

**ADJUSTING UNSUSTAINABLE BUDGET DEFICITS
AND CROWDING OUT**

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Summary

We use an intertemporal general equilibrium model to study the crowding out effects of tax cuts. In the economy considered, deficits incurred by cutting taxes are unsustainable in the long run but the necessary budget adjustment can be rapid or slow. The model has an overlapping generations structure and is solved numerically for its steady state as well as the transition path between different steady states. We report two main results. First, crowding out due to a tax cut is barely detectable over a medium run of time, say 10 years, but is substantial in the long run for realistic assumptions about the structural parameters of the model economy. Second, slow adjustment of fiscal policy to long run sustainable deficits can aggravate crowding out markedly.

Zusammenfassung

Diese Arbeit untersucht Crowding Out Effekte von Steuersenkungen an Hand eines intertemporalen allgemeinen Gleichgewichtsmodells. Die notwendige Anpassung des Budgetdefizits an ein langfristig finanzierbares Niveau wird über eine Anpassungsregel modelliert. Das Modell nimmt auf der privaten Haushaltsseite überlappende Generationen an und wird numerisch gelöst. Dadurch ist es möglich, sowohl langfristige Gleichgewichte wie den Übergangspfad zwischen diesen Gleichgewichten explizit zu berechnen. Wir kommen zu dem Schluß, daß für realistische Annahmen über die strukturellen Parameter des Modells, Crowding Out Effekte mittelfristig quantitative unbedeutend sind, aber langfristig beachtliche Ausmaße annehmen können. Weiters führt eine verzögerte Anpassung der Budgetpolitik zu einer erheblichen Verstärkung des langfristig auftretenden Crowding Outs.

1. Introduction

Practice and rhetoric of fiscal policy has shifted in the 80ies away from short run stabilization issues. Stress on long run solvency considerations and crowding out as well as concern about the effects of tax structures on resource allocation have substituted for the goal of smoothing the economy's output path via transitory changes in fiscal instruments. Although economic analysis has only recently been endowed with the appropriate instruments to study the issues involved, a substantial amount of literature referenced below has already appeared over the last few years.

How did this reorientation come about? Restricting attention to economic causes, the 80ies have so far seen a continuation of the low growth experience of the 70ies coupled with historically high real interest rates. This combination of events created an environment that left public finances in several countries in patently unsustainable positions if past trends of expenditures (exclusive of interest payments) and revenues would have simply been extrapolated. Another reason for deranged deficits can be found in tax cutting or tax reform activities (sometimes hard to distinguish) unaccompanied by appropriate expenditure cuts because of unrealistic hopes based on the revenue enhancing effects of these activities.

In this paper we analyze through numerical simulations the behavior of the intertemporal equilibrium of an overlapping generations economy with a government facing an unsustainable fiscal position. The unsustainable budget position is due to a transient tax cut financed through public debt accumulation. We introduce a fiscal adjustment rule to account for the real world observation that adjustment to long run sustainable budget positions is in general not achieved immediately. The primary purpose of the paper is to learn something about the crowding out effects of tax cuts, the relationship between the speed of adjustment to long run sustainable deficits and the long run equilibrium of the economy. Further, we inquire into the sensitivity of answers to these questions to changes in structural parameter configurations of our model economy.

Modigliani (1961) contains a perceptive early discussion of long run crowding out through public debt accumulation with conclusions similar as drawn in this paper. The methodology of solving numerically general equilibrium models to analyze fiscal policy issues was pioneered by Auerbach and Kotlikoff (1983, 1987). Other work along these lines dealing with liquidity constraints and social security issues was published by Hubbard and Judd (1986, 1987) among others. Frenkel and Razin (1987, chapters 10-13) use simple open economy versions of an overlapping generations framework to study fiscal policy issues analytically. Our work is most closely related to chapter 6 of the book by Auerbach and Kotlikoff (1987). They study the crowding out effects of tax cuts reaching the conclusion that these effects can be large for moderate tax cuts in the long run. We extend their work by introducing the possibility of rapid versus slow adjustment to the long run sustainable budget deficit whereas Auerbach and Kotlikoff assume instantaneous adjustment after the tax cut is phased out. Further, we present a couple of sensitivity exercises shedding light on the robustness of conclusions with respect to changes in structural parameters.

