



The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search

<http://ageconsearch.umn.edu>

aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.

Debt

D.P. #8809

Department of Economics
UNIVERSITY OF CANTERBURY
CHRISTCHURCH, NEW ZEALAND



GIANNINI FOUNDATION OF
AGRICULTURAL ECONOMICS
LIBRARY

FEB 8 1989

BUDGET DEFICITS AND ASSET SALES

By Ewen McCann

Discussion Paper

No. 8809

Department of Economics, University of Canterbury
Christchurch, New Zealand

Discussion Paper No. 8809

October, 1988

BUDGET DEFICITS AND ASSET SALES*

by

EWEN McCANN

This paper is circulated for discussion and comments. It should not be quoted without the prior approval of the author.

* The paper has been improved by referees' remarks on changes to the stock of government debt.

BUDGET DEFICITS AND ASSET SALES*

EWEN MCCANN⁺

I. INTRODUCTION

About one-fifth of the New Zealand government's expenditure is required to meet the annual servicing charge for official debt. The government has sold some state owned assets, and plans to sell more. The intention of the sales is to use the proceeds to repurchase foreign-owned New Zealand official debt in order to reduce interest payments and future budget deficits.

This article establishes that the policy will fail under plausible conditions and that it will then increase the discounted budget deficit. It considers the consequences of the proceeds of sale being used re-purchase locally held bonds, as well as to re-purchase foreign held bonds. International interest arbitrage will occur and the exchange rate is included. Local tax rates are

⁺ University of Canterbury

^{*} The paper has been improved by the referees' remarks on changes in the stock of government debt.

explicit and the possibility of an asset being more, or less, profitable in private hands than if it is government owned is admitted.

Two effects operate in the problem. First, the existing stock of public debt must always equal the inherited stock plus the fresh issue arising from the finance of the current budget deficit. The stock of public debt therefore changes over time in response to successive deficits. Second, the repurchase of bonds reduces interest payments and so changes future deficits and also future public debt.

A full analysis requires the consideration of both of the above effects. The sale of a government asset and the repurchase of debt alters terms in both the current and future budget constraints of the government. The problem thus requires the explicit examination of the inter-temporal government budget constraint.

The analysis will be conducted for a constant price level. It is acknowledged that inflation reduces the real value of inherited public debt but the consideration of the inflation issue is beyond the scope of this problem as it involves the different issues examined by Sargent and Wallace (1986). The issue of base money as a method of deficit finance will be formally incorporated in the problem.

The degree of integration of the world capital markets, and the size of government's bond repurchases in relation to them, affect the responses of local and foreign interest rates to the asset sale-bond repurchase programme. Interest rates in local and

foreign markets will be allowed to vary and differ over time, though the special case where they are constant over time in each market is of particular interest. Bonds are of the fixed price variable interest rate variety. If interest arbitrage is complete then interest rates are not equalized in local and foreign markets because, as the covered interest arbitrage formula requires, the interest rate differential and forward exchange rate premium are linked for each maturity. Covered interest arbitrage will be allowed.

The outline of the paper is that Section II defines the budget deficit highlighting the terms relevant to the problem; Section III evaluates the change in the budget deficit and shows the asset sale and debt repurchase policy is likely to cause it to increase; Section IV concludes the paper by interpreting the results.

II. INTER-TEMPORAL BUDGET CONSTRAINT

The government's budget constraint for period t is

$$\begin{aligned}
 & P^h(B_t^h - B_{t-1}^h) + s_t P^f(B_t^f - B_{t-1}^f) + H_t - H_{t-1} + P^k(K_{t-1} - K_t) \\
 & + v_t + r(Y_t + i_{t-1} P^h B_{t-1}^h) \\
 & - G_t + s_t r_{t-1} P^f B_{t-1}^f + i_{t-1} P^h B_{t-1}^h \quad (1)
 \end{aligned}$$

where

P^h is the nominal price of the government's assets, assumed constant throughout.

K_t is the quantity of the government's assets at time t .

