currency debt fluctuations in the value of debt are negatively correlated with the need for the government to raise taxes. This is not true for domestically denominated debt.

The positive correlation between innovations in inflation and output growth, detailed in table 1, is the key reason identified for the optimality of foreign currency debt. To see this, it is useful to decompose equation (5) into the underlying variances and covariances of the innovation terms being calculated[8].

(12)

$$\begin{bmatrix} d_D \\ d_F \end{bmatrix} = \frac{w}{\Delta}\begin{bmatrix} -\operatorname{var}(\Delta s)\operatorname{cov}(\pi, y) - \operatorname{var}(\pi)\operatorname{cov}(\Delta s, y) + \operatorname{cov}(\pi, y)\operatorname{cov}(\Delta s, \pi) + \operatorname{cov}(\Delta s, y)\operatorname{cov}(\Delta s, \pi) \\ \operatorname{var}(\pi)\operatorname{cov}(\Delta s, y) - \operatorname{cov}(\pi, y)\operatorname{cov}(\Delta s, \pi) \end{bmatrix}$$

[8] $\Delta s = \Delta s_{t+1} - E_t \Delta s_{t+1}$, $\pi = (\pi_{t+1} - E_t \pi_{t+1})$, $y = \sum_{j \geq 0} \psi^j \hat{y}_{t+1+j}$. The derivation of equation (12) is given in the appendix.

Results for each of these components are calculated and reported in table 2 below.

Table 2: Covariance and variance terms

	$US	*Yen*	*Deutschmark*
var(Δs)	0.3243079*10(-1)	0.1762826	0.2402367
var(π)	0.5800845*10(-3)	0.5182069*10(-3)	0.6245950*10(-3)
cov(Δs,π)	-0.5287609*10(-3)	0.3563048*10(-2)	0.3737700*10(-2)
cov(Δs,y)	0.1653572*10(-2)	0.1927873*10(-1)	0.3384689*10(-1)
cov(π,y)	0.2118702*10(-2)	0.7163173*10(-3)	0.2223319*10(-2)

Note: Each column represents the analysis with respect to a specific currency.

The results show that the sign of the correlation term between inflation and output growth is critical in determining whether domestic debt should be issued[9]. In the first term in equation (12) the covariance between inflation and ouput growth is multiplied by the variance of exchange rate movements. Due to the high volatility of exchange rates under a floating rate system, this covariance term dominates the domestic debt equation. If inflation is positively correlated with output, as may be expected if aggregate demand shocks dominate the economy, then the optimal amount of domestic debt issued will be negative. That is, it is optimal for the government to be a net lender of domestic currency assets and to borrow in foreign currency.

To illustrate this result further suppose the correlations between inflation and output growth in table 1 take on the same values but are negative rather than positive. With all other correlations and variances unchanged then the optimal tax smoothing proportion of foreign currency debt is now: against the US dollar, 0% foreign debt, against the Japanese Yen, 6.43% foreign debt, and against the German Mark, 13.25% foreign debt.

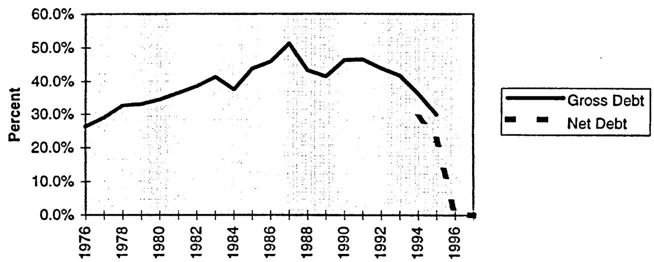
Another interpretation of these results is that whether domestic (foreign) currency debt is optimal depends on whether aggregate supply (demand) shocks

[9] In fact in preliminary work we have shown this result for a further 10 countries. In each case whether a country should issue domestic currency or foreign currency debt depended on the sign of the correlation between inflation and ouput. In most countries the sign was negative and domestic currency debt was optimal: Canada, Germany, Italy, Japan, Netherlands, Spain, UK, and the USA. However for New Zealand, Australia and South Africa the sign was positive and foreign currency debt was optimal.

dominate the economy. An aggregate supply shock, such as an oil shock, will generally change output and prices in opposite directions, hence creating a negative correlation between inflation and output growth. In contrast, an aggregate demand shock will generally change ouput and prices in the same direction, creating a positive correlation between inflation and output growth.

