*Applied Economics*, 1989, **21**, 113–124

# *An empirical analysis of the macroeconomic effects of government debt: evidence from Canada*

W. DOUGLAS McMILLIN* and FAIK KORAY

*Department of Economics, Louisiana State University, Baton Rouge, LA 70803-6306, USA*

## I. INTRODUCTION

The role of government debt in explaining movements in price, output, and interest rates has been the subject of increasing theoretical and empirical analysis in recent years. The conventional view that government debt is wealth and that a switch from lump-sum tax finance to bond finance of a given level of government purchases has consequential effects on the price level, output, and the interest rate has been challenged by the Ricardian equivalence hypothesis popularized by Barro (1974). In the Ricardian hypothesis, government debt is not wealth, and a switch from lump-sum tax finance to bond finance of a given level of government purchases has no effects on the price level, output, or the interest rate.

The theoretical foundations of the Ricardian view have been criticized by Tobin and Buiter (1980) and by Brunner (1986), among others. Empirical analysis, much of which has focused upon the United States, has not resolved this theoretical ambiguity. The studies by Yawitz and Meyer (1976), Feldstein (1982), Makin (1983), Eisner and Pieper (1984), de Leeuw and Holloway (1985), Hoelscher (1986), and Wachtel and Young (1987)[1] for the United States and Koskela and Viren (1983) and Johnson (1986) for Canada find evidence that debt affects interest rates, consumption, or output. The opposite is found by the studies of Kochin (1974), Tanner (1979), Plosser (1982), Dwyer (1982), Kormendi (1983), Evans (1985, 1987), Seater and Mariano (1985), Aschauer (1985) and McMillin (1986) for the United States and Koray and McMillin (1987) for Canada.

The aim of this study is to analyse empirically the effects of Canadian government debt on the Canadian price level, output, and the interest rate using quarterly data for the period 1963:2–1984:4. This study differs from previous studies by estimating the effects of government debt within a small empirical macro model of the Canadian economy.[2] Specifically, the empirical analysis is performed using vector autoregressive models (VARs). In order to check the sensitivity of the results to the particular type of VAR model estimated,

*All further correspondence should be sent to this author.

[1]Unlike the other studies cited, Wachtel and Young (1987) examine the effects of deficit announcements by the OMB and the CBO on interest rates of various maturities.

[2]The studies cited earlier, with the exceptions of Dwyer (1982) and Plosser (1982), are single-equation studies. Dwyer and Plosser analyse the impact of US government debt within vector autoregressive models. Their sample periods do not, however, capture the build up of debt in the 1980s.

0003–6846/89 $03.00+.12  

three different types of VARs are estimated. Since most previous studies have focused on the US economy, it is important to examine the role of debt in other industrialized economies. The Canadian economy is chosen for several reasons: (1) a series for the market value of Canadian government debt developed by Cox and Haslag (1986) is available, and the use of market value data is more defensible on theoretical grounds (since it is the market value of debt that is relevant for wealth effects) than is the use of par value data which are available for other countries; and (2) the largest trading partner of Canada is the US and hence the impact of the rest-of-the-world on the Canadian economy can reasonably be approximated by inclusion of US variables in the model.

The remainder of the paper is organized as follows. Section II discusses methodological issues and the data while Section III presents empirical results. Concluding comments follow in Section IV.

## II. DATA AND METHODOLOGY

### *A. Methodology*

Since, if government debt is wealth, variations in debt will affect the price level, output, and the interest rate, it seems most appropriate to analyse empirically the effects of government debt within the context of a small macro model. Vector autoregressive (VAR) models rather than a structural model approach are used to analyse the role of government debt. VAR models are chosen for several reasons. They avoid the imposition of potentially spurious *a priori* constraints (such as, for example, econometric exogeneity of debt in the interest rate equation or exclusion of debt from the equations for the other system variables). Furthermore, as noted by Fischer (1981) and Genberg, Salemi and Swoboda (1987), VARs are well-suited to an examination of the channels through which a variable operates since few restrictions are imposed on the way the system's variables interact. However, as is widely known, it is difficult to distinguish sharply among structural hypotheses with the VAR technique since it is a reduced form approach. Other limitations of the approach have been discussed by Cooley and LeRoy (1985). But, since our purpose is to gain some insight into the channels through which debt operates, VAR models are well suited to our purposes.