We conclude the introduction by noting three noteworthy features of our approach beforehand.

First, the model is a dynamic general equilibrium model based on explicit specifications of preferences, technology, endowments and rules of the game. Hence, interpretations of policy experiments will not suffer from the fundamental objections raised by the Lucas critique. Furthermore, the analyses will not have the partial equilibrium character of work based solely on the mechanics of the government budget constraint (e.g. Blanchard (1984), section 2).

Second, the model is silent on the role of fiscal policy as an instrument to dampen business cycle fluctuations. The model abstracts from "Keynesian problems" and the economy is always on its supply-side determined "natural output" path. We think that this abstraction is justified given our question. Fiscal policy typically gets into unsustainable budget positions not by reacting

to short run deviations of the economy from its "natural output" path by incurring transitory deficits but by running deficits unrelated to business cycle fluctuations.

Third, the model assumes that Ricardian equivalence does not hold. According to this doctrine, private agents will compensate changes in fiscal deficits (=public savings) unrelated to public expenditures by changing private savings leaving the real equilibrium of the economy unaffected by the fiscal policy action. The critical assumptions generating this result are the absence of distortionary taxes and that private agents effectively have an infinite planning horizon (see the survey by Leidermann and Blejer (1988)). It is a well known feature of overlapping generation models without bequest motive, however, that Ricardian equivalence will not hold because of the finite horizons of private agents (see Diamond (1965)). In a famous paper, Barro (1974) has argued that operative intergenerational linkages between generations through bequests will reestablish Ricardian equivalence in overlapping generations models as a first order approximation. From the accumulated evidence on this question it is probably fair to conclude that the argument by Barro is of theoretical interest only (see e.g. the survey by Bernheim (1987)).

We proceed as follows: In the next section we present the structure of the model. Section three presents the numerical simulations and discusses the findings. The last section summarizes and proposes possible extensions.

2. The Model

The household sector is modeled along the lines of the life-cycle theory pioneered by Modigliani and Brumberg (1979). In every time period, the household sector consists of 55 overlapping generations $i = 1, \dots, 55$, living for 55 periods each. Households supply labor inelastically during their working life, demand consumption goods and save for their retirement. Consider generation $i=1$ at time $t=1$. Labor supply of this generation is given by

$$L_1^S(t) = \begin{cases} 2 & \text{for } 1 \leq t \leq 45 \\ 0 & \text{for } 45 < t \leq 55. \end{cases} \quad (1)$$

Lower indexes denote the generation in the following. Aggregate labor supply is therefore inelastically given by

$$L^S(t) = \sum_{i=1}^{55} L_i^S(t) = 90. \quad (2)$$

Consumption of generation 1 at $t=1$ is determined through maximizing the utility function

$$U(C_1(1), \dots, C_1(55)) = \sum_{t=1}^{55} \frac{C_1(t)^{(1-1/\Gamma)}}{(1-1/\Gamma)} \cdot \frac{1}{(1+\delta)^{(t-1)}} \quad (3)$$

subject to the intertemporal budget constraint

$$\sum_{t=1}^{55} \frac{(1-\tau_t) \cdot w(t) \cdot L_1(t)}{\pi^t (1+r(s))} = \sum_{t=1}^{55} \frac{C_1(t)}{\pi^t (1+r(s))} \quad (4)$$

Symbols denote: $r(t)$ after-tax real interest rate; $w(t)$ gross real wage rate; $\tau(t)$ proportional income tax rate; $C_1(t)$ consumption of

generation 1 at time t ; δ constant rate of time preference; Γ utility function parameter equal to the intertemporal elasticity of substitution.¹

Setting up the Lagrangean for maximizing (3) subject to the constraint (4), one can derive from the first order conditions

$$C_1(t) = \left[\frac{1+r(t)}{1+\delta} \right]^\Gamma C_1(t-1). \quad (5)$$

Repeated use of equation (5) for substituting out the $C_1(t)$ for $t \geq 2$ in the intertemporal budget constraint (4) and rearranging gives "the consumption function" for generation 1 at $t=1$

$$C_1(1) = \Omega_1(1) HW_1(1) \quad (6)$$

where

$$HW_1(1) = \frac{\sum_{t=1}^{\infty} (1-\tau_t) \cdot w(t) L_1(t)}{\sum_{s=2}^{\infty} \pi^s (1+r_s)} \quad \text{and} \quad (7)$$

$$\Omega_1(1) = \left\{ \sum_{t=1}^{\infty} [(1+\delta)^{(1-t)\Gamma} \cdot \sum_{s=2}^{\infty} \pi^s (1+r_s)^{(\Gamma-1)}] \right\}^{-1}$$

