WEALTH EFFECTS OF PUBLIC DEBT IN OPEN ECONOMIES*

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Abstract

The paper studies the long-run effects of public debt accumulation on the capital stock and private sector wealth in a two country overlapping generations model. Numerical simulation methods are used to solve the model. Quantitative as well as qualitative effects depend critically on the size and openness of countries, the values of taste and technology parameters, and the type of tax employed to finance interest payments on newly incurred public debt.

Das Papier untersucht die langfristigen Auswirkungen öffentlicher Schuld auf die Realkapitalbildung und die Entwicklung des Gesamtvermögens des privaten Sektors in einem Zwei-Länder-Modell mit überlappenden Generationen. Wir gewinnen die Ergebnisse aus numerischen Simulationen des Modells, da eine analytische Aggregation des Haushaltssektors nicht möglich ist. Quantitative wie qualitative Ergebnisse hängen in kritischer Weise von der Größe und Offenheit der Länder, von den Werten für Präferenz- und Technologieparametern und der Art der Steuerfinanzierung der auflaufenden Zinszahlungen ab.

1 Introduction

Over the last 15 years, many OECD countries have accumulated public debt at an unusual pace. In total OECD, gross public debt as a percentage of nominal output increased from 35.5 percent in 1974 to 54.1 percent in 1986 [Chouraqui, Jones, and Montador (1986, p. 108)]. While these overall debt figures camouflage substantial differences in individual country experiences, it is hardly controversial that the rise in public sector indebtedness has recently been a dominating policy concern in most OECD countries.

Discussions of the long-run consequences of debt accumulation usually focus attention on capital crowding out in closed economies [Modigliani (1961), Tobin (1986), Auerbach and Kotlikoff (1987)]. The main point emerging from these analyses is that absent Ricardian neutrality higher public debt will impoverish future generations through reduced capital accumulation. Considering open economies with integrated capital markets may, however, provide new perspectives on the effects of public debt. To investigate this conjecture, we consider in this paper a two country overlapping generations model. The use of numerical simulation techniques allows for a rough quantitative assessment of the differences in long-run effects from increased public debt as the size and openness of countries varies. Additionally, we study the sensitivity of results to different tax regimes and asymmetric taste and technology parameterizations in the home and foreign country.

A number of recent papers has studied public debt accumulation in open economies. Persson (1985) looks at transitory budget deficits leading to permanent increases in public debt and investigates the consequences of such policies for capital accumulation and welfare in a two period overlapping generations model. A disadvantage of the two period structure is, however, that human capital effects are not taken into account. Buiter (1987) and Obstfeld (1989) study similar issues in infinite horizon models of the type suggested by Blanchard (1985) and Weil (1989). We use in this paper a multi-period overlapping generations model which leaves the life-cycle motivation of private savings decisions intact. This type of perfect foresight general equilibrium simulation model of life-cycle savings was pioneered by Auerbach and Kotlikoff (1983, 1987) for a closed economy.

In section 2, the structure of the model is specified. Simulation results are discussed in section 3. The conclusions are set out in section 4.

2 The Model

The world economy comprises a home country and a foreign country both producing the same good. Each country is made up of three sectors: A private household sector, a production sector, and a government sector. This section describes the behavior of agents and the determination of the balance of payments between the two countries.

2.1 Private Household Behavior

The private household sector is populated by fiftyfive generations. Each member of the youngest generation which enters the population, expects with certainty a lifetime of fifty five years. She retires after a working life of forty five years. At each date t, generations are indexed by $i = 0, \ldots, 54$ where i denotes their planning horizon over the rest of their life. Labor supply of the younger generations ($i = 10, \ldots, 54$) is fixed and normalized to unity. Hence, labor supply of generation i at date t is given by

$$L_{i,t} = \begin{cases} 0 & 0 \leq i < 10 \\ 1 & 10 \leq i \leq 54 \end{cases} \tag{1}$$

Consumption and savings decisions are determined by the life-cycle motive. Generation i maximizes the utility index

$$U_i[C_{i,t}, \ldots, C_{i,t+i}] = \sum_{s=t}^{t+i} \frac{C_{i,s}^{1-1/\beta}}{1-1/\beta} \frac{1}{(1+\delta)^{s-t}} \tag{2}$$

