Fiscal policy and economic growth: the role of financial intermediation.*

Gilles Saint-Paul
GREMAQ-IDEI, Université des Sciences Sociales de Toulouse
Universitat Pompeu Fabra
CEPR and IZA

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ABSTRACT

This paper analyzes the impact of public debt on financial efficiency in an overlapping generations model. We argue that public debt may reduce intermediation costs by increasing the collateral of entrepreneurs. This effect is stronger, the stronger the non-Ricardian component of public debt, i.e. the more it is associated with intergenerational redistribution. This effect can be interpreted as future generations acting as a guarantee for the loans provided to the entrepreneurs of the current generation. Furthermore, multiple growth paths may arise as low taxes increase private collateral, which in turn boosts growth via financial efficiency, while higher growth allows to maintain the same debt/GDP ratio with reduced taxes.

JEL:E6, G2, H3, H6

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1 Introduction

The standard view about public debt is that it is harmful for growth because it crowds out private capital accumulation. However, there are some historical episodes that suggest that it can have positive side-effects on growth. For example, the Treasury's large amount of debt played a crucial role in the establishment of the Bank of England in the late seventeenth century and the subsequent "Financial Revolution" (See Kindleberger (1984)).

This suggests that government debt, while deterring capital accumulation, may at the same time positively affect the *efficiency* of capital because it affects the efficiency of the financial sector.

In previous work (Saint-Paul, 1996), we have shown that if there is learning by doing in the sector of financial services, and if knowledge acquired in trading public debt is transferable to other activities, then a higher debt/gdp ratio may positively affect growth because it will increase the pace of knowledge accumulation in the financial sector. Here we look at another channel, namely the fact that by increasing private wealth, public debt may make it easier for entrepreneurs and firms to borrow because it will be used as collateral.

We make this point in the context of an overlapping generations (OLG) model (Diamond, 1965) where financial contracts involve costly state verification, so that collateral reduces the severity of the financial problem by lowering the amount of resources spent on monitoring (As in the papers by Bernanke and Gertler (1989), Kiyotaki and Moore (1997), Williamson (1986), etc.)

Our work is related to several strands of literature. The role of balance sheet in the access to credit, which is related to the traditional "debt/deflation" and "credit crunch" arguments about recessions, have been emphasized by

Holmstrom and Tirole (1996), Fuerst (1991). That redistribution from unconstrained agents to constrained agents increases the level of investment and therefore economic activity is analyzed in Banerjee and Newman (1991,1993), Aghion and Bolton (1997), and, in the context of firms and the business cycle, Bachetta and Caminal (1996). Here the focus is on the role of fiscal policy, mostly in its intergenerational dimension, for the efficiency of the financial sector. This paper is to my knowledge the first one to use the costly monitoring framework to analyze the effect of fiscal policy on growth through the efficiency of the financial sector. Aiyagari and McGrattan (1998) also find that debt may be beneficial because it enhances financial markets, but their mechanism is totally different. They argue that it provides an additional instrument for market participants to smooth consumption.[1]

Our results are as follows. First, the magnitude of the collateral effect is directly related to the magnitude of the failure of Ricardian Equivalence; that is the extent to which public debt is considered as net wealth by private agents. Second, that effect declines as debt increases, because as it does so does private wealth, which reduces the severity of the monitoring problem. This in turn reduces the marginal effect of public debt on financial efficiency. Thus, if we look at the net effect of debt on output, it is the net of two contributions: on the one hand there is the direct reduction in capital accumulation, on the other hand this capital is better allocated as less resources are spent on monitoring. There may be a zone where the latter effect dominates; over that zone public debt is favourable for growth. However at high levels of debt the first effect is bound to dominate. Third, in balanced growth paths there exists a "fiscal/financial" accelerator: faster growth eases the tax burden required to maintain a constant debt/gdp ratio,

[1] One differential implication is that here public debt may increase measured total factor productivity at the aggregate level, which is not the case in their model.

which in turns increases the collateral of entrepreneur, thus improving the financial sector and further increasing growth. This may potentially generate multiple equilibrium growth paths.

Finally, we provide empirical evidence that supports the idea that controlling for capital accumulation, budget deficits increase the efficiency of capital.

2 The structure of the model

2.1 Basic setting

Figure 1 describes the basic structure of the model. Agents live for two periods. Each period t is divided into two subperiods, t^- and t^+. There are two goods, indexed by 1 and 2. Good 1 is produced and consumed in the second subperiod, while good 2 is produced and consumed in the first subperiod. The size of each generation is normalized to 1. Total population is therefore equal to 2.

The lifetime of a generation born at t evolves as follows.

At t^- agents are born.

At t^+ they are endowed with an amount ϕY_t of good 1, where Y_t is the aggregate output of good 1 produced by the previous generation (born at $(t-1)^-$) at time t. This assumption may be viewed as a short-cut for agents working in the first period of their life, in which case their salary will depend on the amount of capital accumulated by the previous generation. Agents use their endowment of good 1 to consume and to save. There are two assets: physical capital and public debt. Savings is allocated between public debt D_t and physical capital K_t.

We think of agents as actually owning the physical stock of capital, while public debt are paper claims promising to pay a given amount of good 1 at $(t+1)^+$.

At $(t+1)^-$ Z_{t+1} units of good 2 are generated. The production function for good 2 is linear in the capital stock:

$$Z_{t+1} = AK_t \tag{1}$$

This linearity assumption allows for endogenous growth, and greatly simplifies the solving of the model. The model could obviously be rewritten with a more traditional production function.

All of good 2 is given to generation t as payment for their accumulation of capital. Therefore the return to capital in terms of good 2 is equal to A. Each member of this generation therefore owns Z_{t+1} units of good 2 at $(t+1)^-$.