- H_t is the base money at the beginning of period t .
- t is the period defined by the half open time interval $[t, t+1)$. All transactions occur at the beginning of each period t . Interest is paid at the start of period t on bonds inherited from period $t-1$. Taxes are paid at the beginning of period t on that interest income and on other income earned in period t .
- G_t is nominal government expenditure other than interest payments in period t
- i_{t-1} is the nominal interest rate paid in period t to residents at the interest rate for $t-1$.
- P^h is the nominal local price of government stock assumed constant throughout
- B_{t-1}^h is the quantity of government stock held by residents at time t inherited from period $t-1$.
- s_t is the spot exchange rate for period t , i.e. the number of units of local currency exchanging for one unit of foreign currency.
- r_{t-1} is the nominal interest rate paid to foreign holders of government stock paid at time t at the rate for $t-1$.
- P^f is the nominal price in foreign currency of the government's stock on world markets, assumed constant.
- B_{t-1}^f is the quantity of the government's bonds held over by foreigners from period $t-1$ to period t .
- τ is the average local tax rate.

Y_t is the nominal income in period t of the private sector including its foreign interest income but excluding interest income from local official debt which is shown separately.

v_t is nominal profit income from government owned assets in period t .

The order of the lagged subscript in equation (1) is different for assets than it is for liabilities because an accumulation of liabilities adds to currently available funds while it is the decumulation of assets that does so.

It will be seen from the government's budget constraint that the issue of bonds in one period adds to the bond stocks and interest payments in future periods - to meet the point raised in Section I. Similarly if the government sells assets to purchase some of its outstanding bonds in one period, asset and bond stocks and revenue in all future periods are affected. An inter-temporal budget constraint is required to incorporate these effects.

The procedure to derive the inter-temporal government budget constraint^{is} to solve equation (1) for B_t^h and to obtain from the solution expressions for B_{t+T}^h , B_{t+T-1}^h , B_{t+T-2}^h , Starting with B_{t+T}^h back substitution is used to eliminate B_{t+T-1}^h , then B_{t+T-2}^h is eliminated and so on until an expression for B_t^h is obtained which is a present value expression and is the government's inter-temporal budget constraint. The government's inter-temporal budget constraint is thus,

$$\begin{aligned}
& \sum_{j=t}^{t+T} \frac{1}{\rho_j} \left\{ G_j - rY_j - v_j + H_{j-1} - H_j + P^k(K_j - K_{j-1}) \right\} \\
& + P^f \left\{ \sum_{j=t}^{t+T-1} \left[\frac{s_{j+1}^a}{\rho_{j+1}} - \frac{s_j}{\rho_j} \right] B_j^f + s_{t0}^f B_0^f - \frac{s_{t+T}}{\rho_{t+T}} B_{t+T}^f \right\} \\
& + P^h \left[\beta_0 B_0^h - \frac{B_{t+T}^h}{\rho_{t+T}} \right] \\
& = 0
\end{aligned} \tag{2}$$

Where the discount factors, ρ_u , are defined by

$$\rho_u = \begin{cases} 1, & u = t \\ \prod_{j=t}^{u-1} [1 + (1-r)i_j], & t+1 \leq u \leq t+T \end{cases} \tag{3}$$

and

$$\beta_0 = 1 + (1-r)i_0 \tag{4}$$

$$a_u = 1 + r_u \tag{5}$$

The inter-temporal budget constraint includes the government's discount rate, the term $(1-r)i_u$ in equation (3). That discount rate is a direct consequence of the analysis. It emerges from the decision to eliminate B_t^h from equation (1) because equation (1) contains the term $[1 + (1-r)i_{t-1}]B_{t-1}^h$.

The budget deficit of present value D , may be defined by rearranging the appropriate terms in equation (2), using the definitions of a_0 and β_0 (equations (4) and (5)). It is,

$$\begin{aligned}
 D = & \sum_{j=t}^{t+T} \frac{1}{\rho_j} \left\{ G_j - rY_j - v_j \right\} \\
 & + P^f \left\{ \sum_{j=t}^{t+T-1} \left[\frac{s_{j+1} a_j}{\rho_{j+1}} - \frac{s_j}{\rho_j} \right] B_j^f + s_t r_0 B_0^f \right\} \\
 & + P^h (1-r) i_0 B_0^h \\
 & - \sum_{j=t}^{t+T} \frac{1}{\rho_j} \left\{ H_j - H_{j-1} - P^k (K_j - K_{j-1}) \right\} \\
 & + P^f \left\{ \frac{s_{t+T}}{\rho_{t+T}} B_{t+T}^f - s_t B_0^f \right\} \\
 & + P^h \left\{ \frac{B_{t+T}^h}{\rho_{t+T}} - B_0^h \right\} \quad (6)
 \end{aligned}$$