Savings of generation 1 in each time period t are defined by

$$S_1(t) = (1-\tau(t))w(t)L_1(t) + r(t)A_1(t) - C_1(t) \quad (8)$$

¹ The intertemporal elasticity of substitution (σ_C) is defined

$$\sigma_C = \frac{d \ln [C(t+1)/C(t)]}{d \ln [U'(C(t+1))/U'(C(t))]}$$

For the utility function employed in (3), $\sigma_C = \Gamma$.

where $A_1(t)$ denotes accumulated savings or the stock of real assets of generation 1 at the beginning of period t . Real assets will therefore develop according to

$$A_1(t+1) = A_1(t)(1+r(t)) + (1-\tau(t))w(t)L_1(t) - C_1(t) \quad (9)$$

with initial and end conditions $A_1(1) = 0$ and $A_1(56) = 0$.

Similar expressions for consumption and asset accumulation can be derived for the other generations $i = 2, \dots, 55$. Aggregating over the generations we have aggregate consumption and aggregate assets supplied at $t = 1$

$$C(1) = \sum_{i=1}^{55} C_i(1) \quad \text{and} \quad A(1) = \sum_{i=1}^{55} A_i(1). \quad (10)$$

We comment on two features of the household sector set-up.

First, the specification of labor supply assumes an inelastic labor supply and generates presumably an unrealistic age-earnings profile over an individual life cycle. These simplifications could be removed at the cost of introducing a few additional parameters. We think, however, that assuming labor supply to be inelastic in the long run and further assuming that liquidity constraints are not an important aspect of household behavior are defensible for long run economic analysis.²

Second, we assume a zero bequest economy and savings are therefore motivated exclusively by consumption smoothing over the life cycle. Intended or non-intended bequests could, however, be an important separate source of savings.³ We plan to pursue this objection in further work.

² See, however, the analysis by Judd and Hubbard (1986) and Mariger (1987) stressing the prevalence of liquidity constraints.

³ Kotlikoff and Summers (1981) find that the pure life cycle motive can not account for the size of aggregate savings in the USA.

2.2 Firm Behavior

The economy is a one-good economy and the single good is produced via a Cobb-Douglas technology

$$Y(t) = K(t)^\alpha [L(t)(1+g)^{t-1}]^{1-\alpha}. \quad (11)$$

where $Y(t)$ is output, $K(t)$ the capital stock and g an exogenously given rate of technical progress (Harrod neutral technical progress). Profit maximization for given factor and output prices gives demand functions for labor and capital

$$w(t) = K(t)^\alpha (1-\alpha) [L(t)(1+g(t))^{t-1}]^{-\alpha} (1+g(t))^{t-1} \quad (12)$$

$$r^*(t) = \alpha K(t)^{\alpha-1} [L(t)(1+g(t))^{t-1}]^{1-\alpha} \quad (13)$$

The marginal products of labor and capital are set equal to the gross real wage and the pre-tax interest rate $r^*(t)$. The after-tax and pre-tax interest rate are linked via

$$r(t) = (1-\tau(t))r^*(t), \quad (14)$$

i.e. we assume that capital and labor are taxed at the same proportional rate $\tau(t)$. Finally, investment in new capital is denoted by $I(t)$ and the capital stock develops according to

$$K(t) = I(t) + K(t-1) \quad (15)$$

We assume that capital does not depreciate.

The modeling of firm behavior is intentionally kept simple. More complicated technologies (e.g. CES-technology) or more complicated capital demand rules (e.g. Tobin's q-theory) could be implemented.

These extensions would, however, inflate the number of parameters considerably but presumably add nothing important given the problem we want to study.