It is important to note at this point, that the results achieved from this analysis are normative in nature. They provide a theory for the actions that the government should be taking but do not try to explain the actual actions of the government. In New Zealand the government has traditionally issued a significant proportion of its debt in foreign currency. Over the past decade much of this debt has been repaid. Figure 1 graphs the percentage of New Zealand's debt which has been denominated in foreign currency since 1975. It does this for both gross and net foreign currency debt where observations were available.

Figure 1: Percentage of Public Debt which is Denoted in Foreign Currency



Note: Data is taken from New Zealand Yearbooks, Financial Statements of the Government of New Zealand and the Economic Fiscal Outlook

The reduction in foreign currency debt, through the proceeds of asset sales, was undertaken due to strong pressure from the NZDMO. It was concerned with minimizing the risk to which the government debt portfolio was exposed. By matching the public debt to interest rate and currency characteristics, as illustrated in the risk minimization approach above, the NZDMO determined that an optimal debt portfolio would consist entirely of domestic debt. This action would seem also to be consistent with overcoming of inflation credibility problems via the Reserve Bank Act 1989. However achieving inflation credibility does not necessitate a return to high levels of domestic debt. Rather it implies that optimal debt allocation should become an issue of portfolio choice. This being the case a welfare maximizing approach to public debt implies that all New Zealand debt should be denominated in foreign currency (as illustrated in table 1).

V Other Issues in Optimal Debt Denomination Decisions

There are many other issues that surround the issue of optimal debt allocation that are not directly addressed by this paper. Political concerns may be important in the New Zealand context. High levels of foreign debt seem to be politically unpopular. When it comes to investing or borrowing there seems to be a certain contingent of the population who favor doing so within our borders. This issue is in some respects independent of how we choose to denominate our currency. A large fraction of our domestically denominated government debt is of course owned directly or indirectly by foreigners. Thus eliminating foreign currency debt has not necessarily reduced the amount of money the government owes to foreigners.

Moreover tax smoothing is a politically justifiable concept. It would seem reasonable to assume that it is in the best interests of the government not to alter taxes frequently. Such a move is likely to be politically unpopular and will be avoided if possible by a government in an election year. If the government can structure its debt portfolio in such a way that taxes do not have to be altered significantly when the economy is faced with a negative shock to output, the government in power is less likely to harm its political image.

There are also advantages to foreign debt which arise from the economies of scale in the foreign market. A small economy such as New Zealand can benefit from issuing foreign debt due to its relatively narrow domestic capital markets. The size of the foreign market may mean that the real cost of borrowing is less expensive than domestic borrowing at market rates. In addition, the variety of instruments available may be more diverse allowing the government to spread the risk of its liabilities. In these cases issuing debt in foreign markets will probably require issuance in foreign currency.

VI Conclusion

Barro (1979) first illustrated the optimality of smoothing tax rates over time. Bohn (1990) generalized this model into a stochastic environment where uncertainties existed pertaining to the return on risky assets and output levels of the economy. He established that for post war US data, tax smoothing could not be rejected as a positive theory of policy.

This paper analyses the portfolio choice issue for public debt from a welfare maximizing perspective using only foreign and domestic debt. Its approach is normative in nature and only seeks to show what the government should be doing rather than trying to explain its actual actions. Optimality requires smoothing of taxes over both time and states of nature and in doing so provides a possible place for both foreign and domestic debt in a government debt portfolio. In New Zealand, optimality requires a debt portfolio consisting entirely of foreign denominated instruments. It would appear that in recent times New Zealand has been influenced, for the most part, by demand side shocks. To the extent that this can be expected to continue into the future, it has severe implications for the policy of the New Zealand government at present. Proceeds from government asset sales have being directed solely towards the repayment of foreign debt to the point that all net public debt is now denominated in New Zealand dollars. Our results suggest that this is a sub-optimal policy. Welfare could be improved by replacing domestic currency debt with foreign currency debt.