The three models estimated contain eight variables, and the variables chosen for inclusion are those suggested by a textbook-type aggregate demand-aggregate supply model with the IS–LM–BP model serving as the foundation for aggregate demand. The endogenous variables in this type of model (with wealth included) can be reduced to the price level, output, the interest rate, and the exchange rate; exogenous variables are fiscal policy variables (including government debt) and the money supply. However, in the VAR approach, all variables are typically treated as jointly determined and no *a priori* distinctions are made between exogenous and endogenous variables. Thus, our models include measures of private, domestic holdings of government debt, real government purchases of goods and services, the money supply, real output, the price level, the long-term interest rate, the US–Canadian exchange rate, and the US money supply.[3] The long-term interest rate is

[3]It is important to include government purchases since, unless government purchases are perfect substitutes for private expenditures, variations in government purchases will have effects on macro variables even if debt is not wealth. If government purchases were excluded, macro effects due to variations in government purchases might be incorrectly attributed to debt since government purchases and debt are correlated.

included rather than a short-term interest rate since it is generally thought that investment decisions depend more closely upon the long-term rate than the short-term rate. However, the model is also estimated with a short-term interest rate replacing the long-term rate. None of the results reported below are materially altered, so only the results for the model with the long-term interest rate are reported. The results with the short-term interest rate are available on request. Only one US variable is included in order to keep the size of the model manageable. The US money supply is chosen due to the close integration of US and Canadian financial markets.

The use of the market value of domestic holdings of government debt is based upon economic and econometric reasons. Suppose for the moment that bonds are wealth and that capital is not perfectly mobile. The sale of bonds to finance a deficit should initially raise the domestic interest rate relative to foreign rates. As a consequence, there is a foreign capital inflow which should take the form, at least in part, of increased foreign purchases of government bonds and which mitigates, at least to some degree, the impact of the initial bond sale on the interest rate. Thus, combining domestic and foreign holdings into one series, as is generally done, consolidates two series with opposite effects on interest rates. Consolidating domestic and foreign holdings into one series makes it more difficult to detect econometrically any effect of debt on interest rates. For these reasons, the market value of domestic holdings of government debt is used.

The VAR models can be written in general form as:

$$\mathbf{X}_t = \mathbf{A}_0 + \mathbf{B}(L)\,\mathbf{X}_t + \mathbf{e}_t \tag{1}$$

where $\mathbf{X}_t = 8 \times 1$ vector of the model variables, $[X_{1t} \ldots X_{8t}]$,
$A_0 = 8 \times 1$ vector of constants,
$e_t = 8 \times 1$ vector of white-noise error terms,
$\mathbf{B}(L) = 8 \times 8$ vector of polynomials in the lag operator, L, such that

$$B(L) = \begin{bmatrix} B_{11}(L) \ldots B_{18}(L) \\ \vdots \quad \ddots \quad \vdots \\ B_{81}(L) \ldots B_{88}(L) \end{bmatrix} \quad \text{and, for example,}$$

$B_{11}(L)$ = polynomial in the lag operator $= \Sigma_{i=1}^{k} b_{11,i} L^i$, $k$ = lag length,
$b_{11,i}$ = coefficient on $i$ th lag of variable $X_1$ in Equation 1, and
$L^i X_{1t} = X_{1t-it}$. The other elements of B(L) are defined analogously.

The first type of VAR model is the standard Sims-type model in which every variable enters every equation with the same lag length. Each variable in the model has a separate equation, but the explanatory variables in each equation are identical. This type of model allows feedback from the Canadian variables to M1US, an assumption that may not be appropriate given the relative sizes of the US and Canadian economies. A second VAR model is a modified Sims-type model which is identical to the Sims model with the exception of the M1US equation. In the modified Sims model, only lagged values of M1US appear on the right hand side of the M1US equation, but the lag length is the same as for the Sims

[3](continued)
Ideally one might want to include a tax rate measure so that effects of changes in tax rates with government spending held constant are not inappropriately assigned to changes in debt. This was not done because of the size of the system and because of the lack of availability of a good tax rate measure.

model. Thus, no feedback from the Canadian variables to M1US is allowed in the modified Sims model.

Following Lutkepohl (1982), Akaike's AIC criterion was used to determine the lag length of the Sims and modified Sims models. The lag length chosen is the one minimizes

$$\text{AIC(k)} = \ln \det \Sigma_k + (2d^2k)/T, \quad k = 1, \ldots, m \tag{2}$$

where $d$ = the number of variables in the system, $m$ = maximum lag length considered (set to 8 quarters),[4] det $\Sigma_k$ = determinant of $\Sigma_k$, and $\Sigma_k$ = estimated variance–covariance matrix for lag $k$. Use of this criterion suggested a lag length of 8 quarters for the estimation period 1963:2–1984:4. The modified Sims model employs 8 lags of M1US in the M1US equation, and the other equations are identical to those in the Sims model. $Q$ statistics for both models indicated white noise residuals.