However, people only consume in the second sub-period. The technology that transforms good 2 into good 1 between the first and the second sub-periods involves risky projects. Any member of generation t can engage into at most one project. We shall call those who do so "entrepreneurs". Note that we impose that entrepreneurship takes place in the second period of life. We discuss how robust the results are to that assumption below.

A project uses xZ_{t+1} units of good 2. Agents cannot use their own endowment of good 2 for their own project.[2]Nor can they use their holdings of public debt, which can only be liquidated in the second sub-period. All entrepreneurs must therefore borrow the full amount xZ_{t+1} of their investment from other members of the same generation. These loans transit via financial

[2]This is an "incest prohibition" assumption identical to the one made in Diamond (1981). It is made here for simplicity, although it is necessary in the special case where $x = 1$. Otherwise entrepreneurs would not need to use financial markets in order to finance their projects.

intermediaries, who also perform the task of monitoring them.[3] We assume $x \geq 1$, so that in general not every member of generation t can engage into a project in equilibrium, except in the special case where $x = 1$.

Projects are risky. With probability $1 - \varepsilon$ they yield RxZ_{t+1} units of good 1 at $(t+1)^+$ (that is, their gross rate of return if successful is R). With probability ε they yield 0 units of good 1. Returns are uncorrelated across projects, and a continuum of projects are undertaken, so that the aggregate return to projects is safe, unlike the individual return.

All individuals lend their endowment of good 2 to those financial intermediaries, who give them a safe return equal to $1 + \rho_{t+1}$ units of good 1 at $(t+1)^+$ per unit of good 2 lent at $(t+1)^-$.

At $(t+1)^+$ financial intermediaries must spend an amount M_{t+1} of good 1 in monitoring activity in order to collect repayment on their loans. This amount will be determined endogenously below. Because of monitoring costs, competitive intermediaries charge an intermediation margin, defined as the gap between average repayments by the borrower and payments to the lender, per unit of good 2 lent. The lower M_{t+1} relative to the amount lent, the lower the intermediation margin and the more efficient the financial sector.

In equilibrium all of good 2 must be invested into projects, since good 2 has no alternative use. Hence the proportion of individuals who undertake projects is:

$$n = 1/x$$

The aggregate amount of good 1 produced by generation t at $(t+1)^+$ is thus:

$$Y_{t+1} = RZ_{t+1}(1 - \varepsilon) - M_{t+1} \tag{2}$$

[3]The literature has shown that such intermediaries will endogenously arise in order to solve the free rider problem associated with monitoring. See Williamson (1986).

Finally, at $(t+1)^+$ members of generation t consume the return on their savings and/or project. The resource constraint of the economy at $(t+1)^+$ is thus

$$Y_{t+1}(1+\phi) = K_{t+1} + C_{t+1}^y + C_{t+1}^o + G_{t+1},$$

where C_{t+1}^o is the old's consumption, C_{t+1}^y the young's consumption, and G_{t+1} is government expenditure, which, for simplicity, is assumed exogenous and does not enter the utility function.

2.2 Preferences

The preferences of an agent born at t are of the non-expected utility (Kreps and Porteus, 1978, Weil, 1990) type:

$$U(c_{jt}, c_{vt+1}) = u(c_{jt}) + \beta u(E_t c_{vt+1}), \tag{3}$$

with $u' > 0$, $u'' < 0$. Therefore agents are risk-neutral when evaluating whether they want to engage in a project or not. However, their intertemporal elasticity of substitution is finite. This risk neutrality assumption, in addition to simplifying the analysis, is meant to capture the fact that in reality, most investment is undertaken by firms whose owners hold a diversified portfolio, so that the firms will behave as a risk-neutral agent. That is, our individuals are meant to represent firms when deciding whether to engage into a project or not, and consumers when choosing the intertemporal path of their consumption.

2.3 Taxes

Each individual pays a fixed tax in the second subperiod of each period of his life. We assume that the young pay a tax T_{jt} and the old pay a tax T_{vt}. This will allow us to show that the effect of public debt on financial efficiency is intimately related to the failure of Ricardian equivalence. One could consider a more general tax structure that would allow for intragenerational as well as intergenerational redistribution. In particular, one may allow taxes to differ between savers and entrepreneurs, which would embody a subsidy to entrepreneurship into the tax structure. It can be shown that such a subsidy has standard effects on capital accumulation, and that it affects the efficiency of the financial system only through its effect on the outstanding stock of debt held by entrepreneurs (see appendix), that is, only indirectly through its intergenerational effects. As for differences in the taxes paid by successful and bankrupt entrepreneurs, it can be checked that it does not affect our results.

Therefore, total tax receipts at date t are equal to:

$$\mathcal{T}_t = T_{jt} + T_{vt}$$

Government bonds promise to pay a safe return equal to $1 + r_{t+1}$ of good 1 at $(t+1)^+$ in exchange for 1 unit of good 1 at t^+. The evolution of public debt (in per capita terms) is thus:

$$D_{t+1} = (1 + r_{t+1})D_t + G_{t+1} - \mathcal{T}_{t+1},$$

where G_{t+1} denotes government expenditure, which we treat as exogenous. Finally, agents must be indifferent between lending to the government or buying capital and lending its return to financial intermediaries. This implies the following arbitrage condition:

$$1 + r_{t+1} = A(1 + \rho_{t+1}) \tag{4}$$

2.4 The arbitrage between savings and projects

Since in equilibrium not all agents invest in a project, people must be indifferent between investing in a project or not. Any financial contract will specify that the entrepreneur pays U_{t+1} to the financial intermediary if the project is successful and V_{t+1} if it fails. These quantities will be determined below. Also $m_{t+1}xZ_{t+1}$ is spent on monitoring on each project, where m_{t+1} is the intermediation margin (and $M_{t+1} = nm_{t+1}xZ_{t+1} = m_{t+1}Z_{t+1}$). Let us renormalize repayments in terms of the amount lent, introducing $u_{t+1} = U_{t+1}/(xZ_{t+1})$ and $v_{t+1} = V_{t+1}/(xZ_{t+1})$

Then if intermediaries are competitive their zero profit condition implies:

$$(1-\varepsilon)u_{t+1} + \varepsilon v_{t+1} - m_{t+1} = (1+\rho_{t+1}) \tag{5}$$

If an individual does not start a project, his expected consumption at $(t+1)^+$ is simply:

$$E_t c_{vt+1} = c_{vt+1} = (1+r_{t+1})(\phi Y_t - c_{jt} - T_{jt}) - T_{vt+1} \tag{6}$$

Note that because of the arbitrage condition (4), the split of savings between public debt and projects is irrelevant to the individual.