The methods used in this paper to model the tax smoothing approach to optimal debt portfolio analysis are open to modifications and extensions. We could allow for the effect of changes in government expenditure on the analysis. The question raised is whether such an exercise would have a significant effect on the analysis. If government spending and output growth are negatively correlated then allowing for government spending in the analysis is likely only to make our results stronger. The argument follows from the fact we have already found a positive correlation between inflation and output growth. In this case domestic debt would imply that at times when government spending was high, the real value of the governments debt obligations would also be high. A tax smoothing argument would suggest avoiding such debt. Other debt instruments could also be included in the analysis. Modelling the optimal currency choice in conjunction with an optimal maturity distribution may provide some hedging benefits.

Most importantly however, this analysis will require testing at some point in the future to determine how stable the results are over time. As previously mentioned this is likely to depend on the importance of demand and supply shocks in differing periods. Cooley and Ohanian (1991) found that although for the United States the correlation between output and prices was positive from 1870 to 1975, it appeared to be negative during the postwar period. This could imply that the dominance of demand or supply shocks is susceptible to the economic environment of the time. Consequently, it would seem that further analysis will be required at some point in the future to determine the effects of the new economic environment in New Zealand on its optimal public debt portfolio.

References

Barro, R.J. (1979), "On the Determination of the Public Debt", *Journal of Political Economy*, 87, 940-971.

Bohn, H. (1990), "Tax Smoothing with Financial Instruments", *American Economic Review*, 80(5), 1217-1230.

Bohn, H. (1991) "Time Consistency of Monetary Policy in the Open Economy", *Journal of International Economy*, 30, 249-266.

Cooley, T.F. and Ohanian, L.E. (1991), "The Cyclical Behaviour of Prices", *Journal of Monetary Economics*, 28, 25-60.

Dalziel, P and Wright, J. (1993), "Policy Credibility and Debt Management in a Small Open Economy", *New Zealand Economic Papers*, 27(1), 81-89.

Kydland, Finn, E. and Prescott, Edward C., "Rules Rather than Discretion : The Inconsistency of Optimal Plans", *Journal of Political Economy*, June 1977, 85, 473-491

Appendix - Derivation of Equation (12)

Define $\Delta s = \Delta s_{t+1} - E_t \Delta s_{t+1}$, $\pi = (\pi_{t+1} - E_t \pi_{t+1})$, $y = \sum_{j \geq 0} \psi^j \hat{y}_{t+1+j}$. Then ignoring the constant term and expanding equation (4) we get:

$$\begin{bmatrix} d_D \\ d_F \end{bmatrix} = \begin{bmatrix} c(r_1, y)v(r_2) & -c(r_1, r_2)c(r_2, y) \\ -c(r_1, y)c(r_1, r_2) & v(r_1)c(r_2, y) \end{bmatrix}$$

$$= \begin{bmatrix} -c(\pi, y)v(\Delta s - \pi) + c(\pi, \Delta s - \pi)c(\Delta s - \pi, y) \\ -c(\pi, y)c(\pi, \Delta s - \pi) + v(\pi)c(\Delta s - \pi, y) \end{bmatrix}$$

$$= \begin{bmatrix} -c(\pi, y)v(\Delta s) - c(\pi, y)v(\pi) + 2c(\pi, y)c(\Delta s, \pi) - v(\pi)c(\Delta s, y) \\ + v(\pi)c(\pi, y) + c(\pi, \Delta s)c(\Delta s, y) - c(\pi, \Delta s)c(\pi, y) \\ \\ -c(\pi, y)c(\pi, \Delta s) + v(\pi)c(\pi, y) + v(\pi)c(\Delta s, y) - v(\pi)c(\pi, y) \end{bmatrix}$$

$$= \begin{bmatrix} -v(\Delta s)c(\pi, y) - v(\pi)c(\Delta s, y) + c(\pi, y)c(\Delta s, \pi) + c(\Delta s, y)c(\Delta s, \pi) \\ v(\pi)c(\Delta s, y) - c(\pi, y)c(\Delta s, \pi) \end{bmatrix}$$

LIST OF DISCUSSION PAPERS

No. 9301 Assessing Starmer's Evidence for New Theories of Choice: A Subjectivist's Comment, by John Fountain.