The third model is specified using a variant of the VAR technique suggested by Hsiao (1981) and extended by Caines, Keng and Sethi (1981). Rather than employing the same lag length for each variable in each equation, Akiake's final prediction error (FPE) criterion is used to determine the appropriate lag length for each variable in each equation. This allows a potential reduction in the number of parameters to be estimated, and it also has appeal since there is little basis in economic theory to believe that the same lag length is appropriate for all variables in each equation. According to Hsiao (1981, p. 88), the FPE criterion is '. . . appealing because it balances the risk due to the bias when a lower order is selected and the risk due to the increase of variance when a higher order is selected.'

The specification of the FPE model proceeds equation by equation, and the details, which are available on request, are not reported here in order to conserve space. Application of a similar procedure in a single-equation setting is described in detail in McMillin (1986). The end result is a model in which all variables appear in every equation (except the US money equation), typically with different lag lengths.[5] In the US money equation, only lags of US money are employed, and the own lag length is determined by the FPE procedure. As in the case of the modified Sims system, no direct feedback is allowed from the Canadian variables to M1US. Since the specification of each equation is different (see footnote 5), the FPE system is estimated using the seemingly unrelated regression technique. As in the case of the other two systems, $Q$ statistics indicated that the residuals of the FPE system were white noise.

[4]Given the relatively large number of variables in the model, it was felt that considering a maximum lag of greater than 8 quarters would undesirably reduce the degrees of freedom for estimation.

[5]The specification of the FPE model is:

| Equation | Right-hand side variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $y$ | $P$ | AAA | ER | M1C | $g$ | $D$ | M1US |
| $y$ | 1 | 3 | 1 | 2 | 6 | 1 | 1 | 2 |
| $P$ | 1 | 3 | 1 | 3 | 8 | 1 | 6 | 6 |
| AAA | 4 | 1 | 5 | 7 | 1 | 1 | 8 | 7 |
| ER | 2 | 3 | 7 | 1 | 2 | 1 | 1 | 3 |
| M1C | 5 | 7 | 1 | 1 | 4 | 3 | 1 | 2 |
| $g$ | 2 | 1 | 1 | 4 | 1 | 1 | 3 | 1 |
| $D$ | 6 | 1 | 4 | 4 | 1 | 1 | 3 | 5 |
| M1US | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |

The entries in the rows and columns are the lag length of variable at the top in the equation at the left. A constant term was included in each equation.

The effects of government debt on the price level, output, and the interest rate are evaluated by examining variance decompositions (VDCs) and impulse response functions (IRFs). The VDCs and IRFs are based on the moving average representations of the models. The moving average representation of a VAR can be written as:

$$X_t = \Sigma_{i=0}^{\infty} M_i e_{t-i} \quad (3)$$

where $X_t$ and $e$ are as previously defined, and $M_i$ = matrix of impulse response weights conformable to the dimensions of $X$ and $e$.[6] The $e$s represent the shocks to or the innovations in the system's variables. The impulse response weights are derived from the estimated coefficients of the VAR, i.e. the elements of $B$(L). The details of the derivation of the moving average representation and the calculation of the VDCs and IRFs are provided in Judge *et al.* (1988).

VDCs show the proportion of forecast error variance for each variable that is attributable to its own innovations and to shocks to the other system variables. Since VDCs capture both direct and indirect effects, Sims (1982) has argued that the strength of Granger-causal relations can be measured by VDCs. Sims (1982, p. 131) pointed out that 'A variable that is optimally forecast from its own lagged values will have all its forecast error variance accounted for by its own disturbances.' For example, if government debt explains only a small portion of the forecast error variance of output, this could be interpreted as a weak Granger-causal relation.

IRFs show the predictable response of each variable in the system to a one-standard deviation shock to one of the system's variables and can be thought of as a type of dynamic multiplier. The matrices $M_i$ contain these dynamic multipliers. Thus the effect of a change in government debt on the price level, output, and the interest rate can be estimated by computing IRFs.

## *B. Data*

Quarterly data for the period 1961:1–1984:4 are used in the analysis. Data collection begins in 1961:1 since government purchases data are not available before this period. The period ends in 1984:4 since the market value of government debt series of Cox and Haslag (1986) ends at this point. Data from 1961:1–1963:1 are used as presample data, and the estimation of the systems is carried out over 1963:2–1984:4.[7]

The eight variables in the model are: real GNP ($y$), the GNP deflator ($P$), the narrowly defined Canadian and US money supplies (M1C and M1US, respectively), the AAA

[6]The effects of the intercept terms are ignored since they play no role in the calculation of the VDCs and IRFs.