Consider now the decision of engaging into a project. Expected consumption is then:

$$\begin{aligned} E_t c_{vt+1} &= (1+r_{t+1})(\phi Y_t - c_{jt} - T_{jt}) + \\ &\quad (1-\varepsilon)(RxZ_{t+1} - U_{t+1}) + \varepsilon(-V_{t+1}) - T_{vt+1} \end{aligned} \tag{7}$$

Indifference between running a project and lending to intermediaries implies that expected consumption must be the same under either option. Making use of (5), we see that this is equivalent to:

$$1 + \rho_{t+1} = R(1-\varepsilon) - m_{t+1}, \tag{8}$$

Equation (8) tells us that the rate of return paid to savers between $(t+1)^-$ and $(t+1)^+$ by financial intermediaries is equal to the expected rate of return on projects $R(1-\varepsilon)$, minus the intermediation margin m_{t+1}. It in effect determines the equilibrium rate of return on savings as a function of monitoring activity and tax policy. Because of constant returns to scale in the return to projects, entrepreneurs do not earn any rent on their project and all their expected return is paid to savers.

Using (8),(2), (1), and the fact that $M_{t+1} = m_{t+1}Z_{t+1}$ we get a useful relationship between output and the rate of return on loans:

$$Y_{t+1} = A(1+\rho_{t+1})K_t \tag{9}$$

This simply tells us that in equilibrium each unit of good 2 yields on average $1+\rho_{t+1}$ of good 1, the net average return to entrepreneurs. The quantity $1+\rho_{t+1}$ is the efficiency of capital, it tells us how much output is generated by one unit of capital once monitoring costs have been deducted. Under perfect financial markets ($\gamma = 0$), it would be equal to $AR(1-\varepsilon)$. Under imperfect financial markets it is lower than $AR(1-\varepsilon)$ and potentially affected by government policy via its effect on financial monitoring.

2.5 Consumption and wealth accumulation

Consumers determine their spending when young by maximizing (3) under the constraint (6) or equivalently (7). Given the homotheticity of the utility function, consumption when young is given by

$$c_{jt} = h(r_{t+1})\left[\phi Y_t - T_{jt} - \frac{T_{vt+1}}{1+r_{t+1}}\right] \tag{10}$$

Throughout the paper we shall assume that substitution effects dominate, that is $h' \leq 0$. The wealth accumulated by the young is then split between public debt and physical capital, in the fashion of Diamond (1965):

$$K_t + D_t = [\phi Y_t - c_{jt} - T_{jt}] \tag{11}$$

It is useful to use (8), (6) and (11) to express expected consumption when old in the following way:

$$E_t c_{vt+1} = A(1+\rho_{t+1})K_t + A(1+\rho_{t+1})D_t - T_{vt+1} \tag{12}$$

3 The determination of financial contracts

The structure of financial contracts follows a now well studied structure (See Gale and Hellwig (1985), Williamson (1986), Bernanke and Gertler (1989)). We assume that it is costly for lenders to observe the outcome of a project. To do so one must pay a monitoring cost equal to $\gamma.xZ_{t+1}$.

We then know (see Bernanke and Gertler, 1989) that the optimal contract has the following characteristics. Given risk-neutrality, the contract should minimize the resources spent on monitoring under the constraint that adequate incentives are provided. If the entrepreneur claims that the project succeeds, the state of nature is not verified and U_{t+1} is repaid. If he claims that the project fails, it is optimal to transfer as much as possible to the lender and to observe the state with random probability π_{t+1} (This improves on systematically observing the outcome when the bad state is reported).

The condition that everything is paid to the lender in the case of bankruptcy implies:

$$V_{t+1} = (1+r_{t+1})(\phi Y_t - c_{jt} - T_{jt}) - T_{vt+1} = W_{t+1} - T_{vt+1},$$

where

$$W_{t+1} = (1+r_{t+1})(\phi Y_t - c_{jt} - T_{jt}) = (1+r_{t+1})\left(K_t + D_t\right) \tag{13}$$

is the pre-tax wealth of the entrepreneur. Thus, the collateral seizable by the lender is that wealth net of taxes. For simplicity we ignore non-negativity constraints on V_{t+1}. This means that if the bankrupt entrepreneur cannot meet its tax obligations the lender has to do it on his behalf.

We now turn to the incentive compatibility constraint, that is the constraint that the borrower must truthfully report the outcome of his project. If the borrower cheats by falsely reporting a failure, he can keep the return to his project RxZ_{t+1} if not monitored, but loses everything if monitored. Therefore the IC constraint reads as:

$$W_{t+1} - T_{vt+1} + RxZ_{t+1} - U_{t+1} \geqslant (1 - \pi_{t+1})RxZ_{t+1}$$

This is equivalent to the following relationship between the monitoring probability and repayment:

$$\pi_{t+1} = \frac{U_{t+1} - W_{t+1} + T_{vt+1}}{RxZ_{t+1}} \tag{14}$$

Thus, given contractual repayment U_{t+1} more entrepreneurial wealth (net of taxes) reduces the incentive to cheat, thus lowering the incentive compatible probability of monitoring.