2.3. Government Behavior

Government behavior is described by three variables: the real public debt, $D(t)$, real government expenditures, $G(t)$, and the general income tax rate $\tau(t)$. Due to the period-to-period government budget constraint

$$D(t+1) = (1+r(t))D(t) + G(t) - \tau(t)Y(t) \quad (16)$$

with $D(1)$ given, only two of the three fiscal policy variables can be set exogenously in any time period. We will always assume that government expenditures $G(t)$ are fixed at a constant $G^*(1)$ in period 1 and grow with the rate $(1+g)$ equal to the rate of technical progress. As the government is assumed to live forever we have to make sure that in long run equilibrium the tax rate is set in a way to prevent explosive growth of the public debt in case $(1+r(t)) \geq (1+g)$ (a case always obtaining in our simulations). Dividing equation (16) through $Y(t+1) = (1+g)Y(t)$ and abbreviating $[G^*(1)/Y(1)]$ by G^* we have

$$d(t+1) = [(1+r(t))/(1+g)]d(t) + G^*/(1+g) - \tau(t)/(1+g). \quad (17)$$

where $d(t)$ is the debt-income ratio $D(t)/Y(t)$. In steady state (SS), output, capital and labor in efficiency units are constant or grow at the rate $(1+g)$ and the income tax rate τ must be set so that the debt-income ratio is constant

$$\tau_{(SS)} = (r_{(SS)} - g)d_{(SS)} + G^* \quad (18)$$

Or reformulated, the budget surplus ratio (inclusive of interest payments) (v), defined via the first equality in the next equation, in the long run must be equal to

$$v(ss) = \tau(ss) - G^* - r(ss)d(ss) = -g \cdot d(ss). \quad (19)$$

2.4. Market Clearing Conditions and Equilibrium

Market clearing requires that the following three equations hold for each t

$$\sum_{i=1}^{55} L_i(t) = L(t) \quad \text{----> Labor market} \quad (20)$$

$$\sum_{i=1}^{55} A_i(t) = D(t) + K(t) \quad \text{----> Capital market} \quad (21)$$

$$Y(t) = \sum_{i=1}^{55} C_i(t) + G(t) + I(t) \quad \text{----> Goods market.} \quad (22)$$

An equilibrium for this economy consists of infinite sequences for all variables in the model fulfilling the following conditions:

(I) For correctly anticipated paths of $r(t)$ and $w(t)$, consumption and asset paths for all generations as well as investment and labor demand paths for all firms must solve the relevant optimization problems.

(II) Market clearing conditions (20)-(22) must hold at each (t).

(III) The intertemporal government budget constraint obtainable from (16) by solving recursively forward for D_t must be consistent with an appropriate transversality condition for $t \rightarrow \infty$.

In summary, we use the concept of a perfect foresight general equilibrium for solving the model. In the long run or steady state equilibrium the economy will exhibit balanced growth at the rate g .

3. Simulations Results

3.1. Parametrization and Computation

To solve the model numerically, values for the parameters and the exogenous variables have to be assigned (parametrization).⁴ We have kept the number of structural parameters⁵ low to make the working of the model as transparent as possible. Given a set of values for the parameters and the exogenous variables, the model can be solved numerically for its initial steady state (ISS) using the concept of a perfect foresight equilibrium.⁶ Implementation of fiscal policy changes of the type considered in this paper requires that the model is solved simultaneously for its final steady state (FSS) as well as the transition path between the steady states. The reason for this complication relates to the fact that the final steady state depends on the amount of public debt accumulated during the transition. We chose a length of 100 periods for the transition path although convergence to the the new steady state is quite close in most simulations after 50 periods.⁷

4 This step bears a close resemblance to work on "real business cycles" where numerical values for parameters based on empirical evidence are also imposed (see the survey by McCallum (1987)).

5 We use the word "structural" in the meaning "invariant with respect to changes in the policy regime" and not in the sense "motivated by an explicit economic theory".

6 The statistical software package GAUSS was used for programming and simulating the model. The version of the model used in this paper can easily be run on a PC equipped with a math coprocessor and a minimum of 256K RAM. The model is available from the authors upon remittance of a floppy disk.