[7]In estimating the VARs, it is assumed that the macroeconomy may be treated as stable over the period of estimation and that policymaker's behaviour in relation to the other variables in the macro model was consistent over this period. Sims (1982) has argued that, for the US economy, evidence suggests that the structure of the economy changes slowly over time so that one can estimate a model for the postwar period as a whole without undue concern for bias due to changes in parameters. An appeal to arguments of this sort is made in using Canadian data spanning the period of fixed and floating exchange rates. In essence it is assumed that the move to floating rates in 1970:3 did not change the macroeconomic structure substantially. Ideally this would be formally tested through Chow tests for each equation or a likelihood ratio test for the system. We were unable to do this because of the small number of observations in the fixed rate and floating rate parts of the sample and the number of parameters in our system.

corporate bond rate (AAA), the US–Canadian exchange rate (ER), real government purchases of goods and services ($g$), and the market value of private, domestic holdings of direct government of Canada debt ($D$). All data except for AAA and ER are seasonally adjusted. Although we recognize that seasonally unadjusted data are often preferable for this type of study, the desire to use real GNP and the GNP deflator which are not available in seasonally unadjusted form necessitated the use of seasonally adjusted data.

Data for $y$, $P$, AAA, M1C, and $g$ were provided by the Bank of Canada. ER was taken from the November, 1986 International Financial Statistics tape produced by the IMF, and M1US was taken from Citibase. $D$ was constructed in the following manner. First, data for the market value of privately held domestic direct debt and for the price index for marketable domestic direct debt (Tables 6 and 8, Cox and Haslag (1986)) were seasonally adjusted using the X11 procedure of SAS, as were data on the par value of foreign holdings of Canadian debt (from the Bank of Canada). The seasonally adjusted price index for marketable debt was then multiplied by the par value of foreign holdings of debt to obtain a measure of the market value of foreign holdings of debt. The market value of foreign holdings was then subtracted from the market value of privately held debt to obtain a proxy for the market value of private, domestic holdings of direct debt. The resulting series is $D$.

Quarterly data rather than monthly data were used for the following reasons. As noted earlier, it is crucial when examining the effects of government debt to control for the level of government purchases, and government purchases are available only quarterly. A government expenditures series (which includes transfer payments) is available monthly. However, the use of expenditures rather than purchases is undesirable from a theoretical perspective. Second, as mentioned before, on theoretical and econometric grounds a distinction has to be made between the market value of private, domestically held government debt and the market value of privately held debt. The former is derived using foreign holdings of Canadian government debt which is available only quarterly. Finally, the use of quarterly data allow us to use real GNP and the GNP deflator which are not available monthly.

Prior to specification and estimation of the VAR, $y$, $P$, M1C, M1US, $g$, and $D$ were transformed by taking first differences of the log of these variables. AAA and ER were transformed by taking the first difference of the level of these variables. The first difference transformations were performed since unit root tests of the type described by Nelson and Plosser (1982) indicated that the hypothesis of a first order unit root could not be rejected.[8] The unit root test results are available on request.

## III. EMPIRICAL RESULTS

Estimates of the effect of changes in government debt on the price level, output, and the interest rate are presented in this section. The effects are evaluated using the previously described VDCs and IRFs.

Since no contemporaneous terms enter the equations of the VAR, any contemporaneous relations among the variables are reflected in the correlation of residuals across equations. In

[8]Our unit root test results for exchange rates are broadly consistent with those of Meese and Singleton (1982) and Doukas and Rahman (1987). Meese and Singleton cannot reject first-order unit roots in the log of spot and forward rates for several countries, including the Canadian dollar/US dollar rate. Doukas and Rahman cannot reject unit roots for the log of foreign exchange futures rates for several countries, again including the Canadian dollar/US dollar rate.

calculating the VDCs and IRFs, the variables are ordered in a particular fashion, and the variance–covariance matrix is orthogonalized by the Choleski decomposition. Because of the cross-equation residual correlation, when a variable higher in the order changes, variables lower in the order are assumed to change. The extent of the change depends upon the covariance of the variables higher in the order with those lower in the order. The orderings considered are: (1) M1US, $g$, $D$, M1C, AAA, ER, $y$, and $P$; (2) M1US, M1C, $g$, $D$, AAA, ER, $y$, and $P$; (3) M1US, $g$, $D$, M1C, $y$, $P$, AAA, and ER; (4) M1US, M1C, $g$, $D$, $y$, $P$, AAA, and ER; (5) $y$, $P$, M1US, $g$, $D$, M1C, AAA, and ER; and (6) $y$, $P$, M1US, M1C, $g$, $D$, AAA, and ER.