Finally, the return to the lender must on average be $(1 + \rho_{t+1})$ in competitive equilibrium, so that:

$$(1 - \varepsilon)U_{t+1} + \varepsilon \left[W_{t+1} - T_{vt+1} - \gamma\pi_{t+1}xZ_{t+1}\right] = (1 + \rho_{t+1})xZ_{t+1} \tag{15}$$

The last term in the LHS is the loss due to monitoring costs. Average monitoring costs per unit lent are $m_{t+1} = \varepsilon\gamma\pi_{t+1}$.

Equations (14) and (15) determine the parameters of the optimal contract U_{t+1} and π_{t+1} as a function of entrepreneurial wealth, taxes, and required rate of return on savings. We get:

$$\pi_{t+1} = \frac{1}{R(1-\varepsilon) - \varepsilon\gamma}\left[1 + \rho_{t+1} - \frac{W_{t+1} - T_{vt+1}}{xZ_{t+1}}\right] = m_{t+1}/\varepsilon\gamma, \tag{16}$$

and:

$$U_{t+1} = \frac{(1+\rho_{t+1})xZ_{t+1} - (\varepsilon\gamma/R + \varepsilon)\,(W_{t+1} - T_{vt+1})}{1 - \varepsilon - \varepsilon\gamma/R} \tag{17}$$

Equation (16) tells us that the monitoring probability (and therefore the resources spent on monitoring) is (i) higher with required repayment $1 + \rho_{t+1}$, and (ii) lower with the wealth of the old W_{t+1}, net of taxes. Higher entrepreneurial wealth reduces the incentives to cheat, because more is lost in case of being monitored. Consequently one can monitor less often and waste less resources in monitoring. Higher taxes paid by entrepreneurs lower their collateral, thus forcing an increase in the required repayment U_{t+1} and consequently of the monitoring probability π_{t+1}.

Equation (17) relates the nominal interest rate charged on a loan to the required rate of return on savings ρ, the collateral that can be seized $(W_{t+1} - T_{vt+1})$ and the cost of monitoring γ.

4 Equilibrium

We are now in a position to solve the model and to analyze the properties of the solution. The main two variables of interest are ρ, which describes the equilibrium return to savings and affects capital accumulation through (10), and m, which describes the efficiency of the financial sector. We first solve for them as a function of accumulated wealth W_{t+1}.

The equilibrium rate of return can be obtained by plugging (16) into (8), yielding:

$$1 + \rho_{t+1} = R(1-\varepsilon) - \varepsilon\gamma + \frac{\varepsilon\gamma}{Rx(1-\varepsilon)Z_{t+1}}\,[W_{t+1} - T_{vt+1}] \tag{18}$$

Substituting (18) into (16) we get the equilibrium level of monitoring, or intermediation margin:

$$m_{t+1} = \varepsilon\gamma \left[1 - \frac{W_{t+1} - T_{vt+1}}{RxZ_{t+1}(1-\varepsilon)}\right] \tag{19}$$

These two equations illustrate how entrepreneurial wealth affect financial contracts. Incentives are improved, less is spent on monitoring, which increases the return to savers. Collateral, which is picked up by the last term in (18), will have a greater effect on the equilibrium rate of return when monitoring costs are higher, i.e. when γ is higher. Absent monitoring costs there is no collateral effect.

We now analyze the effects of fiscal policy. We first deal with its partial equilibrium effects (taking interest rates as given), and then tackle general equilibrium effects.

4.1 Partial equilibrium effects of fiscal policy

Equation (13) implies that given K_t, a greater level of public debt increases private wealth and therefore collateral, which has a positive impact on the efficiency of the financial sector.

Interestingly, this effect is directly related to the extent to which government debt is perceived as net wealth to the private sector, that is to the degree of failure of Ricardian equivalence. To see this, consider the impact of a Ricardian increase in public debt. That is, an increase in public debt such that the net wealth of current generations is unaffected; the increase in their future taxes exactly offsets the reduction in their current taxes. Assuming the entrepreneurial subsidy is also unchanged, this implies:

$$\Delta T_{jt} = -\frac{\Delta T_{vt+1}}{1 + r_{t+1}}$$

Clearly the young's consumption is unchanged, so that $\Delta W_{t+1} = -(1 + r_{t+1})\Delta T_{jt} = \Delta T_{vt+1}$. Hence the collateral effect $W_{t+1} - T_{vt+1}$ is unaffected, and so is the efficiency of the financial sector. Debt is then neutral in that it neither affects capital accumulation nor the efficiency of the financial sector. When, on the other hand, part of future taxes are paid by future generations, the increase in debt increases the wealth of current generations. Next period's entrepreneurs will have greater collateral, which reduces the severity of the monitoring problem.

This is because indirectly, through their tax liabilities, future generations are acting as a guarantee for the entrepreneurs of the current generation.

Consider for example the special case where all agents pay the same tax, i.e. $T_{vt} = T_{vt}^B = T_{vt}^S = T_{jt}$. Using (18) and (9) we can express output as a function of capital and post-tax wealth of the old generation:

$$\begin{aligned} Y_{t+1} &= AK_t R(1 - \varepsilon - \varepsilon\gamma/(R)) + \frac{\varepsilon\gamma}{Rx(1-\varepsilon)} [W_{t+1} - T_{t+1}] \\ &= aK_t + b[W_{t+1} - T_{t+1}], \end{aligned} \tag{20}$$

where $a = A(R(1-\varepsilon) - \varepsilon\gamma)$ and $b = \varepsilon\gamma/Rx(1-\varepsilon)$

We thus get a reduced form production function where output depends not only on physical capital but also on private wealth. It is more sensitive to wealth, and less to output, the greater the monitoring cost parameter γ. More severe monitoring problems make collateral more relevant, and at the same time increase the share of capital lost in monitoring, which reduces its net marginal product.