$C_{i,t}$ is consumption of generation i in period t, β is the intertemporal elasticity of substitution, and δ denotes the time preference rate. Utility is maximized subject to the intertemporal wealth constraint of generation i

$$W_{i,t} \equiv [1 + (1 - t_{k_t})r_t]A_{i,t} + \sum_{s=t}^{t+i} \frac{[(1-t_{l_s})w_s L_{i,s} - \tau_{i,s}]}{d_{t+1,s}} = \sum_{s=t}^{t+i} \frac{(1+t_{c_s})C_{i,s}}{d_{t+1,s}} \tag{3}$$

Here, $W_{i,t}$ denotes total wealth as perceived by generation i while $A_{i,t}$ are accumulated financial assets. Households earn a market interest rate r_t on financial wealth and gross real wages w_t on labor supplied. They pay taxes on capital income at a rate t_{k_t} and on

wage income at a rate t_{l_t}. The equality of these tax rates covers the case of an income tax. Furthermore, consumption is taxed at a rate t_{c_t} and generations also pay per capita lump-sum taxes $\tau_{i,t}$. All future income is discounted at the net interest rate which defines the discount factor

$$d_{t,s} = \prod_{u=t}^{s}[1 + (1 - t_{k_u})r_u]; \qquad d_{t+1,1} = 1.$$

The intertemporal budget constraint (3) is based on the assumption that generations leave no bequests. The missing intergenerational linkages are an important reason for the failure of public debt neutrality in this model [Barro (1974)]. The solution of the optimization problem gives the "consumption function" of generation i

$$C_{i,t} = \Gamma_{i,t} W_{i,t} \tag{4}$$

where the marginal propensity to consume out of wealth, $\Gamma_{i,t}$, is given by

$$\Gamma_{i,t} = \{\ (1 + t_{c_t})^{\beta} \sum_{s=t}^{t+i}[(1 + \delta)^{(t-s)\beta}(1 + t_{c_s})^{1-\beta} d_{t+1,s}^{\beta-1}]\ \}^{-1}.$$

Consumption of each generation is proportional to its total wealth in period t. The old display high, the young have low and unborne future generations have zero propensities to consume. Aggregation across generations defines aggregate consumption, labor supply, and wealth of the private sector.[1] Total private wealth of the entire household sector is

$$W_t = \sum_{i=0}^{54} A_{i,t} + \sum_{i=0}^{54}\sum_{s=t}^{t+i} \frac{w_s L_{i,s}}{d_{t,s}} - \sum_{i=0}^{54}\sum_{s=t}^{t+i} \frac{[\tau_{i,s} + t_{l_s} w_s L_{i,s} + t_{c_s} C_{i,s}]}{d_{t,s}} = \sum_{i=0}^{54}\sum_{s=t}^{t+i} \frac{C_{i,s}}{d_{t,s}} \tag{5}$$

Total private sector wealth W_t is the sum of non-human assets plus human wealth minus anticipated tax liabilities and is equal to the present value of aggregate private

[1]We obtain aggregates by summing across generations: $A_t = \sum_{i=0}^{54} A_{i,t}$, $L_t = \sum_{i=0}^{54} L_{i,t}$, $\tau_t = \sum_{i=0}^{54} \tau_{i,t}$ and $C_t = \sum_{i=0}^{54} C_{i,t}$.

consumption.[2] There are three types of non-human assets in this economy each yielding an identical rate of return

$$A_t = K_t + D_t + F_t \tag{6}$$

where K_t is the (non-depreciating) capital stock, D_t denotes public debt, and F_t net foreign asset holdings by home country residents. The three assets are perfect substitutes. From (5) and (6), we see that the extent to which public debt is perceived as net wealth by the private sector depends on the size of the public debt relative to the anticipated tax liability.

The household sector of the foreign country has the same structure. But preference parameters and the size of each cohort may take different values in the home and foreign countries.