The government's budget deficit is a flow magnitude which is financed by changes in stocks. That is the interpretation of the deficit equation (6), where the flows are to the left and the stock changes are to the right. The present value of the government's budget deficit, equation (6), is the excess of

government expenditure over its tax receipts and profit income, plus interest payments and the exchange rate losses on foreign bonds. That deficit is financed by changes in the stocks of fiduciary issue, government owned assets and foreign plus locally held bonds.

III. ASSET SALES AND DEFICITS

The time sequences of the government's flows and of its stocks are affected by a policy of asset sales and bond repurchase. Consider two different policies with discounted budget deficits D' and D . Let D' be defined by the sequences of flows to the left of equation (6) which are to be distinguished by primes. The other deficit, D , has defined sequences of flows without primes. Then, using the left side of (6) for the primed and non-primed flows the difference between the budget deficits is

$$D' - D = \sum_{j=t}^{t+T} \frac{1}{\rho_j} \left[G'_j - G_j - rY'_j + rY_j - v'_j + v_j \right] + p^f \left[\sum_{j=t}^{t+T-1} \left[\frac{s_{j+1} a_j}{\rho_{j+1}} - \frac{s_j}{\rho_j} \right] \left[B_j^{f'} - B_j^f \right] \right] \quad (7)$$

The sale of government owned assets to buy back official debt can now be readily examined. Let the government sell a quantity of assets, k , in period 1. The fractions of the proceeds, θ^f , θ^h are respectively used to purchase foreign held official debt, and to purchase locally held government bonds. Let b_1^f be the quantity of foreign held government bonds which the government purchases in

period 1. The asset sale - bond purchase transactions occur in period 1 and are not repeated. The government continues to accumulate or decumulate capital and local debt but without linking the two. Stocks each period in the two situations differ by b_1^f , k as the case may be.

Define D' for the sequences of flows which arise by selling k assets and buying back debt. Let D be for the flow sequences which would emerge in the absence of that policy towards assets and bonds. Initial stocks will be equal in the two situations.

Assume that government expenditure is unchanged. The policy alters the government's revenue from the assets it owns and it changes the interest cost of official debt. Since an asset has become privately owned the profit from it attracts tax. Let μ be the constant annual profit from the assets to be sold when they are government owned and $(1+\alpha)\mu$, $\alpha > -1$, be their profits in the private sector. Then from those assumptions.

$$Y'_j = Y_j + (1+\alpha)\mu$$

$$v'_j = v_j - \mu \quad (8)$$

$$b_1^f = B_j^f - B_j^{f'}$$

Substitute (8) into (7) obtaining the change in the discounted budget deficit.

$$D' - D = \sum_{j=t}^{t+T} \frac{1}{\rho_j} \left[\mu(1-\tau(1+\alpha)) \right] - P^f \sum_{j=t}^{t+T-1} \left[\frac{s_{j+1}^a}{\rho_{j+1}} - \frac{s_j}{\rho_j} \right] b_1^f \quad (9)$$

The government sells a quantity of assets, k , and spends a portion of $\theta^f P^k_k$ on a quantity, b_1^f , of foreign bonds so

$$s_1 P^f b_1^f = \theta^f P^k_k$$

and

$$b_1^f = \frac{\theta^f P^k_k}{s_1 P^f} \quad (10)$$

To obtain the total proceeds from the sale of k assume that domestic interest rates are constant over time, $i_j = i$ all j , and recall that a uniform income stream, c , has a present value of

$$\sum_{n=1}^{\infty} \frac{c}{(1+i)^{n-1}} = \frac{(1+i)c}{i} \quad (11)$$

Now the assets provide the private sector with an after tax annual income of $(1-\tau)(1+\alpha)\mu$ which, from (11), has a present value and a capital sum of