At the same time, the well known crowding-out effects also step in. The more debt is net wealth to current generations, the greater their consumption and the lower their capital accumulation. Consequently public debt exerts two countervailing effects on output and growth. Crowding out reduces capital accumulation, but that capital is more efficiently used because less of it is spent on monitoring. These effects are of opposite signs, but their magnitudes are intimately related, since they both act through the current generation's net wealth.

4.2 Intra-period equilibrium determination

We now turn to the joint determination of output, financial efficiency, and interest rates. It is convenient to first analyze what happens absent public debt ($D = T = G = 0$). The model is then easily reduced to 4 equations:

$$
\begin{aligned}
c_{jt} &= h(r_{t+1})\phi Y_t \\
K_t &= (1 - h(r_{t+1}))\phi Y_t \qquad (21) \\
Y_{t+1} &= (1 + r_{t+1})K_t \qquad (22) \\
1 + r_{t+1} &= a + b(1 + r_{t+1})
\end{aligned}
$$

Clearly, there exists a unique equilibrium path that is also an balanced endogenous growth path (this is due to the linear-in-capital structure of the model). The equilibrium interest rate can be solved from the last equation:

$$
\begin{aligned}
1 + r &= \frac{a}{1 - b} \qquad (23) \\
&= \frac{A(R(1-\varepsilon) - \varepsilon\gamma)}{1 - \varepsilon\gamma/Rx(1-\varepsilon)} \qquad (24)
\end{aligned}
$$

Given that $x \geq 1$, this amount is smaller than the expected return on projects between t and $t+1$, $AR(1-\varepsilon)$. Note that when $x = 1$ one has $m = 0$ and $1 + r = AR(1-\varepsilon)$. The loans are fully collateralized since the size of the project is precisely equal to the individual's endowment of good 2. In that case the wealth that can be seized is exactly equal to the amount to be repaid, so that incentives to report bankruptcy are zero and we are back to the perfect financial markets case.

The growth rate is then computed by making the appropriate substitution into (22):[4]

$$g = \phi(1 - h\left(\frac{a}{1-b}\right))\frac{a}{1-b}$$

As long as h is decreasing in r this has standard properties. We now turn to the more interesting case where there is public debt.

Let us now reintroduce fiscal policy, assuming that every individual pays the same tax T_t. The system evolves now according to:

$$c_{jt} = h(r_{t+1})(\phi Y_t - T_t - T_{t+1}/(1 + r_{t+1})) \tag{25}$$

$$K_t = (1 - h(r_{t+1}))(\phi Y_t - T_t) + h(r_{t+1})T_{t+1}/(1 + r_{t+1}) - D_t \tag{26}$$

$$Y_{t+1} = (1 + r_{t+1})K_t \tag{27}$$

$$1 + r_{t+1} = a + b(\frac{(1 + r_{t+1})(K_t + D_t) - T_{t+1}}{K_t}) \tag{28}$$

Figure 2 illustrates equilibrium determination. The upward sloping locus, associated with (26), defines the stock of capital acquired by the young as a function of the real interest rate. We assume that it is upward sloping[5]; that is, the usual substitution effects dominate. The downward sloping locus, given by (28), defines the effect of accumulated capital on the equilibrium rate of return. Note that borrowing requirements are higher when the economy has accumulated more capital, while because its debt component is fixed collateral does not increase proportionally. Thus as capital increases collateral falls relative to borrowing requirement so that more is spent on monitoring and rates of return fall. This decreasing returns property comes entirely from imperfections in the financial sector, coupled with the existence

[4] We make use of (21), (23) and of the definitions of a and b.

[5] This is not really needed, what we need is that if it is downward sloping, then it is flat enough.

of public debt. Absent public debt more capital increased collateral by exactly the same proportion as borrowing requirements. Thus this locus was horizontal and the interest rate was basically exogenous. Here the interest rate paid to creditors increases with the debt/capital ratio but this is not due to the usual crowding out properties[6], nor to any "peso problem" associated with debt, simply to the spillovers of public debt to the efficiency of private lending.

Figure 3 represents the net effect of a reduction in tax rates today matched by an increase in public debt, assuming that T_{t+1} is unchanged (that is, this is rolled over at least one extra period and paid back by subsequent generations). Both loci shift upwards. The upward shift in the savings locus represents the usual crowding out effect: capital accumulation falls, and the induced effect on financial efficiency leads to a rise in rates of return. At the same time, the increase in public debt raises collateral and therefore the financial efficiency locus also shifts upwards. The interest rate unambiguously increases because of collateral effects. The intermediation margin clearly falls. Capital accumulation may even increase if the impact of financial efficiency is large enough, and so may output.

The beneficial effects of debt on monitoring costs, have to be exhausted since after a certain level of debt loans are fully collateralized. The corresponding level of debt will be the one such that $1 + r_{t+1}$ is equal to the full information return on capital, i.e. $D_t = K_t(x - 1) + T_{t+1}/(AR(1 - \varepsilon))$. This suggests that if output (or capital) rises with debt it will only be over a certain range. To illustrate this effect let us consider what happens when $h(.)$ is a constant, when there are no taxes next period, and when last period's debt is zero, so that $D_t + T_t = 0$. In such a case debt unambiguously reduces

[6]If there are constant returns to capital crowding out is in the form of lower growth, not higher interest rates, see Saint-Paul (1992).

capital but may increase output. We get:

$$\begin{aligned} Y_{t+1} &= \frac{a\left((1-h)\phi Y_t - hD_t\right)^2}{\phi Y_t - (\phi Y_t + D_t)(h + b(1-h))}, \\ \text{for } D_t &\leq \frac{(1-h)\phi Y_t(x-1)}{1+h(x-1)}; \end{aligned}$$

$$\begin{aligned} Y_{t+1} &= a(1-h)\phi Y_t - ahD_t, \\ \text{for } D_t &> \frac{(1-h)\phi Y_t(x-1)}{1+h(x-1)}. \end{aligned}$$

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The dependence of output on debt is illustrated on figure 4.[7] The net effect of debt on output is hump-shaped. At low debt levels the financial efficiency effect dominates, while only the crowding-out effect remains if debt is too high.[8]

4.3 Balanced growth paths

We now compute the balanced growth paths of the economy, assuming that the government maintains a constant ratio d between the value of public debt and the stock of capital.