2.2 Firm Behavior

A single good is produced in the world economy by the home and foreign countries using a Cobb-Douglas technology. In the home country, output, or more precisely, domestic product is determined by

$$Y_t = K_t^{\alpha}[L_t(1+g)^t]^{1-\alpha} \tag{7}$$

where Y_t is output, g the exogenously given rate of Harrod-neutral technical progress, α the output elasticity of capital and L_t is aggregate labor input. Profit maximization implies that factors are paid their marginal products

$$\begin{aligned} w_t &= (1-\alpha)K_t^{\alpha}[L_t(1+g)^t]^{-\alpha}(1+g)^t \\ r_t &= \alpha K_t^{\alpha-1}[L_t(1+g)^t]^{1-\alpha}. \end{aligned} \tag{8}$$

[2]Aggregate private wealth is discounted to the beginning of period t to make it consistent with the dating of non-human assets. Consumption decisions, however, depend on end of period wealth as defined by the intertemporal budget constraint in (3). Also, capital income tax liabilities are accounted for by discounting with the net interest rate $(1-t_k)r$.

2.3 Government Behavior

The government raises taxes and pays interest on public debt. For the purposes of this paper, it is convenient to fix public consumption at zero in all periods. Debt accumulates according to

$$D_{t+1} - D_t = r_t D_t - R_t \tag{9}$$

Since all tax rates are proportional, aggregate tax revenues are simply $R_t = t_{l_t} w_t L_t + t_{c_t} C_t + t_{k_t} r_t A_t + \tau_t$. Note that interest income is taxed according to the residence principle which means that interest on domestic and foreign assets is subject to the domestic tax rate. The intertemporal government budget constraint imposes the condition that debt does not increase asymptotically at a rate faster than the interest rate.

$$D_t = \sum_{s=t}^{\infty} R_s \prod_{u=t}^{s} (1 + r_u)^{-1} \tag{10}$$

In other words, the intertemporal constraint states that, in the absence of government consumption, the value of public debt must be funded by the present value of future tax revenues.

2.4 Balance of Payments Determination

The trade surplus B_t is the excess of domestic product over domestic absorption. In a one-good world, we have $B_t = Y_t - C_t - I_t$. By definition, the trade surplus of the foreign country must be the negative of the home country's surplus, $B_t^* \equiv -B_t$. Starred variables denote variables of the foreign country. The current account surplus is the excess of national product, which is the sum of domestic product and income from foreign assets, over domestic absorption. The current account determines the accumulation of net foreign assets

$$F_{t+1} - F_t = r_t F_t + B_t. \tag{11}$$

By symmetry $F_t^* \equiv -F_t$. Because of perfect capital mobility, arbitrage dictates that real interest rates are equal in both countries if the residence principle of interest taxation

is in operation: $(1-t_k)r^* = (1-t_k)r$. Solving (11) and assuming that the foreign asset position of the home economy can not grow asymptotically at a rate faster than the interest rate, we derive the intertemporal constraint on the accumulation of net foreign wealth

$$F_t = \sum_{s=t}^{\infty} -B_s \prod_{u=t}^{s} (1+r_u)^{-1}. \tag{12}$$

The intertemporal constraint (12) implies that a country with positive net foreign wealth may run future trade deficits with a present value equal to the current level of assets. In a steady state with underaccumulation ($r > g$), a creditor nation runs a current account surplus equal to gF to finance the growth of its foreign asset position, but its trade balance is in deficit by an amount equal to $-B = (r-g)F$.

3 Simulation Results

3.1 Solving the Model

The labor, goods, and capital markets are assumed to clear in each period and agents in both economies have perfect foresight. Conditional on values for the preference and technology parameters and the initial value of public debt, the model can be solved for its initial steady state (ISS).[3] In a steady state, the economy exhibits balanced growth at a rate g in both countries. In all equilibria that we computed, the real interest rate always exceeds the growth rate. Thus, the initial capital labor ratios are below the golden rule ratio.

We normalize the size of home country cohorts to unity. In the case of two equally large countries, foreign generations are identical in size to those in the home country. When we simulate the case of a small open economy, we assume that the population of the foreign country is larger by a factor of thousand. This is sufficient for the home country to have practically no influence on the world interest rate.

[3] A solution algorithm is described by Auerbach and Kotlikoff (1987, chapter 4). The two country structure of our model requires some modifications of their algorithm.