The rationale for these orderings is based upon the following considerations. M1US is placed first based upon the assumption that current period shocks to US money are determined primarily by events in the US economy. In orderings (1) and (2) the goods market variables ($P$ and $y$) are placed last in the ordering, with AAA and ER preceding the goods market variables. The monetary and fiscal policy variables precede the interest rate. This allows shocks to M1US, $g$, $D$, and M1C to contemporaneously affect AAA and ER; it also allows AAA to contemporaneously affect ER. In turn, current period shocks to M1US, $g$, $D$, M1C, AAA, and ER alter the goods market variables. In ordering (1) the fiscal variables precede the monetary variable. This allows the monetary authorities to be affected by or to respond to fiscal policy developments, which does not seem unreasonable in light of the relative flexibility of implementation of monetary policy as opposed to fiscal policy. However, in ordering (2), M1C precedes the fiscal variables.

We note that in these orderings, as well as in orderings (3) and (4), the policy variables are placed first. Any contemporaneous correlation between these policy variables and the macro variables of interest, $P$, $y$, and AAA, is assigned to the policy variables. We thus assume that the information set that conditions the settings of the policy variables contains only lagged values of $P$, $y$, and AAA. This type of feedback relationship has been widely employed in the macro literature in recent years; see Mishkin (1982) for an example.

Similar theoretical and institutional considerations guide the selection of orderings (3) and (4) except that AAA and ER are placed last based upon the efficient markets argument of Gordon and Veitch (1986). When AAA and ER are placed last, all other variables in the system contemporaneously affect AAA and ER. In orderings (5) and (6), the goods market variables are placed first and thereby are allowed to alter contemporaneously the policy variables as well as AAA and ER.[9]

The VDCs for ordering (1) are presented in Table 1. In order to conserve space and to focus sharply upon debt's effects on the macroeconomy, only the effects of $D$ on AAA, $y$, and $P$ are presented. This allows us to concentrate upon the macro variables of immediate concern to the Ricardian equivalence hypothesis. Since the alternative orderings considered do not have substantial effects on the results, only the results for ordering (1) are discussed; the other VDC results are available on request. VDCs at horizons of 1, 4, 8, 12, and 20 quarters are provided in order to convey the dynamics of adjustment of the system to shocks to $D$. We note that the effects across the three models are quite comparable. With just a few exceptions, the Sims system generates somewhat larger effects than the other two systems.

We see that $D$ explains 44–48% of the variation in AAA in quarter 1, and 26–34% in quarter 4. The proportion of the variation in AAA explained by $D$ drops steadily over time,

[9]Bernanke (1986) has also argued that theoretical considerations should be employed in computing the VDCs. However, he has suggested an alternative method of orthogonalizing the residuals to the Choleski decomposition used here.

Table 1. *Variance Decompositions*

| Ordering: M1US, $g$, $D$, MIC, AAA, ER, $y$, $P$ | | | | |
|---|---|---|---|---|
| Relative variation in | Horizon (quarters) | Explained by innovations in $D$ | | |
| | | FPE system | Sims system | Modified Sims system |
| AAA | 1 | 43.8 | 45.5 | 48.4 |
| | 4 | 29.2 | 33.6 | 25.9 |
| | 8 | 18.5 | 27.7 | 19.4 |
| | 12 | 16.2 | 23.2 | 16.8 |
| | 20 | 14.9 | 17.0 | 12.0 |
| $y$ | 1 | 6.3 | 3.2 | 2.2 |
| | 4 | 8.5 | 9.7 | 6.6 |
| | 8 | 11.3 | 15.2 | 10.6 |
| | 12 | 10.8 | 15.9 | 10.6 |
| | 20 | 11.0 | 15.0 | 12.4 |
| $P$ | 1 | 0.7 | 0.3 | 0.3 |
| | 4 | 15.3 | 3.2 | 2.5 |
| | 8 | 10.4 | 10.0 | 3.5 |
| | 12 | 8.7 | 14.2 | 5.9 |
| | 20 | 9.2 | 12.4 | 9.6 |

but it appears that $D$ has substantial effects on AAA, especially in the short-run. The effects of $D$ on $y$ and $P$ are more moderate, however. In quarter 1 $D$ explains only 2–6% of the variation in $y$, and, at the end of a year, this has risen to 7–10%. At the end of 20 quarters, $D$ explains 11–15% of the variation in $y$. The biggest differences across the systems occurs for $P$. All suggest, however, that $D$ explains little of the forecast error variation in $P$ in quarter 1. The FPE system indicates that $D$ explains about 15% of the variation in $P$ in quarter 4, while the other two systems indicate a trivial amount of the variation in $P$ (3%) is explained by $D$. At the end of 20 quarters, $D$ explains 9–12% of the variation in $P$.