It is convenient to study the equilibrium in terms of several relationships between the interest rate r and the growth rate g.

First, note that to maintain constant the ratio $d = D_t/K_t$ taxes must be equal to:

$$T_t = d(r-g)K_{t-1} \tag{29}$$

[7]Figure 4 was drawn with the following parameter values: $x = 2; h = 0.5; a = 1; b = 0.3; \phi = 1$.

[8]The non monotonicity is associated with a discontinuity in the derivative, but this would not be so if there was heterogeneity across borrowers in the amount borrowed.

This is the standard results that if $r > g$ a positive tax rate is needed to prevent debt from exploding, while if $r < g$ debt dynamics are stable so that a negative tax rate is compatible with a positive level of debt.

Second, equation (28), which tells us how private entrepreneurial wealth affects the rate of return on capital, becomes, in a balanced growth path:

$$1 + r = a + b((1 + r)(1 + d) - d(r - g))$$

This defines a positive relationship between the growth rate and the interest rate. This positive relationship is in contrast with the negative relationship between capital and interest rates that prevailed in the intra-period equilibrium, when taxes were held fixed. Here faster growth allows to maintain a given debt burden with lower taxes (relative to the capital stock). Lower taxes in turn increase the collateral of entrepreneurs, thus increasing the rate of return to lenders in equilibrium.

Thus when there is public debt, there is a "financial accelerator" associated with faster growth, as a lower tax burden on entrepreneurs improves their solvency and reduces the amount of resources dissipated in monitoring costs. The size of this effect is directly related to the size of public debt.

Concerning the other relationship between growth and interest rates, they are also perturbated by fiscal policy. The accumulation equation for capital becomes:

$$K_t(1 + d) = (1 - h(r))\phi Y_t + d(r - g)K_t \left[\frac{h(r)}{1 + r} - \frac{1 - h(r)}{1 + g}\right]$$

The last term represents the contribution of taxes to savings and is ambiguous as more taxes tomorrow increase savings today while more taxes today reduce them. The first term will induce a positive relationship between interest rates and capital accumulation. Using (27) we can then get a relationship between growth and interest rates that tells us how much rates of return affect the incentives for capital accumulation.

$$g = \frac{(1+r)\phi(1-h(r))}{1+d-d(r-g)\left(\frac{h(r)}{1+r}-\frac{1-h(r)}{1+g}\right)}$$

This relationship is in principle upward sloping, so that there may be multiple equilibria, that are analyzed below.

Equilibrium is represented on figure 5; it is determined by the intersection of two upward-sloping loci, which represent both savings behaviour and the impact of wealth on financial efficiency, as in the previous subsection. The financial efficiency locus is assumed flat enough to guarantee a unique equilibrium.

The impact of an increase in the debt/GDP ratio is analyzed in figure 6. In an endogenous growth model, the usual crowding out effects take the form of a reduction in the growth rate, here an upward shift of the savings schedule[9]. But the financial efficiency schedule also shifts up for the reasons already explained. The rate of return unambiguously goes up, while growth may either rise or fall.

The possibility of multiple equilibria is represented on figure 7. Multiplicity is due to a fiscal/financial accelerator: faster growth allows to maintain the same debt/gdp ratio with lower taxes; lower taxes increase the collateral of borrowers; rates of returns rise because less is spent on monitoring. Growth increases as both the efficiency of capital and the incentives for capital accumulation increase.

[9] See Saint-Paul (1992).

5 On the timing of entrepreneurial activity

The above model has established an intimate link between intergenerational redistribution and financial efficiency. One may wonder whether this result is robust, and in particular whether it is not due to the special assumption that only members of the old generation can engage into entrepreneurial activity. If the opposite assumption had been made, only the young could become entrepreneurs and redistribution from young to old would presumably harm entrepreneurship.

Here we want to argue that the assumption we are making is reasonable, because liquidity constraints lead to a *self-selection* of entrepreneurs among the wealthiest groups, that is those who are most likely to own the public debt. If both the young and the old can become entrepreneurs, they will compete for funds and those with greater collateral will be able to outbid the others. Under constant returns, if the old have greater wealth than the young and if there are enough old entrepreneurs then in equilibrium only these will indeed engage into projects.

To capture this the model could be modified as follows. A fraction θ of the young can engage into projects (identical to the old's projects) between t^- and t^+. The remaining fraction $1-\theta$ can have projects when they are old. Hence, there are now two groups of entrepreneurs (young and old) who only differ by their collateral. (18) can now be rewritten

$$1 + \rho_{it+1} = R(1-\varepsilon) - \varepsilon\gamma + \frac{\varepsilon\gamma}{Rx(1-\varepsilon)Z_{t+1}}\Xi_{it+1}, \tag{30}$$

where i refers to the type of an entrepreneur (young, old), Ξ_i is his seizable collateral, and ρ_{it+1} is the maximum rate of return that this type of borrower can offer to lenders. We assume that labor income is not collaterizable, implying $\Xi_{\text{old}} > \Xi_{\text{young}} = 0$. Hence $\rho_{\text{old}} > \rho_{\text{young}}$. Then the equilibrium rate of return is determined by (30) applied to the *marginal* group of borrowers. Two cases should then be distinguished:

1. If $x(1-\theta) \geq 1$, then old entrepreneurs can potentially exhaust all the endowment of good 2. In that case they are the marginal group and young entrepreneurs are better-off not undertaking a project because its expected net return is lower than the equilibrium rate of return. This case validates our assumption that only the old undertake projects. The solution of the model is exactly the same as derived above.