7 For a more detailed description of the solution methodology see Auerbach and Kotlikoff (1987, pp. 46-50). Additionally, Auerbach and Kotlikoff discuss briefly the intricate problem of non-uniqueness of transition paths in overlapping generations models. From the examples in Sargent (1987, chapter 7) it appears that non-uniqueness is prevalent in overlapping generation economies with positively valued fiat money and/or economies with interest rates below growth rates. Both aspects are absent in our model. Furthermore, similar to Auerbach and Kotlikoff (1987, p.49) we have found that steady states and transition paths do not depend on initial guesses. This assurance is, however, probably small consolation for the theoretical purist.

Table 1 contains alternative parametrizations for calculating the initial steady state of the model. Column (1) displays the configuration for the base simulation. The intertemporal elasticity of substitution (Γ) is assigned a value of .4. Sensitivity analysis will reveal that the size of this parameter is of major importance for the extent of crowding out. Recent empirical analysis of private consumption behavior has unfortunately produced estimates of Γ ranging from near 0 (Hall (1988)) to 1 or above (Mankiw, Rotemberg and Summers (1985) and Kugler (1988)). Superficial examination of the data generated so far by the 80ies does not suggest, however, that private savings increase significantly in response to higher real interest rates. A value of .4 might therefore be an upper boundary of what can be assumed realistically. There is scant evidence on the rate of time preference. We have set it in all simulations to .01. Increases in time preference have similar effects on the initial steady state of the model as decreases of the intertemporal elasticity of substitution. The capital share is a not so controversial parameter and was fixed at .3. The rate of Harrod neutral technical progress is set to 2 % in the base simulations. The fiscal policy variables in the initial steady state were set to make the public expenditure-income ratio and the debt-income ratio equal to approximately 15 %.

Table 1: Parametrization of Model

Parameter/Exogenous Variable	Base Simulation	Sensitivity Analysis			
	(1)	(2)	(3)	(4)	(5)
Intertemporal Elasticity of Substitution (Γ)	.4	<u>1.25</u>	<u>.2</u>	.4	.4
Rate of Time Preference (δ)	.01	.01	.01	.01	.01
Capital Share (α)	.3	.3	.3	.3	.3
Technological Progress (g)	.02	.02	.02	<u>.00</u>	<u>.04</u>
Public Expenditures ($G^*(1)$)	20	20	20	20	20
Public Debt ($D(1)$)	20	20	20	20	20

Notes: This table reports the numerical values assigned to parameters and exogenous variables. Column (1) contains the configuration for the base simulation. Columns (2) through (5) contain alternative configurations employed for sensitivity analysis.

3.2. Description of the Fiscal Experiment

We consider the following fiscal experiment: Let the economy start from an ISS. The income tax rate in the ISS is determined endogenously by the long run requirement of a constant debt-income ratio. From period 1 on we introduce a new fiscal regime. The income tax rate is cut by 20 % relative to its value in the ISS for 10 periods, i.e.

$$\tau(t) = .8\tau(\text{ISS}) \quad \text{for } 1 \leq t \leq 10. \quad (23)$$

During periods 1 to 10, the income tax rate is therefore exogenous and public debt is determined endogenously via the government budget identity (16). The income tax cut is not sustainable in the long run. From period 11 onwards, we enter the era of budget consolidation. We assume that the budget surplus ratio ($v(t)$) is adjusted according to the rule

$$v(t) = v(t-1) + \beta[v^* - v(t-1)] \quad \text{for } 11 \leq t \text{ and } 0 < \beta \leq 1. \quad (24)$$

The budget adjustment rule (24) says that the budget surplus ratio (which is negative in case of a deficit) from time period 11 on is set equal to its value in the previous period plus part of the difference between a long run target surplus ratio (v^*) and the value of v in the previous period. The target ratio v^* is assumed to be given by $v^* = -g.d(11)$, i.e. as the negative of the product between the long run growth rate g and the debt-income ratio in period 11.

To mimic different adjustment regimes, the adjustment parameter β will take values 1, .5 and .05 in each simulation. A value of 1 corresponds to the notion of "instantaneous adjustment" to the long run target ratio. An adjustment speed of .5 should be classified as "quick adjustment" as already 50 % of the difference between the long run target surplus ratio and the value of the surplus ratio in period 10 is eliminated in period 11. Obviously, the value of .05 for β implies a very slow adjustment speed with

adjustment spread out over many years. Too low an adjustment speed can turn out to be unstable in the sense that the economy does not converge to a new steady state.⁸ Notice that a fiscal regime in the context of a general equilibrium model with perfect foresight consists of a description of the full path.