$$\begin{aligned} \sum_{n=1}^{\infty} \frac{(1-\tau)(1+\alpha)\mu}{(1+(1-\tau)i)^{n-1}} &= \frac{(1+\alpha)\mu(1+(1-\tau)i)}{i} \\ &= P^k_k \end{aligned}$$

so

$$\mu = \frac{i P^k_k}{(1+\alpha)(1+(1-\tau)i)} \quad (12)$$

Substitute (10), (12) into (9) and rearrange to obtain

$$D' - D = P^k_k \left\{ \sum_{j=t}^{t+T} \frac{1}{\rho_j} \left[\frac{i[1-\tau(1+\alpha)]}{(1+\alpha)(1-(1-\tau)i)} \right] - \sum_{j=t}^{t+T-1} \left[\frac{s_{j+1}^a}{\rho_{j+1}} - \frac{s_j}{\rho_j} \right] \frac{\theta^f}{s_1} \right\} \quad (13)$$

Notice that

$$\rho_{j+1} = [1+(1-\tau)i]\rho_j \quad (14)$$

International interest arbitrage is now introduced. Income, Y_t , was taxed at rate τ in equation (1) and was defined there to include the private sector's overseas investment income. Residents' income from official bonds is also taxed at rate τ . A resident contemplating a foreign investment therefore compares local and foreign interest rates both net of tax at rate τ . Covered international interest arbitrage for a one period investment made at time t ensures that

$$1 + (1-\tau)i_t = \frac{F_{t+1}}{s_t} (1 + (1-\tau)r_t)$$

where F_{t+1} is the forward exchange rate for delivery one period ahead of t . Covered international investments of maturity j made at time t therefore require the product of j terms, which, with uniform interest rates over time, yield

$$(1+(1-\tau)i)^j = \frac{F_{t+j}}{s_t} (1+(1-\tau)r)^j \quad (15)$$

Let $F_{t+j} = s_{t+j}$ then equation (15) provides

$$\frac{s_{t+j}}{s_t} = \left[\frac{1+(1-\tau)i}{1+(1-\tau)r} \right]^j \quad (16)$$

Using equations (14), (16), the definition of ρ_j from equation (3), in equation (13) and letting $t = 1$ yields the change in the deficit,

$$D' - D = p_k^k \left\{ \sum_{j=1}^{1+T} \frac{i(1-r)(1+\alpha)}{(1+\alpha)(1+(1-r)i)^j} - \sum_{j=1}^T \frac{\theta^f r r}{(1+(1-r)r)^j} \right\} \quad (17)$$

Taking the partial sums of the geometric series in equation (17) shows that the change in the discounted deficit as a result of the asset sale-bond repurchase scheme is

$$D' - D = \frac{p_k^k}{1-r} \left\{ \frac{1-r(1+\alpha)}{1+\alpha} \left[1 - \left(\frac{1}{1+(1-r)i} \right)^{T+1} \right] - \theta^f r \left[1 - \left(\frac{1}{1+(1-r)r} \right)^T \right] \right\}$$

$$> 0 \text{ iff } \frac{1-r(1+\alpha)}{(1+\alpha)\theta^f r} > \frac{1 - \left(\frac{1}{1+(1-r)r} \right)^T}{1 - \left(\frac{1}{1+(1-r)i} \right)^{T+1}} \quad (18)$$

so the policy increases the budget deficit when the side condition holds. The side condition does hold for plausible values of the arguments. Notice that the right side of (18) is less than unity when New Zealand interest rates, i , exceed foreign interest rates, r , and possibly when they do not. The condition therefore applies when, for example, $r = 0.33$, $\theta^f = 1$ and $\alpha = 0.5$. To emphasise the point, with even a 50% improvement in the assets' profitability after it becomes privately owned the deficit still increases as a result of the scheme. Many other combinations of values have the

same effect. Use of the sale proceeds for other than foreign debt repurchase is incorporated in (18) by using $\theta^f = 1 - \theta^h$.

IV. CONCLUSION

The policy of selling government owned assets and of using the proceeds of the sale to purchase local and/or foreign bonds has been examined in this paper. The policy increases the discounted value of the government's budget deficit, see equation (18), when the side condition holds. The side condition is quite likely to apply.