2. If $x(1-\theta) < 1$, then the marginal group of borrowers is the young, and old entrepreneurs earn strictly positive rents on their projects. The rate of return is constant and equal to $R(1-\varepsilon) - \varepsilon\gamma$. (16) then implies that the monitoring probability is equal to 1 for the young and $\pi_{t+1} = 1 - \frac{1}{R(1-\varepsilon)-\varepsilon\gamma}\left[\frac{W_{t+1}-T_{vt+1}}{xZ_{t+1}}\right]$ for the old. Public debt again increases the old's wealth and reduces the resources spent on monitoring.

To summarize, while we assume an exogenous age of entrepreneurial activity, the very existence of financial imperfections is likely to generate such timing endogenously, so that our results are robust to allowing both the young and the old to engage into projects.

6 Empirical evidence

We now turn to the empirical evidence. The above analysis suggests a simple way of testing the model. It predicts that controlling for the capital stock output should be higher when national private wealth is higher. We therefore aim at estimating a reduced form production function of the following type:

$$Y_t = A_t \tilde{K}_t^{\alpha} L_t^{1-\alpha}, \tag{31}$$

where L is employment, Y output, and $\tilde{K}$ is total "efficient" capital, that is the total effect of capital on output taking into account (as in 20) that part of it is wasted in intermediation costs and that this part depends on private wealth because of collateral effects:

$$\tilde{K}_t = aK_t + b\left[K_t + \theta D_t\right],$$

where K_t is physical capital and $K_t + \theta D_t$ total wealth. θ is the part of national debt considered as net wealth by the private sector. Under $\theta = 0$ Ricardian equivalence holds, while under $\theta = 1$ the debt is expected to be entirely reimbursed by future generations. The coefficient b is a measure of the impact of collateral on the efficiency of investment, it is therefore related to the cost of monitoring.

Note that monitoring costs may have a more general specification than in the model and that they may involve labor as well as capital resources.

Differentiating equation (31) we find:

$$\begin{aligned} \dot{Y}/Y &= \dot{A}/A + \alpha\frac{(a+b)\dot{K}_t + b\theta\dot{D}_t}{aK_t + b\left[K_t + \theta D_t\right]} + (1-\alpha)\dot{L}/L \\ &\approx a_0 + a_1\dot{K}_t/K_t + a_2\dot{L}_t/L_t + a_3\dot{D}_t/K_t \\ &\quad + a_4 D_t/K_t \cdot \dot{K}_t/K_t + a_5 D_t/K_t \cdot \dot{D}_t/K_t \end{aligned} \tag{32}$$

Equation (32) will form the basis of our empirical specification. We have:

$$\begin{aligned} a_1 &= \alpha \\ a_2 &= 1-\alpha \\ a_3 &= \frac{\alpha\theta b}{a+b} \\ a_4 &= -\frac{\alpha\theta b}{a+b} \\ a_5 &= -\frac{\alpha\theta b^2}{(a+b)^2} \end{aligned}$$

Therefore, our empirical strategy is to test for a greater output level, controlling for inputs, when debt (more generally private wealth) is higher. The error term is interpreted as shocks to total factor productivity growth.

The equation was estimated on a panel of OECD countries where fixed and time effects were included.[10]

The estimation was carried out in both OLS and Instrumental variables, because the counter-cyclical behaviour of public debt is likely to generate a downward bias in the estimation of a_3. Lags were used as instruments.

The results are reported in table 1.

Our main question of interest is whether a_3 is positive. As is clear from table 1, a_3 is not significantly positive when estimated by OLS but becomes so when estimated by IV (note also that the quadratic terms, when included, come out with the right sign). Indeed, the effect may look too large. The implied value of b/a is no less than 9, given that θ must be less than one. The share of intermediation costs is

$$\frac{m}{1+\rho+m} = \frac{\varepsilon\gamma(1-W/(AKRx(1-\varepsilon)))}{R(1-\varepsilon)}$$

For a borrower with no collateral this can be rewritten as

$$\frac{1}{(a/b)\,\frac{1}{ARx(1-\varepsilon)}+1}$$

With a ratio of collateral over capital of $1/x = 0.5$, a 15 % rate of return on projects $AR(1-\varepsilon) = 1.15$, this would imply that arount 90 % of the gross returns to a project are dissipated in monitoring costs, an unplausibly large number (although this clearly falls with collateral).

[10] The data were the *OECD Economic Outlook* database.

	OLS	OLS	IV	IV
$\dot{L}/L$	0.66	0.62	0.6	0.5
	(12.5)	(13.0)	(6.7)	(5.3)
$\dot{K}/K$	0.24	0.222	0.15	0.26
	(2.82)	(2.81)	(1.4)	(2.4)
$\dot{D}/K$	0.02	-0.01	0.56	0.29
	(0.17)	(-0.23)	(2.8)	(2.7)
$\frac{D}{K}\frac{\dot{K}}{K}$	-0.23		-0.13	
	(-0.55)		(-0.27)	
$\frac{D}{K}\frac{\dot{D}}{K}$	-0.23		-1.5	
	(-1.63)		(-2.5)	

Table 1: Dependent variable: output growth

7 Conclusion

In this paper, we have shown that by affecting the balance sheet of entrepreneurs, public debt may improve the efficiency of the financial sector. This effect partly offsets its negative impact on capital accumulation. Indeed, if savings are very reactive to the interest rate, capital accumulation may even increase.