3.2 Measures of Long-Run Crowding Out

The following basic policy experiment is considered. The economy is first solved for its ISS given numerical values for the taste and preference parameters and an initial level of public debt. Then, public debt is increased by a certain amount and the model is solved for the new final steady state (FSS). One may imagine that the government sector cuts taxes initially, incurs deficits and, thus, accumulates debt. Eventually, taxes have to be raised sufficiently to stabilize the growth of public debt at its FSS level. Of course, many different transition paths to the FSS are possible but there is no need to consider a specific path here since the focus of the paper is on long-run crowding-out effects.

We report two indicators of long-run crowding out. Our measure of long-run real capital crowding out indicates how much of the productive capital stock is displaced after issuing new public debt:

$$\phi = \frac{(K/L^e)_{ISS} - (K/L^e)_{FSS}}{(D/L^e)_{FSS} - (D/L^e)_{ISS}} \tag{13}$$

where L^e denotes labor input measured in effective labor units. The second indicator measures the change in total wealth as defined in equation (5).

$$\theta = \frac{(W/L^e)_{ISS} - (W/L^e)_{FSS}}{(D/L^e)_{FSS} - (D/L^e)_{ISS}} \tag{14}$$

The indicator θ measures "total crowding out" and includes the changes in human capital as well as net foreign wealth. The value of θ can be interpreted as the loss of lifetime resources available for financing present and future consumption. Hence, θ captures the changes in lifetime consumption aggregated over all generations alive in the FSS.

3.3 The Baseline Case

To examine the role of public debt in an overlapping generations model, it may be useful to reflect first on the calculations of infinitely lived private agents. Since the intertemporal budget constraint of such an agent is of the same nature as the intertemporal constraint

of the government, the value of public debt in private portfolios is exactly offset by the present value of future tax liabilities. Hence, private agents do not consider public debt as net wealth. In the basic intertemporal model, consumption depends on net wealth only. If the government chooses to cut taxes temporarily and to finance it with new debt, such a policy cannot affect private consumption since it does not change net wealth. The tax cuts are completely saved by the agent. The changes in public and private savings exactly offset each other. There is no reason for the initial equilibrium to be displaced, Ricardian neutrality of public debt is observed.

The overlapping generations model, however, allows for a non-neutral role of public debt. Due to finite horizons, private households calculate a smaller present value of tax liabilities than the government does. The value of public debt in private portfolios is not fully offset by the privately calculated tax liabilities. An increase in public debt brought about by temporary tax cuts is partly perceived as an increase in net wealth. Households do not live long enough to fully bear the future tax burden of an increased level of debt and therefore tend to consume part of the present tax cuts. Private sector savings increase by a smaller amount than public deficits. In a model with finite lives and missing intergenerational linkages public debt is non-neutral.

New public debt creates excess demand in the capital market. From prior theoretical reasoning in a closed economy framework, we expect interest rates to increase. Although households save more, private savings do not increase enough to absorb all of the new public debt. Hence, real capital formation is depressed. Labor which is in fixed supply, earns lower wages. The decline in human wealth is further accentuated as future wages are discounted at higher interest rates. The increased level of public debt as well as higher interest rates on old and new debt necessitate tax increases to pay for debt servicing. For the moment, we consider only lump-sum taxes which are distributed evenly among all generations. The case of intertemporally distorting taxes on capital income will be considered later. How is savings of young generations affected? Current incomes decline due to lower wages and higher taxes. This income effect reduces savings. On the other hand, the decline in human wealth tends to reduce current consumption of young savers. This wealth effect increases savings. The rise in the interest rate leads households to substitute present for future consumption. This substitution effect increases savings. Overall, the household sector accumulates more financial wealth but total wealth will most probably decline because of reduced human wealth and higher tax liabilities. Hence,

we expect total wealth crowding out in addition to real capital crowding out in the closed economy.

If the economy is open to international capital movements and trade in goods, the perspective on the non-neutrality of public debt is different. In the extreme, but not so unrealistic case of a small open economy, the home country exerts no influence on the world interest rate. Real capital formation as well as wages remain unaffected, too. Human wealth stays the same but taxes must increase to support public debt service. Savings of young generations will decline because of a reduction in current incomes due to higher tax payments. Lower financial wealth as well as increased tax liabilities reduce total wealth. We expect total wealth crowding out, but no real crowding out in the small open economy. Any excess demand for financial assets is covered by the inflow of foreign capital. Since the home country accumulates more public as well as foreign debt, we observe the well-known twin deficits in the government budget and current account. The case of two large countries does not offer any new insights but is only intermediate to the closed economy and the small open economy cases.