An economic interpretation can be placed on these results. When a government sells an asset in order to purchase official debt it foregoes the profit from the asset and it avoids the interest payments on the debt. The effect on the deficit is partly the difference between the profit reduction and after tax interest costs avoided. Effectively, the government is exchanging a revenue reduction for a cost reduction. When discounting is allowed the profit reduction can exceed the cost reduction and the deficit increases. The rate of discount has to be considered before a further interpretation can be made.

The government's discount rate is inherent to the problem. It is not chosen by the investigator either arbitrarily or on a priori grounds, as was noted after equation (5). The government's rate of discount which emerges from the analysis is $(1-\tau) i_u$.

One heuristic interpretation of the result arises from the consideration of income streams and cost streams. Suppose the government has a quantity of an asset, k , which returns it a profit of \$1 per period. Using equation (11) and the government's

discount rate $(1-r)i$ when interest rates are constant shows that the present value of the profit stream to the government is

$$\frac{1[1 + (1-r)i]}{(1-r)i} \quad (19)$$

So when the government sells the asset it loses the profit stream (19).

When the government buys back its bonds it buys an income stream from the private sector paying the capital sum P^k_k . Now an income stream which has a capital value of P^k_k at the private sector's discount rate is $1(1-r)$ per period. $(1-r)$ is in fact what the private sector received on the repurchased government bonds each period. So the government buys back an income stream which has a present value to the private sector of

$$\frac{(1-r)(1 + (1-r)i)}{(1-r)i} = \frac{1 + (1-r)i}{i} \quad (20)$$

Equation (20) is also the present value to the government of the government's interest savings. The extra tax collected on profits of \$1 when the asset is in private hands is r per period which has a present value to the government of

$$\frac{[1 + (1-r)i]}{(1-r)i} \quad (21)$$

The change in the deficit is the change in profits plus the change in interest cost plus the change in tax collections i.e. from (19), (20), (21)

$$\frac{[1 + (1-r)i]}{(1-r)i} - \frac{1 + (1-r)i}{i} - \frac{[1 + (1-r)i]r}{(1+r)i}$$

- 0

(23)

This example shows that using the proceeds of the asset sales to buy local bonds when productivity is unchanged does not decrease the budget deficit.

The essential point is that asset sales made to repurchase foreign and/or local official debt are likely to increase the discounted budget deficit because

the government loses all of the profits from the assets it sells. It gets back only the tax on the profits of those assets when they are in private hands, even though private profits may exceed the government's profits from the assets. The interest payments which the government avoids need be by no means enough to offset the foregoing and to reduce the deficit.

Finally, the preferred policy would be for the government to retain ownership of the assets and to increase their profitability.

APPENDIX

The government's budget constraint for period t , equation (1) in the text, when solved for B_t^h yields

$$B_t^h = \frac{1}{p^h} \left[G_t + s_t P^f B_{t-1}^f a_{t-1} + P^h B_{t-1}^h \beta_{t-1} - P^k K_{t-1} + H_{t-1} - (s_t P^f B_t^f + H_t + rY_t - K_t + v_t) \right]$$

Advance the time subscripts:

$$B_{t+1}^h = \frac{1}{p^h} \left[G_{t+1} + s_{t+1} P^f B_{t+1}^f a_{t+1} + P^h B_t^h \beta_t - P^k K_t + H_t - (s_{t+1} P^f B_{t+1}^f + H_{t+1} + rY_{t+1} - P^k K_{t+1} + v_{t+1}) \right]$$