Given the size of the system, it is difficult to gauge what constitutes a substantial effect of $D$ on AAA, $y$, and $P$. However, by any reasonable standard, $D$ appears to have substantial short-run effects on AAA, with the effects becoming muted over time. We judge $D$'s effects on $y$ and $P$ to be moderate to weak.

The VDCs provide no evidence about the *direction* of the effects of $D$ on AAA, $y$, and $P$. For this information, we turn to the IRFs. The responses of AAA, $y$, and $P$ to a one standard deviation shock to $D$ are presented in Fig. 1. Again we note that the patterns of effects from all three systems are comparable, although the magnitudes of effects differ somewhat. It is interesting to note that the initial effects of $D$ on AAA are *negative*, not positive as would be expected if debt is wealth. The negative effects persist for the first 4–5 quarters, and fluctuate around zero thereafter. The initial effects on $y$ are negative for all three systems, but quickly become positive and then fluctuate around zero. Two of the three systems also indicate an initial negative effect on $P$; for the other system the effect becomes negative in quarter 2. The negative effect on $P$ remains longer for the FPE and Sims systems. The pattern of effects for the FPE and modified Sims systems is similar after quarter 9; both suggest positive effects which decline toward zero at quarter 20. The Sims system suggests fluctuations around zero after quarter 9.

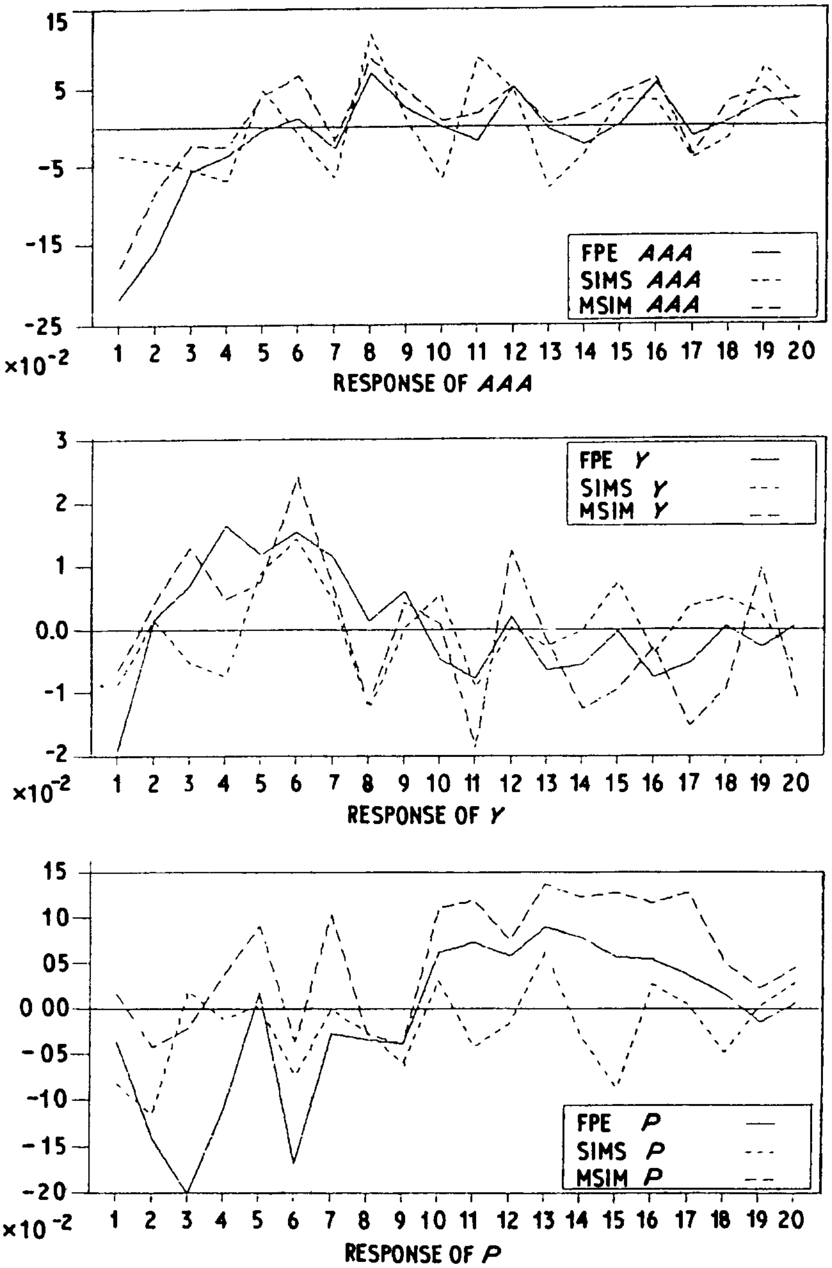


Fig. 1. Responses to *D* innovation.