In the light of these a priori arguments, we may easily interpret table 1 which reports the long run, steady state effects of increasing public debt. We first need to characterize the initial equilibrium. In both countries the intertemporal elasticity of substitution is fixed at $\beta = 0.40$, the time preference rate at $\delta = 0.02$, the output elasticity of capital at $\alpha = 0.30$, and the rate of technological progress at $g = 0.02$. The sensitivity of results to variations in these parameter values is the subject of the next subsection. In the ISS, public debt is fixed at 0.50 per labor efficiency units in both countries. This value corresponds roughly to a debt-income ratio of 30 percent. All numbers reported in table 1 refer to the home country except column (4) which reports FSS values for the foreign country.

Column (1) gives the ISS values for the different components defining total private sector wealth. Columns (2) to (5) report FSS values for the wealth components and the two crowding out indicators for three different cases. In the first case, both countries are equally sized and both increase their debt-labor ratio simultaneously from 0.50 to 1.00. Hence, no capital movements occur and crowding-out effects in the home country mimic the case of a closed economy. Second, both countries are equally sized but only the home country increases its public debt. Third, the home economy is assumed to be a small

open economy which has no influence on the world interest rate.

The ISS values of the various wealth components expressed in labor efficiency units for the home country are the same in each of the three cases. In the ISS, anticipated tax liabilities amount to about 75 percent of the public debt. Only about 25 percent of public debt is therefore perceived as net wealth by the private sector. Another interesting feature of the ISS is the quantitative importance of human wealth in this multi-period model which makes up about two thirds of total perceived wealth.

In the closed economy case, the real capital crowding-out effect is 0.67. Total wealth crowding out is substantially larger, however, because human wealth is lowered by increased interest rates and decreased real wages. In the case of a large open economy, part of real capital crowding out takes place in the foreign country. The home country will also experience a smaller drop in human wealth than in the closed economy case but it will accumulate some foreign debt. In sum, total wealth crowding out in the home economy (column 3) is smaller than in the closed economy. Finally, in the small open economy case, real capital and human wealth crowding out are zero because the world interest rate and national wage rates are not affected by the increase in domestic public debt. Wealth crowding out takes place exclusively via the change in financial wealth and tax liabilities.

The results reported in table 1 are not sensitive to different sizes of the increase in public debt. The numerical simulations illustrate that the qualitative and quantitative features of the crowding out process can differ substantially as we move from a closed economy to a small open economy. For the assumed parameterization of the model, by accumulating public debt a large open economy may impose a detrimental externality on the foreign economy. A small open economy will experience substantially lower total wealth crowding out than a closed economy. These simulation results may explain why large increases in debt-income ratios in small open economies raise few outside concerns whereas relatively small increases in debt-income ratios in large open economies may incite much concern in foreign countries.

3.4 Sensitivity to Different Parameter Configurations

Tables 2 and 3 report the results of sensitivity analyses using different values for preference and technology parameters. In table 2, the underlined parameter is changed relative to the

baseline case but we still assume a symmetric parameterization for the home and foreign countries. The fiscal experiment considered is the same as in table 1. First we observe that over a wide range of parameters all initial equilibria suffer from underaccumulation of capital. The interest rates clearly exceed the growth rates.

Second, the qualitative crowding out results in table 1 are confirmed but the quantitative results are quite sensitive to the assumed value of the intertemporal elasticity of substitution β. With a high β, households choose steep consumption profiles even at low interest rates.[4] Therefore, accumulated savings of the private sector, or total financial wealth, is large relative to the size of debt. Consistent with low interest rates, real capital in labor efficiency units is large, too. Even a doubling of the debt labor ratio creates only a small excess demand in the capital market relative to the total stock of financial wealth. Hence, the resulting change in the interest rate is small even in a closed economy but nevertheless effectively generates more savings because of the high intertemporal elasticity of substitution. Real crowding out is lower than in the base line case. Furthermore, a small rise in the interest rate will produce only a minor decrease in human wealth. Since smaller human wealth and larger tax liabilities are partly offset by increased financial wealth, total wealth crowding out is smaller than in the base line case. The opposite is true with a small intertemporal elasticity of substitution. Public debt is large relative to the total stock of financial wealth. Any debt issues produce large increases in the interest rate and large revaluations of wealth. Hence, we observe high values for our crowding out measures in the closed economy.[5]