⋮

$$B_{t+T-1}^h = \frac{1}{p^h} \left[G_{t+T-1} + s_{t+T-1} P^f B_{t+T-2}^f a_{t+T-2} + P^h B_{t+T-2}^h \beta_{t+T-2} - P^k K_{t+T-2} + H_{t+T-2} - (s_{t+T-1} P^f B_{t+T-1}^f + H_{t+T-1} + rY_{t+T-1} - P^k K_{t+T-1} + v_{t+T-1}) \right]$$

$$B_{t+T}^h = \frac{1}{p^h} \left[G_{t+T} + s_{t+T} P^f B_{t+T-1}^f a_{t+T-1} + P^h B_{t+T-1}^h \beta_{t+T-1} - P^k K_{t+T-1} + H_{t+T-1} - (s_{t+T} P^f B_{t+T}^f + H_{t+T} + rY_{t+T} - P^k K_{t+T} + v_{t+T}) \right]$$

where

$$a_u = 1 + r_u, \quad \beta_u = 1 + (1-r) i_u \quad (i)$$

substituting the expression for B_{t+T-1}^h into the equation for B_{t+T}^h gives an equation containing B_{t+T-2}^h . If B_{t+T-2}^h is then eliminated from B_{t+T}^h one obtains

$$\begin{aligned} B_{t+T}^h = & \frac{1}{p^h} \left\{ G_{t+T} + s_{t+T} p_{B_{t+T-1}^f}^f a_{t+T-1} + \beta_{t+T-1} \left[G_{t+T-1} \right. \right. \\ & + s_{t+T-1} p_{B_{t+T-2}^f}^f a_{t+T-2} + \beta_{t+T-2} \left[G_{t+T-2} \right. \\ & + s_{t+T-2} p_{B_{t+T-3}^f}^f a_{t+T-3} + p_{B_{t+T-3}^h}^h \beta_{t+T-3} \\ & - p_{K_{t+T-3}}^k + H_{t+T-3} - \left. \left. \left[s_{t+T-2} p_{B_{t+T-2}^f}^f + H_{t+T-2} \right. \right. \right. \\ & \left. \left. \left. + rY_{t+T-2} - p_{K_{t+T-2}}^k + v_{t+T-2} \right] \right] \right. \\ & - p_{K_{t+T-2}}^k + H_{t+T-2} - \left. \left. \left[s_{t+T-1} p_{B_{t+T-1}^f}^f + H_{t+T-1} \right. \right. \right. \\ & \left. \left. \left. + rY_{t+T-1} - p_{K_{t+T-1}}^k + v_{t+T-1} \right] \right] \right. \\ & - p_{K_{t+T-1}}^k + H_{t+T-1} - \left. \left. \left[s_{t+T} p_{B_{t+T}^f}^f + H_{t+T} + rY_{t+T} \right. \right. \right. \\ & \left. \left. \left. - p_{K_{t+T}}^k + v_{t+T} \right] \right] \right\} \quad (ii) \end{aligned}$$

continue back substituting for the terms B_{t+T-j}^h , T times in total. Collect terms for each variable, for example the collected terms in G_u are

$$\frac{1}{p^h} G_{t+T} + \frac{1}{p^h} \beta_{t+T-1} G_{t+T-1} + \frac{1}{p^h} \beta_{t+T-1} \beta_{t+T-2} G_{t+T-2} \dots$$

Notice that using equation (3) in the text

$$\begin{aligned} \beta_{t+T-1} \beta_{t+T-2} &= \frac{\beta_{t+T-1} \beta_{t+T-2} \beta_{t+T-3} \dots \beta_t}{\beta_{t+T-3} \beta_{t+T-4} \dots \beta_t} \\ &= \frac{\rho_{t+T}}{\rho_{t+T-2}} \end{aligned}$$

so the terms in G_u are

$$\frac{\rho_{t+T}}{p^h} \sum_{j=t}^{t+T} \frac{G_j}{\rho_j} \quad (\text{iii})$$

and similarly for the terms in K_j (which require factorization of the products of β 's), H_j , rY_j and v_j obtaining

$$- \frac{\rho_{t+T} p^k}{p^h} \left\{ \sum_{j=t}^{t+T} \left[\frac{K_{j-1} - K_j}{\rho_j} \right] \right\} \quad (\text{iv})$$

and

$$\frac{\rho_{t+T}}{p^h} \left\{ \sum_{j=t}^{t+T} \left[\frac{H_{j-1} - H_j}{\rho_j} \right] \right\} \quad (\text{v})$$

and

$$\frac{-r\rho_{t+T}}{p^h} \left[\begin{array}{c} t+T \quad Y_j \\ \Sigma \\ j=t \quad \rho_j \end{array} \right] \quad (\text{vi})$$

and

$$\frac{-\rho_{t+T}}{p^h} \left[\begin{array}{c} t+T \quad v_j \\ \Sigma \\ j=t \quad \rho_j \end{array} \right] \quad (\text{vii})$$