The initial negative effects are not consistent with the conventional view that debt is wealth, and they also appear inconsistent with the Ricardian view that debt is not wealth. However, prior empirical work by Kormendi (1983) and Evans (1985) generated results consistent with those reported here even though their methodologies differed from those used here. Kormendi finds some evidence of a significant negative effect of government debt on consumption and Evans finds evidence of a significant negative effect of deficits on interest rates. Kormendi, following a prior argument of Barro, offers the following explanation of the negative effects. Because of uncertainty about the individual's share of future taxes and the timing of these taxes, individuals may save more than the present value of the income streams associated with bonds issued to finance a deficit. In this view, wealth falls as debt rises, and one would thus expect declines in the interest rate, output, and the price level.

The Kormendi argument is capable of explaining the initial negative effects on AAA, $y$, and $P$. We note, however, that $y$ rebounds very quickly; $P$ also rebounds quickly in the Sims and modified Sims systems. If investment and consumption spending respond quickly and in sufficiently large magnitude to the initial decline in interest rates, then the effects of the initial decline in wealth on aggregate demand will be quickly offset and $y$ and $P$ will rise. The rise in $y$ and $P$ will, in turn, drive the interest rate up. Of course, the dynamic interactions are typically complex, but the scenario just outlined appears to fit the patterns of Fig. 1, particularly if $P$ responds more slowly to aggregate demand changes than does $y$.

## IV. CONCLUSION

This paper has examined the role of government debt in the Canadian economy within eight variable VAR models for the period 1963:2–1984:4. Unlike earlier Canadian studies, and, also unlike most US studies, the effects of debt are analysed within a small macro model so that the effects of debt on interest rates, output, and the price level can be evaluated simultaneously. Furthermore, the robustness of the results is evaluated by estimating and analysing three different VAR models.

The effects of government debt were evaluated by computing variance decompositions and impulse response functions. For all three models, the variance decompositions suggest substantial effects of debt on the interest rate and moderate to weak effects on real GNP and the GNP deflator.

As is widely known, it is difficult to distinguish sharply among structural hypotheses using the techniques of this paper. Based upon the variance decomposition results, one might be tempted to conclude that debt is at least partly wealth. However, the impulse response function results do not appear consistent with the conventional view of the macroeconomic role of debt. The impulse response functions indicate that shocks to debt initially *reduce* the interest rate, output, and the price level. An explanation of this type of result that is consistent with the Ricardian equivalence hypothesis has been offered by Kormendi (1983). He argues that because of uncertainty about the individual's share of future taxes and the timing of these taxes, individuals may save more than the present value of the income streams associated with bonds issued to finance a government deficit. Wealth is thus reduced, and one would expect negative effects on the interest rate, output, and price. While there may be other explanations of these results, our findings do not appear consistent with the conventional view that government debt is wealth and that increases in government debt raise aggregate demand.

## REFERENCES


Aschauer, D. A. (1985) Fiscal policy and aggregate demand, *American Economic Review*, **75**, 117–27.

Barro, R. J. (1974) Are government bonds net wealth? *Journal of Political Economy*, **82**, 1095–117.

Bernanke, B. S. (1986) Alternative explanations of the money–income correlation, *Carnegie–Rochester Conference Series on Public Policy*, **25**, 49–99.

Brunner, K. (1986) Fiscal policy in macro theory: A survey and evaluation, in *The Monetary versus Fiscal Policy Debate: Lessons from Two Decades* (Ed.) R. W. Hafer, Rowman and Allanheld, New Jersey, pp. 33–116.

Caines, P. E., Keng, C. W. and Sethi, S. P. (1981) Causality analysis and multivariate autoregressive modelling with an application to supermarket sales analysis, *Journal of Economic Dynamics and Control*, **3**, 267–98.

Cooley, T. F. and LeRoy, S. F. (1985) Atheoretical macroeconometrics: A critique, *Journal of Monetary Economics*, **16**, 283–308.

Cox, W. M. and Haslag, J. (1986) The market value of Government of Canada debt; Monthly, 1937–1984, *Canadian Journal of Economics*, **19**, 469–97.

de Leeuw, F. and Holloway, T. M. (1985) The measurement and significance of the cyclically adjusted federal budget and debt, *Journal of Money, Credit and Banking*, **17**, 232–42.