3.3. Simulation Results

Table 2 contains the results of model simulations using the base parametrization for parameters and exogenous variables given in column (1) of table 1. The initial steady state values of a selected set of variables is displayed in column (1) of table 2. The values of the capital-labor ratio and the capital-output ratio appear to be reasonable compared to real world observations. The saving ratio is probably too low indicating that the pure life cycle theory of saving can not account for the size of actual saving ratios for the assumed parametrizations. The values of the debt-income ratio and the budget surplus ratio are conditional on the assumed starting values for government expenditures and public debt. Notice that the steady state budget surplus ratio is negative for positive growth rates and is equal to the value given by equation (19).

Turning to the results in table 2, two implications stand out.

First, in column (2) we have listed the equilibrium values for the selected set of variables in period 10 on the transition path to the final steady state for an adjustment speed of $\beta=1$.⁹ Period 10 is the period immediately before budget consolidation starts. We see from the figures in column (2) that crowding out is barely

⁸ In small analytical models it is possible to calculate explicitly a critical adjustment speed β^* that just preserves stability (see Amann and Jaeger (1988)). In numerical models a search over β could in principle provide the same information.

⁹ Due to the perfect foresight assumption, the equilibrium values for period 10 will be different for different adjustment speeds β . Practically, the differences are not too big and the values in column (2) of tables 2-4 can be taken as representative for 10th period equilibrium for the other two adjustment speeds as well.

detectable up to this time period although the budget surplus ratio has deteriorated markedly and the debt-income ratio has risen substantially.

Second, crowding out is substantial when we reach the final steady state and varies significantly between rapid adjustment scenarios (β is 1 or .5) and the slow adjustment scenario (β is .05). The drop in the capital-labor ratio ranges from 14.6 % ($\beta=1$) to 29.2 % ($\beta=.05$).

The disparity between "medium run" and "long run" crowding out effects present in the base simulation is a theme recurring in most of the other simulations. The logic of life cycle behavior accounts for this disparity.¹⁰ The additional income from the 20 % income tax cut is spread by households over the whole life cycle and is therefore not consumed immediately in the years it takes place. This effect prevents the national saving rate from dropping dramatically in response to the tax cut.¹¹ There is also a substitution effect working in this direction because of higher interest rates. After taxes are increased starting in period 11, the crowding out process will receive momentum as households in the later stage of their life cycle will at least partially escape the tax increases and will additionally enjoy living in an economy with higher interest rates. Younger households, on the other hand, will have to pay the higher tax rates part of which are needed to service the "unproductive" public debt.

The results in table 2 also highlight the problem of spreading adjustment of unsustainable deficits over many years as is the case for setting $\beta = .05$. Crowding out effects roughly double for the relevant ratios compared to rapid adjustment scenarios leaving generations living in the new steady state with capital-labor ratios of 30 % below those in the initial steady state.¹²

10 The following observations have also been made by Auerbach and Kotlikoff (1987, p. 93).

11 Note that "Ricardian behavior" would imply an increase in private household's saving rates so as to leave the national saving rate unaffected by the tax cut.

12 An explicit welfare analysis could evaluate the different welfare levels generations enjoy in the ISS and the FSS.

We turn now to the results of the sensitivity analysis. Table 3 displays results for two different assumptions about the intertemporal elasticity of substitution. The assumed value of 1.25 for Γ in panel (I) of table 3 is admittedly high but serves well in illustrating the importance of reliable knowledge about the size of this parameter. The results in panel (I) show that a very high intertemporal elasticity of substitution makes tax cutting experiments almost inconsequential as far as crowding out is concerned. The reason for this result is not hard to pinpoint as a high Γ implies that small variations in the interest rate suffice to induce a substantial increase in the supply of savings.