The terms in B_j^f are more complicated i.e.

$$\begin{aligned} & \frac{p^f}{p^h} \left\{ s_{t+T} a_{t+T-1} \left[\frac{\rho_{t+T}}{\rho_{t+T}} \right] B_{t+T-1}^f + s_{t+T-1} a_{t+T-2} \left[\frac{\rho_{t+T}}{\rho_{t+T-1}} \right] B_{t+T-2}^f \right. \\ & \quad + s_{t+T-2} a_{t+T-3} \left[\frac{\rho_{t+T}}{\rho_{t+T-2}} \right] B_{t+T-3}^f \dots \\ & \quad \left. - s_{t+T} \left[\frac{\rho_{t+T}}{\rho_{t+T}} \right] B_{t+T}^f - s_{t+T-1} \left[\frac{\rho_{t+T}}{\rho_{t+T-1}} \right] B_{t+T-1}^f - s_{t+T-2} \left[\frac{\rho_{t+T}}{\rho_{t+T-2}} \right] B_{t+T-2}^f \dots \right\} \\ & = \frac{\rho_{t+T} p^f}{p^h} \left\{ \begin{array}{c} t+T-1 \\ \Sigma \\ j=t \end{array} \left[\frac{s_{j+1} a_j}{\rho_{j+1}} - \frac{s_j}{\rho_j} \right] B_j^f + \frac{s_t a_{t-1}}{\rho_t} B_{t-1}^f - \frac{s_{t+T}}{\rho_{t+T}} B_{t+T}^f \right\} \quad (\text{viii}) \end{aligned}$$

The expressions (iii) to (viii) are substituted into equation (ii) which is rearranged to provide the government's budget constraint, equation (2) of the text.

Reference

Sargent, T., and Wallace, N., (1981) "Some Unpleasant Monetarist Arithmetic" Quarterly Review of the Federal Reserve Bank of Minneapolis pp 1 - 17, reprinted in Rational Expectations and Inflation, Sargent, T., New York, Harper and Row, 1986.

LIST OF DISCUSSION PAPERS*

- No. 8401 Optimal Search, by Peter B. Morgan and Richard Manning.
- No. 8402 Regional Production Relationships During the Industrialization of New Zealand, 1935-1948, by David E. A. Giles and Peter Hampton.
- No. 8403 Pricing Strategies for a Non-Replenishable Item Under Variable Demand and Inflation, by John A. George.
- No. 8404 Alienation Rights in Traditional Maori Society, by Brent Layton.
- No. 8405 An Engel Curve Analysis of Household Expenditure in New Zealand, by David E. A. Giles and Peter Hampton.
- No. 8406 Paying for Public Inputs, by Richard Manning, James R. Markusen, and John McMillan.
- No. 8501 Perfectly Discriminatory Policies in International Trade, by Richard Manning and Koon-Lam Shea.
- No. 8502 Perfectly Discriminatory Policy Towards International Capital Movements in a Dynamic World, by Richard Manning and Koon-Lam Shea.
- No. 8503 A Regional Consumer Demand Model for New Zealand, by David E. A. Giles and Peter Hampton.
- No. 8504 Optimal Human and Physical Capital Accumulation in a Fixed-Coefficients Economy, by R. Manning.
- No. 8601 Estimating the Error Variance in Regression After a Preliminary Test of Restrictions on the Coefficients, by David E. A. Giles, Judith A. Mikolajczyk and T. Dudley Wallace.
- No. 8602 Search While Consuming, by Richard Manning.
- No. 8603 Implementing Computable General Equilibrium Models: Data Preparation, Calibration, and Replication, by K. R. Henry, R. Manning, E. McCann and A. E. Woodfield.
- No. 8604 Credit Rationing: A Further Remark, by John G. Riley.
- No. 8605 Preliminary-Test Estimation in Mis-Specified Regressions, by David E. A. Giles.
- No. 8606 The Positive-Part Stein-Rule Estimator and Tests of Linear Hypotheses, by Aman Ullah and David E. A. Giles.
- No. 8607 Production Functions that are Consistent with an Arbitrary Production-Possibility Frontier, by Richard Manning.
- No. 8608 Preliminary-Test Estimation of the Error Variance in Linear Regression, by Judith A. Clarke, David E. A. Giles and T. Dudley Wallace.
- No. 8609 Dual Dynamic Programming for Linear Production/Inventory Systems, by E. Grant Read and John A. George.
- No. 8610 Ownership Concentration and the Efficiency of Monopoly, by R. Manning.
- No. 8701 Stochastic Simulation of the Reserve Bank's Model of the New Zealand Economy, by J. N. Lye.
- No. 8702 Urban Expenditure Patterns in New Zealand, by Peter Hampton and David E. A. Giles.
- No. 8703 Preliminary-Test Estimation of Mis-Specified Regression Models, by David E. A. Giles.
- No. 8704 Instrumental Variables Regression Without an Intercept, by David E. A. Giles and Robin W. Harrison.