No. 9302 Preliminary-Test Estimation in a Dynamnic Linear Model, by David E. A. Giles and Matthew C. Cunneen.

No. 9303 Fans, Frames and Risk Aversion: How Robust is the Common Consequence Effect? by John Fountain and Michael McCosker.

No. 9304 Pre-test Estimation of the Regression Scale Parameter with Multivariate Student-t Errors and Independent Sub-Samples, by Juston Z. Anderson and Judith A. Giles

No. 9305 The Exact Powers of Some Autocorrelation Tests When Relevant Regressors are Omitted, by J. P. Small, D. E. Giles and K. J. White.

No. 9306 The Exact Risks of Some Pre-Test and Stein-Type Regression Estimators Under Balanced Loss*, by J. A. Giles, D. E. A. Giles, and K. Ohtani.

No. 9307 The Risk Behavior of a Pre-Test Estimator in a Linear Regression Model with Possible Heteroscedasticity under the Linex Loss Function, by K. Ohtani, D. E. A. Giles and J. A. Giles.

No. 9308 Comparing Standard and Robust Serial Correlation Tests in the Presence of Garch Errors, by John P. Small.

No. 9309 Testing for Serial Independence in Error Components Models: Finite Sample Results, by John P. Small.

No. 9310 Optimal Balanced-Growth Immigration Policy for Investors and Entrepeneurs, by A. E. Woodfield and K-L. Shea.

No. 9311 Optimal Long-Run Business Immigration Under Differential Savings Functions, by A. E. Woodfield and K-L. Shea.

No. 9312 The Welfare Cost of Taxation in New Zealand Following Major Tax Reforms, by P. McKeown and A. Woodfield.

No. 9313 The Power of the Goldfeld-Quandt Test when the errors are autocorrelated, by J.P. Small and R.J. Dennis.

No. 9314 The Nucleolus Strikes Back, by M. Carter and P. Walker.

No. 9315 The Output-Inflation Tradeoff in the United States: New evidence on the New Classical vs. New Keynesian Debate, by Alfred V. Guender.

No. 9401 Insurance Market Equilibrium and the Welfare Costs of Gender-Neutral Insurance Pricing under Alternative Regulatory Regimes by Alan E. Woodfield.

No. 9402 Labour Market Signalling and the Welfare Costs of Regulated Insurance Market Equilibria under Gender-neutral Pricing, by Alan E. Woodfield.

No. 9403 The New Classical Vs The New Keynesian debate On The Output – Inflation tradeoff: Evidence From Four industrialized Countries, by Alfred V. Guender.

No. 9404 Yield Spreads & Real Economic Activity: The Case of New Zealand & Australia, by Alfred V. Guender and Mathias Moersch.

No. 9405 Periodic Integration & cointegration with applications to the New Zealand Aggregate Consumption Function, by Robin Harrison and Aaron Smith.

No. 9406 Linear Programming with Mathematica, by Michael Carter.

No. 9407 Are People Really Risk Seeking When Facing Losses? by John Fountain, Michael McCosker & Dean Morris.

No. 9501 Pricing Internet: The New Zealand Experience by Michael Carter and Graeme Guthrie.

No. 9502 Long term and Short Term Aggregate Uncertainty and the Effect on Real Output, by Alfred V. Guender and Robin Young.

No. 9503 Framing and Incentive Effects on Risk Attitudes When Facing Uncertain Losses, by John Fountain, Michael McCosker and Bruce Macfarlane.

* Copies of these Discussion Papers may be obtained for $4 (including postage, price changes occasionally) each by writing to the Secretary, Department of Economics, University of Canterbury, Christchurch, New Zealand. A list of the Discussion Papers prior to 1992 is available on request.