Table 3 considers asymmetric parameter configurations in the home and the foreign country. Here, the two countries are assumed to be of equal size. The table reports crowding out effects if either the home country or the foreign country increases public debt. In all cases excess demand in the capital market due to the newly issued public debt raises the world interest rate and crowds out real capital in both countries. Real crowding out is higher in the country with the higher output elasticity of capital as its capital input is more sensitive to any change in the common world interest rate. The

[4]While equation (4) gives consumption at the beginning of the planning period, the evolution of consumption over the life-cycle is determined by $C_{s+1} = [\frac{(1+t_{c_s})(1+r_{s+1})}{(1+t_{c_{s+1}})(1+\rho)}]^{\beta} C_s$.

[5]The assumption of a logarithmic utility function ($\beta = 1.0$) in numerical finite–horizon models, e.g. in van der Klundert and van der Ploeg (1989), will accordingly restrict crowding-out effects severely. Campbell and Mankiw (1989) conclude from time series evidence that β is likely to be small.

implications for crowding out of total wealth are more intricate. The most striking result emerging from this table is: If the intertemporal elasticity of substitution in the foreign country is relatively large compared to the home country, an increase of the home country's public debt can actually increase total wealth in the foreign country. Note that under this asymmetry the foreign country is a large lender nation initially. A rising interest rate increases the foreign country's income from abroad. Also, foreign generations are endowed with a high intertemporal elasticity of substitution and therefore save more in response to the higher interest rate even though wage incomes decline. The increase in financial wealth of foreigners more than offsets the slight reduction in human wealth. With tax liabilities approximately the same, the foreign country experiences crowding in of total wealth.

3.5 Sensitivity to Tax Regime

The analysis so far assumed that per capita lump-sum taxes are used to finance interest payments on the public debt. We keep the assumption that in ISS per capita lump-sum taxes are the only revenue source and that the increase in public debt is brought about by a cut in this type of tax. But we now assume that the additional taxes necessary to support debt service in the FSS come from either consumption taxes, wage taxes, or capital income taxes. Consider the closed economy case in table 4. Note that in a steady state, consumption and wage taxes are both intertemporally neutral. Wage taxes, however, are targeted at young wage earners and savers. Hence, any rise in the interest rate elicits additional savings, but less so in the case of a wage tax as compared to a consumption tax. Real crowding out under a wage tax exceeds crowding out under a consumption tax. The capital income tax involves a fundamental intertemporal distortion since it drives a wedge between gross interest rates available for investors and net interest rates available for savers. Even though the increase in the gross interest rate is the highest under a capital income tax, the net interest rate actually falls. The tax on capital income produces quite dramatic real crowding out.

Table 4 produces interesting results with respect to crowding out of total wealth: If, in a small open economy, capital income taxes are raised to finance the increased debt service, then we observe crowding in of total wealth. Gross interest rates and wages are fixed in a small open economy, but net interest rates decline because of the interest tax.

Hence, savings decline. Since future wages are discounted with a lower net interest rate, human wealth increases. The revaluation of human wealth in fact dominates all other effects. Under these circumstances, new public debt may make private households richer in terms of total wealth.

4 Conclusions

This paper has studied the long-run crowding out effects of public debt accumulation in an open overlapping-generations model. The main motivation of the paper was to complement recent analytical studies on this topic with quantitative approximations of crowding out effects and to test the robustness of the results with respect to the assumptions about values of preference and technology parameters. The results illustrated the critical dependence of qualitative and quantitative features of the crowding out process on the size and openness of the economy. Furthermore, assumptions about structural parameter values, in particular for the intertemporal elasticity of substitution and the tax regime, can critically affect the quantitative size of crowding out.

Two extensions of the analysis in this paper might prove worthwhile. First, an extension to a multi-good economy would introduce new crowding out channels along the line studied analytically by Frenkel and Razin (1987) and Obstfeld (1989). Second, a more explicit welfare analysis along the lines of Romer (1988) may sharpen the perspective on the social costs of public debt accumulation.