(continued on back cover)

- No. 8705 Household Expenditure in Sri Lanka: An Engel Curve Analysis, by Mallika Dissanayake and David E. A. Giles.
- No. 8706 Preliminary-Test Estimation of the Standard Error of Estimate in Linear Regression, by Judith A. Clarke.
- No. 8707 Invariance Results for FIML Estimation of an Integrated Model of Expenditure and Portfolio Behaviour, by P. Dorian Owen.
- No. 8708 Social Cost and Benefit as a Basis for Industry Regulation with Special Reference to the Tobacco Industry, by Alan E. Woodfield.
- No. 8709 The Estimation of Allocation Models With Autocorrelated Disturbances, by David E. A. Giles.
- No. 8710 Aggregate Demand Curves in General-Equilibrium Macroeconomic Models: Comparisons with Partial-Equilibrium Microeconomic Demand Curves, by P. Dorian Owen.
- No. 8711 Alternative Aggregate Demand Functions in Macro-economics: A Comment, by P. Dorian Owen.
- No. 8712 Evaluation of the Two-Stage Least Squares Distribution Function by Imhof's Procedure by P. Cribbitt, J. N. Lye and A. Ullah.
- No. 8713 The Size of the Underground Economy: Problems and Evidence, by Michael Carter.
- No. 8714 A Computable General Equilibrium Model of a Fisherine Method to Close the Foreign Sector, by Ewen McCann and Keith McLaren.
- No. 8715 Preliminary-Test Estimation of the Scale Parameter in a Mis-Specified Regression Model, by David E. A. Giles and Judith A. Clarke.
- No. 8716 A Simple Graphical Proof of Arrow's Impossibility Theorem, by John Fountain.
- No. 8717 Rational Choice and Implementation of Social Decision Functions, by Manimay Sen.
- No. 8718 Divisia Monetary Aggregates for New Zealand, by Ewen McCann and David E. A. Giles.
- No. 8719 Telecommunications in New Zealand: The Case for Reform, by John Fountain.
- No. 8801 Workers' Compensation Rates and the Demand for Apprentices and Non-Apprentices in Victoria, by Pasquale M. Sgro and David R. A. Giles.
- No. 8802 The Adventures of Sherlock Holmes, the 48% Solution, by Michael Carter.
- No. 8803 The Exact Distribution of a Simple Pre-Test Estimator, by David E. A. Giles.
- No. 8804 Pre-testing for Linear Restrictions in a Regression Model With Student-t Errors, by Judith A. Clarke.
- No. 8805 Divisia Monetary Aggregates and the Real User Cost of Money, by Ewen McCann and David Giles.
- No. 8806 The Management of New Zealand's Lobster Fishery, by Alan Woodfield and Pim Borren.
- No. 8807 Poverty Measurement: A Generalization of Sen's Result, by Prasanta K. Pattanaik and Manimay Sen.
- No. 8808 A Note on Sen's Normalization Axiom for a Poverty Measure, by Prasanta K. Pattanaik and Manimay Sen.
- No. 8809 Budget Deficits and Asset Sales, by Ewen McCann.

* 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.