A different picture emerges in panel (II) where the intertemporal elasticity of substitution has been set as low as .2. Although the two ISS capital-ratios appear to be unrealistically low under this assumption (the opposite is the case in panel (I)), the qualitative conclusion that fiscal experiments of the sort considered in this paper produce heavy crowding out. For the immediate adjustment rule ($\beta=1$), the economy settles down in a FSS with a 77.8 % reduction in the capital-labor ratio. Slower adjustment speeds are found to be unstable. We conclude that the size of the intertemporal elasticity of substitution parameter is of crucial importance for the extent of crowding out and that realistic values of this parameter are consistent with substantial crowding out.

In table 4, we have inquired into the sensitivity of results for changes in the rate of technical progress. The figures in panel (I) of table 4 correspond to a zero growth economy. Notice that the saving ratio and the budget surplus ratio have to be zero in steady state for the zero-growth assumption. Panel (II) assumes a rather high rate of technical progress of 4 %. The crowding out effects under the different adjustment regimes in percentages of the ISS capital-labor ratio are remarkably similar across the two panels of table 4 as well as compared to the base simulation in table 2. Not too important differences are that crowding out in the zero growth economy for the instantaneous adjustment case is less than in the other cases and that the rapid growth economy can afford a relatively lower budget surplus ratio in the FSS. We

conclude that different assumptions about the rate of technical progress do not affect the results of the base simulation in an important way.

Table 2: Results of Base Simulation

Variable	ISS	Equilibrium (Period 10)	Final Steady State (FSS)		
	(1)		(2)	$\beta=1$ (3)	$\beta=.5$ (4)
Capital-Labor Ratio (K/L)	4.8	4.7	4.1	4.0	3.4
Capital-Output Ratio (K/Y)	3.0	2.9	2.7	2.7	2.4
National Saving Rate (S/Y)	6.0 %	4.5 %	5.4 %	5.4 %	5.5%
Debt-Income Ratio (D/Y)	13.9 %	49.7 %	55.8 %	56.8 %	85.2%
Budget Surplus Ratio (V/Y)	-.3 %	-6.6 %	-1.1 %	-1.1 %	-1.1%
Income Tax Rate (τ)	14.8 %	11.9 %	18.6 %	18.7 %	22.1%
Real Interest Rate (r)	8.6 %	9.0 %	9.1 %	9.2 %	9.9%

Notes: This table contains in column (1) the ISS for the base parametrization of the model given in column (1) of table 1. Column (2) displays the equilibrium in period 10 of the transition path to the FSS for an adjustment speed of $\beta=1$ (see text). Columns (3) to (5) display FSS values of the selected variables for different values of the adjustment speed β .

Table 3: Results of Sensitivity Analysis; Changing the Intertemporal Elasticity of Substitution (Γ)

(I) Intertemporal Elasticity of Substitution = 1.25.

Variable	ISS	Equilibrium (Period 10)	Final Steady State (FSS)		
	(1)	(2)	$\beta=1$ (3)	$\beta=.5$ (4)	$\beta=.05$ (5)
Capital-Labor Ratio (K/L)	13.5	13.4	13.1	13.1	12.8
Capital-Output Ratio (K/Y)	6.2	6.2	6.1	6.0	5.9
National Saving Rate (S/Y)	12.4 %	11.6 %	12.1 %	12.1 %	12.2%
Debt-Income Ratio (D/Y)	10.2 %	30.6 %	32.2 %	33.7 %	46.0%
Budget Surplus Ratio (V/Y)	-.2 %	-3.2 %	-.7 %	-.7 %	-.7 %
Income Tax Rate (τ)	10.8 %	8.3 %	11.1 %	11.1 %	11.5%
Real Interest Rate (r)	4.3 %	4.5 %	4.4 %	4.4 %	4.5%

(II) Intertemporal Elasticity of Substitution = .20.

Variable	ISS	Equilibrium (Period 10)	Final Steady State (FSS)		
	(1)	(2)	$\beta=1$ (3)	$\beta=.5$ (4)	$\beta=.05$ (5)
Capital-Labor Ratio (K/L)	1.8	1.6	.4		
Capital-Output Ratio (K/Y)	1.5	1.4	.5		
National Saving Rate (S/Y)	3.0 %	.2 %	0 %		
Debt-Income Ratio (D/Y)	18.7 %	95.0 %	140.7 %	Unstable	
Budget Surplus Ratio (V/Y)	-.4 %	-18.8 %	-2.3 %		
Income Tax Rate (τ)	21.3 %	17.0 %	61.3 %		
Real Interest Rate (r)	15.8 %	17.6 %	24.0 %		

Notes: This table contains in column (1) of panel (I) the ISS for the parametrization of the model given in column (2) of table 1. Column (1) of panel (II) gives the ISS for the parametrization in column (3) of table 1. Columns (3) to (5) display FSS values of the selected variables for different values of the adjustment speed β .