References

[1] Auerbach, Alan J. and Lawrence J. Kotlikoff, 1983, National Savings, Economic Welfare, and the Structure of Taxation, in: Martin Feldstein, ed., Behavioral Simulation Methods in Tax Policy Analysis (University of Chicago Press, Chicago) 459-493.

[2] Auerbach, Alan J. and Lawrence J. Kotlikoff, 1987, Dynamic Fiscal Policy (Cambridge University Press, Cambridge).

[3] Barro, Robert J., 1974, Are Government Bonds Net Wealth? Journal of Political Economy 82, 1095-1117.

[4] Blanchard, Olivier J., 1985, Debt, Deficits, and Finite Horizons, Journal of Political Economy 93, 223-247.

[5] Buiter, Willem, 1987, Fiscal Policy in Open, Interdependent Economies, in: Assaf Razin and Efraim Sadka, eds., Economic Policy in Theory and Practice (MacMillan Press, London) 101-144.

[6] Campbell, John Y. and Gregory N. Mankiw, 1989, Consumption, Income, and Interest Rates: Reinterpreting the Time Series Evidence, in: Olivier J. Blanchard and Stanley Fischer, eds., Macroeconomics Annual 1989 (MIT Press, Cambridge) 185-216.

[7] Chouraqui, Jean-Claude, Jones Brian and Robert Bruce Montador, 1986, Public Debt in a Medium-Term Perspective, OECD Economic Studies 7, 103-153.

[8] Frenkel, Jacob A. and Assaf Razin, 1987, Fiscal Policies and the World Economy (MIT Press, Cambridge).

[9] Modigliani, Franco, 1961, Long-Run Implications of Alternative Fiscal Policies and the Burden of the National Debt, Economic Journal 71, 730-755.

[10] Obstfeld, Maurice, 1989, Fiscal Deficits and Relative Prices in a Growing World Economy, Journal of Monetary Economics 23, 461-484.

[11] Persson, Torsten, 1985, Deficits and Intergenerational Welfare in Open Economies, Journal of International Economics 19, 67-84.

[12] Romer, David, 1989, What are the Costs of Excessive Deficits? in: Stanley Fischer, ed., Macroeconomics Annual 1988 (MIT Press, Cambridge) 63-98.

[13] Tobin, James, 1986, The Monetary-Fiscal Mix: Long-Run Implications, American Economic Review 76, Papers and Proceedings, 213-218.

[14] Van De Klundert, Theo and Frederick Van De Ploeg, 1989, Finite Lives in Interdependent Economies with Real and Nominal Wage Rigidity, Oxford Economic Papers 41, 459-489.

[15] Weil, Philippe, 1989, Overlapping Families of Infinitively-Lived Agents, Journal of Public Economics 38, 183-189.

Table 1: Crowding Out in Open Overlapping Generations Economies. The Baseline Case[a]

Variable			Public debt increase in			
			Closed economy	Large open economy		Small open economy
		ISS	FSS	FSS_H	FSS_F	FSS
		(1)	(2)	(3)	(4)	(5)
Public debt[b]		0.50	1.00	1.00	0.50	1.00
Capital stock[b]	+	5.03	4.70	4.87	4.87	5.03
Foreign assets[b]	+	0.00	0.00	−0.29	0.29	−0.57
Financial wealth[b]	=	5.53	5.70	5.58	5.66	5.46
Human wealth[b]	+	10.60	9.97	10.29	10.29	10.60
Tax liability[b]	−	0.38	0.78	0.77	0.38	0.76
Total wealth[b]	=	15.76	14.90	15.10	15.57	15.30
Capital stock crowding out	(ϕ)[c]	—	0.67	0.34	0.34	0.00
Total wealth crowding out	(θ)[d]	—	1.72	1.32	0.38	0.91

[a] Parameter configuration in both countries: intertemporal elasticity of substitution $\beta = 0.40$, time preference rate $\delta = 0.02$, output elasticity of capital $\alpha = 0.30$, rate of technological progress $g = 0.02$.

[b] Expressed in labor efficiency units.

[c] Defined in equation (13).

[d] Defined in equation (14).