Doukas, J. and Rahman, A. (1987) Unit root tests: Evidence from the foreign exchange futures market, *Journal of Financial and Quantitative Analysis*, **22**, 101–7.

Dwyer, G. P., Jr. (1982) Inflation and Government deficits, *Economic Inquiry*, **20**, 315–29.

Eisner, R. and Pieper, P. J. (1984) A new view of federal debt and budget deficits, *American Economic Review*, **74**, 11–29.

Evans, P. (1985) Do large deficits produce high interest rates? *American Economic Review*, **75**, 68–87.

Evans, P. (1987) Interest rates and expected future budget deficits in the United States, *Journal of Political Economy*, **95**, 34–58.

Feldstein, M. (1982) Government deficits and aggregate demand, *Journal of Monetary Economics*, **9**, 1–20.

Fischer, S. (1981) Relative shocks, relative price variability, and inflation, *Brookings Papers on Economic Activity*, **2**, 381–431.

Genberg, H., Salemi, M. K. and Swoboda, A. (1987) The relative importance of foreign and domestic disturbances for aggregate fluctuations in the open economy: Switzerland, 1964–1981, *Journal of Monetary Economics*, **19**, 45–67.

Gordon, R. J. and Veitch, J. M. (1986) Fixed investment in the American business cycle, 1919–83, in *The American Business Cycle: Continuity and Change* (Ed.) R. J. Gordon, University of Chicago Press, Chicago, pp. 267–357.

Hoelscher, G. (1986) New evidence on deficits and interest rates, *Journal of Money, Credit and Banking*, **18**, 1–17.

Hsiao, C. (1981) Autoregressive modelling and money-income causality detection, *Journal of Monetary Economics*, **7**, 85–106.

Johnson, D. (1986) Are government bonds net wealth? Intertemporal optimization and the government budget constraint, *Journal of Macroeconomics*, **8**, 435–53.

Judge, G. G., Hill, R. C., Griffiths, W. E., Lutkepohl, H. and Lee, T. S. (1988) *An Introduction to the Theory and Practice of Econometrics*, 2nd edn, John Wiley, New York, pp. 713–14.

Kochin, L. (1974) Are future taxes anticipated by consumers? *Journal of Money, Credit and Banking*, **6**, 385–94

Koray, F. and McMillin, W. D. (1987) The Ricardian Equivalence Hypothesis: Some Canadian evidence, *Economics Letters*, **25**, 15–19.

Kormendi, R. C. (1983) Government debt, government spending, and private sector behavior, *American Economic Review*, **73**, 994–1010.

Koskela, E. and Viren, M. (1983) National debt neutrality: some international evidence, *Kyklos*, **36**, 575–88.

Lutkepohl, H. (1982) Non-causality due to omitted variables, *Journal of Econometrics*, **19**, 367–78.

Makin, J. H. (1983) Real interest, money surprises, anticipated inflation and fiscal deficits, *Review of Economics and Statistics*, **65**, 374–84.

McMillin, W. D. (1986) Federal deficits and short-term interest rates, *Journal of Macroeconomics*, **8**, 403–22.

Meese, R. A. and Singleton, K. J. (1982) On unit roots and the empirical modeling of exchange rates, *Journal of Finance*, **37**, 1029–35.

Mishkin, F. S. (1982) Does anticipated monetary policy matter? An empirical investigation, *Journal of Political Economy*, **90**, 22–51.

Nelson, C. R. and Plosser, C. I. (1982) Trends and random walks in macroeconomic time series: some evidence and implications, *Journal of Monetary Economics*, **10**, 139–62.

Plosser, C. I. (1982) Government financing decisions and asset returns, *Journal of Monetary Economics*, **9**, 325–52.

Seater, J. J. and Mariano, R. S. (1985) New tests of the life cycle and tax discounting hypotheses, *Journal of Monetary Economics*, **15**, 195–215.

Sims, C. A. (1982) Policy analysis with econometric models, *Brookings Papers on Economic Activity*, **1**, 107–52.

Tanner, J. E. (1979) An empirical investigation of tax discounting, *Journal of Money, Credit and Banking*, **11**, 214–18.

Tobin, J. and Buiter, W. (1980) Fiscal and monetary policies, capital formation, and economic activity, in *The Government and Capital Formation* (Ed.) G. von Furstenberg, Ballinger, Cambridge, pp. 73–151.

Wachtel, P. and Young, J. (1987) Deficit announcements and interest rates, *American Economic Review*, **77**, 1007–12.

Yawitz, J. B. and Meyer, L. H. (1976) An empirical test of the extent of tax discounting, *Journal of Money, Credit and Banking*, **8**, 247–54.