Table 4: Results of Sensitivity Analysis; Changing Technical Progress (g)

(I) Rate of Technical Progress = .00

Variable	ISS	Equilibrium (Period 10)	Final Steady State (FSS)		
	(1)		(2)	$\beta=1$ (3)	$\beta=.5$ (4)
Capital-Labor Ratio (K/L)	9.8	9.7	9.0	8.8	6.9
Capital-Output Ratio (K/Y)	5.0	4.9	4.7	4.6	3.9
National Saving Rate (S/Y)	0 %	-1.1 %	0 %	0 %	0 %
Debt-Income Ratio (D/Y)	11.2 %	38.2 %	43.2 %	47.4 %	127.0%
Budget Surplus Ratio (V/Y)	0 %	-3.9 %	0 %	0 %	0 %
Income Tax Rate (τ)	11.8	9.4 %	13.9 %	14.2 %	20.3%
Real Interest Rate (r)	5.4 %	5.5 %	5.6 %	5.6 %	6.2%

(II) Rate of Technical progress = .04

Variable	ISS	Equilibrium (Period 10)	Final Steady State (FSS)		
	(1)		(2)	$\beta=1$ (3)	$\beta=.5$ (4)
Capital-Labor Ratio (K/L)	2.5	2.4	1.9	1.8	1.6
Capital-Output Ratio (K/Y)	1.9	1.8	1.5	1.5	1.4
National Saving Rate (S/Y)	7.5 %	5.4 %	6.2 %	6.2 %	6.7 %
Debt-Income Ratio (D/Y)	17.0 %	66.7 %	76.1 %	76.2 %	88.5 %
Budget Surplus Ratio (V/Y)	-.6 %	-11.7 %	-3.0 %	-3.0 %	-3.0 %
Income Tax Rate (τ)	18.5 %	14.8 %	26.4 %	26.4 %	29.8 %
Real Interest Rate (r)	13.0 %	14.0 %	14.4 %	14.4 %	15.6 %

Notes: The ISS in panel (I) is based on the parametrization of column (4) of table 1. Column (1) of panel (II) gives the ISS for the parametrization in column (5) of table 1. Columns (3) to (5) display FSS values of the selected variables for different values of the adjustment speed β .

4. Conclusion

Most of the model exercises in this paper appear to support the widespread concern about the long run effects of fiscal policy. Crowding out due to unsustainable tax cuts is a slow process spread out over many years and can be intensified considerably if adjustment to sustainable budget positions is slow. To repeat, these conclusions do not obviate the possibility that fiscal policy is a useful tool for smoothing short run variations in real variables due to the business cycle. A considerable part of the fiscal action observed in several industrial countries over the last 15 years had, however, only remote connection to this goal.

There are two implications for empirical analysis to be drawn: The first implication relates to empirical tests for crowding out. If the model results are representative for actual crowding out processes, tests relying on typical sample lengths will have an obvious information problem. Due to the slow working of the crowding out process, the data will not be very informative even if a substantial amount of fiscal action occurred during the period of observation. A second point relates to the critical importance of empirical knowledge about the intertemporal elasticity of substitution. Given the variations in the real rate of interest in the 70ies (when they were low) and 80ies (when they were high), more reliable estimates of this parameters should become available.

The work presented in this paper could be extended in various directions. Growth rate shocks or public expenditure shocks present alternative possibilities to model the transition to unsustainable budget positions. Tinkering with public expenditures, however, is problematic if public expenditures do not appear in the utility functions of private households. Extending the model to an open economy framework would make possible the investigation of real interest rate shocks. The inclusion of liquidity constraints could aggravate the crowding out processes observed in our model markedly whereas taking account of bequests would probably work in the opposite direction.

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