Table 2: Crowding Out Effects and Symmetric Parameter Configurations. Sensitivity Analyses

Parameter configuration[a]	ISS	Public debt increase in					
		Closed economy		Large open economy		Small open economy	
	r in %	ϕ	θ	ϕ	θ	ϕ	θ
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\beta = 0.40$, $\delta = 0.02$ $\alpha = 0.30$, $g = 0.02$	$r = 9.68$	0.67	1.72	0.34	1.32	0.00	0.91
$\underline{\beta = 0.20}$, $\delta = 0.02$ $\alpha = 0.30$, $g = 0.02$	$r = 17.99$	0.87	2.70	0.41	1.86	0.00	1.11
$\underline{\beta = 1.20}$, $\delta = 0.02$ $\alpha = 0.30$, $g = 0.02$	$r = 5.18$	0.54	0.78	0.27	0.72	0.00	0.66
$\beta = 0.40$, $\underline{\delta = 0.00}$ $\alpha = 0.30$, $g = 0.02$	$r = 7.88$	0.80	1.90	0.40	1.37	0.00	0.84
$\beta = 0.40$, $\underline{\delta = 0.04}$ $\alpha = 0.30$, $g = 0.02$	$r = 11.69$	0.57	1.53	0.28	1.26	0.00	0.98
$\beta = 0.40$, $\delta = 0.02$ $\underline{\alpha = 0.20}$, $g = 0.02$	$r = 7.88$	0.50	1.68	0.25	1.21	0.00	0.73
$\beta = 0.40$, $\delta = 0.02$ $\underline{\alpha = 0.40}$, $g = 0.02$	$r = 11.46$	0.91	1.90	0.45	1.51	0.00	1.13
$\beta = 0.40$, $\delta = 0.02$ $\alpha = 0.40$, $\underline{g = 0.00}$	$r = 6.05$	1.03	1.90	0.51	1.42	0.00	0.94
$\beta = 0.40$, $\delta = 0.02$ $\alpha = 0.40$, $\underline{g = 0.04}$	$r = 14.47$	0.44	1.42	0.22	1.19	0.00	0.95

[a] Parameters are: β, the intertemporal elasticity of substitution; δ, the time preference rate; α, the output elasticity of capital; g the rate of technological progress. The underlined parameter is varied relative to the baseline case.

Table 3: Crowding Out Effects and Asymmetric Parameter Configurations. Sensitivity Analyses

Parameter configuration[a]	Public debt increase in			
	Home country		Foreign country	
	ϕ	θ	ϕ	θ
	(1)	(2)	(3)	(4)
A. Asymmetric elast. of intertemp. substitution				
Home country $\underline{\beta = 0.20}$, $\delta = 0.02$ $\alpha = 0.30$, $g = 0.02$	0.21	0.82	0.33	0.47
Foreign country $\underline{\beta = 1.20}$, $\delta = 0.02$ $\alpha = 0.30$, $g = 0.02$	0.21	–0.14	0.33	0.80
B. Asymmetric time preference rate				
Home country $\beta = 0.40$, $\underline{\delta = 0.00}$ $\alpha = 0.30$, $g = 0.02$	0.38	1.50	0.30	0.33
Foreign country $\beta = 0.40$, $\underline{\delta = 0.04}$ $\alpha = 0.30$, $g = 0.02$	0.38	0.44	0.30	1.13
C. Asymmetric output elasticity of capital				
Home country $\beta = 0.40$, $\delta = 0.02$ $\underline{\alpha = 0.20}$, $g = 0.02$	0.12	1.15	0.12	0.14
Foreign country $\beta = 0.40$, $\delta = 0.02$ $\underline{\alpha = 0.40}$, $g = 0.02$	0.64	0.57	0.64	1.58

[a] Parameters are: β, the intertemporal elasticity of substitution; δ, the time preference rate; α, the output elasticity of capital; g the rate of technological progress. The underlined parameter is varied relative to the baseline case.

Table 4: Crowding Out Under Different Tax Regimes

Tax regime	Public debt increase in					
	Closed economy		Large open economy		Small open economy	
	ϕ	θ	ϕ	θ	ϕ	θ
	(1)	(2)	(3)	(4)	(5)	(6)
Per capita lump-sum tax	0.67	1.72	0.34	1.32	0.00	0.91
Consumption tax	0.56	1.43	0.29	1.12	0.00	0.80
Wage tax	0.82	2.11	0.41	1.60	0.00	1.10
Capital income tax	1.31	1.34	0.65	0.57	0.00	−0.22