Conversely, difficulties to issue debt because the government lacks credibility result in a lost in terms of the financial sector's productivity. An interesting avenue for further research would be to test whether this mechanism has any relevance for developing countries.

APPENDIX

We now briefly discuss the role of the *entrepreneurial subsidy,* that is any difference between taxes paid by entrepreneurs and non entrepreneurs. Let us assume that entrepreneurs pay a tax T_{vt}^{E} at t, while non-entrepreneurs pay a tax T_{vt}^{N}. The expected consumption of an entrepreneur is now:

$$\begin{aligned} E_t c_{vt+1} &= (1+r_{t+1})(\phi Y_t - c_{jt} - T_{jt}) + \\ &\quad (1-\varepsilon)(RxZ_{t+1} - U_{t+1}) + \varepsilon(-V_{t+1}) - T_{vt+1}^{E} \end{aligned}$$

The equilibrium return on loans is now:

$$1+\rho_{t+1} = R(1-\varepsilon) + \sigma_{t+1} - m_{t+1}, \tag{33}$$

where

$$\sigma_{t+1} = \frac{T_{vt+1}^{N} - T_{vt+1}^{E}}{xZ_{t+1}}$$

is the entrepreneurial subsidy to entrepreneurship implicit in the tax system.

Let T_{vt} be the old's average taxes at t. We have:

$$T_{vt}^{N} = T_{vt} + n\sigma_t xZ_t$$

and

$$T_{vt}^{E} = T_{vt} - (1-n)\sigma_t xZ_t,$$

where $T_{vt} = (1-n)T_{vt}^{N} + nT_{vt}^{E}$. We shall consider pure intragenerational changes in σ, that is hold T_{vt} constant. It can be easily shown that the equilibrium rates of return and monitoring levels are now determined as follows:

$$\begin{aligned} 1+\rho_{t+1} &= R(1-\varepsilon) - \varepsilon\gamma + \frac{\varepsilon\gamma}{Rx(1-\varepsilon)Z_{t+1}}\left[W_{t+1} - T_{vt+1}\right] \\ &\quad + \sigma_{t+1}\left(1 - \frac{\varepsilon\gamma n}{R(1-\varepsilon)}\right) \end{aligned} \tag{34}$$

Substituting (18) into (16) we get the equilibrium level of monitoring, or intermediation margin:

$$m_{t+1} = \varepsilon\gamma \left[1 - \frac{W_{t+1} - T_{vt+1}}{RxZ_{t+1}(1-\varepsilon)} + \sigma_{t+1}\frac{n}{R(1-\varepsilon)}\right] \tag{35}$$

The effect of the entrepreneurial subsidy is twofold. First, as implied by (33), arbitrage between lending and entrepreneurship ensures that the entrepreneurial subsidy is indirectly rebated to savers in form of a higher rate of return. However, on net, this effect is less than one for one. This is because, as one can see from (35), more is spent on monitoring. This monitoring effect is itself the net of two effects. Each dollar of entrepreneurial subsidy raises the required return on loans by one dollar (controlling for monitoring costs), and at the same time it raises collateral by less than a dollar, since total taxes paid by entrepreneurs have to fall less than the full increase in the subsidy in order to maintain the taxes paid by that generation constant. That is, part of the rise in the subsidy is absorbed by lower taxes paid by entrepreneurs, and part is absorbed by higher taxes paid by non-entrepreneurs. Therefore, monitoring activity has to rise, which in turn reduces the rate of return on savings.

This analysis, however, has ignored the rise in collateral due to the fact that with higher rates of returns wealth W_{t+1} is higher. To reintroduce that effect into the analysis, note that using (13) (34) can be rewritten as:

$$\begin{aligned} & 1 + \rho_{t+1} - \sigma_{t+1} \\ = \; & (1-\varepsilon)R - \varepsilon\gamma + \frac{\varepsilon\gamma}{Rx(1-\varepsilon)}\left[\frac{(1+\rho_{t+1})A(K_t + D_t) - T_{vt+1}}{AK_t} - \sigma_{t+1}\right] \end{aligned}$$

This formula implies that in the absence of public debt, the entrepreneurial subsidy has no effect on the efficiency of capital (since $1 + \rho_{t+1} - \sigma_{t+1}$ which does not depend on σ_{t+1}). This is because the total rise in collateral that it triggers exactly offsets the increased in required repayment.

The intuition is as follows: consider a transfer from "savers" (who include also entrepreneurs since they cannot use their endowment of good 2 to fund their own project) to entrepreneurs. Arbitrage between the two activities requires that rates of return rise so that in equilibrium this transfer is rebated to savers. Given that entrepreneurs are a fraction n of the population, this rate of return increase triggers an increase in their total collateral equal to a fraction n of the transfer. They perceive all the transfers but as savers, they together pay also a fraction n of the transfer, so that the direct increase in their collateral due to the transfer is equal to a fraction $1-n$ of the transfer. Consequently, their total increase in collateral is precisely equal to the total increase in their expected repayment; hence monitoring activity is unchanged and so is the efficiency of capital.

With a positive level of public debt, the entrepreneurial subsidy increases the efficiency of capital. This is because the total rise in collateral is greater than the increase in required repayment.

When public debt is positive, the rise in the equilibrium rate of return increases the wealth of the current generation of savers by *more* than the transfer. This is due to the holding of debt, i.e. claims on the next generation, by that generation. This debt is inframarginal in the sense that it does not intervene in the arbitrage condition between saving and entrepreneurship, but its value at $t+1$ rises when rates of return rise. Therefore, the entrepreneurial subsidy affects financial efficiency only because its wealth effect on debt implies an intergenerational redistribution.

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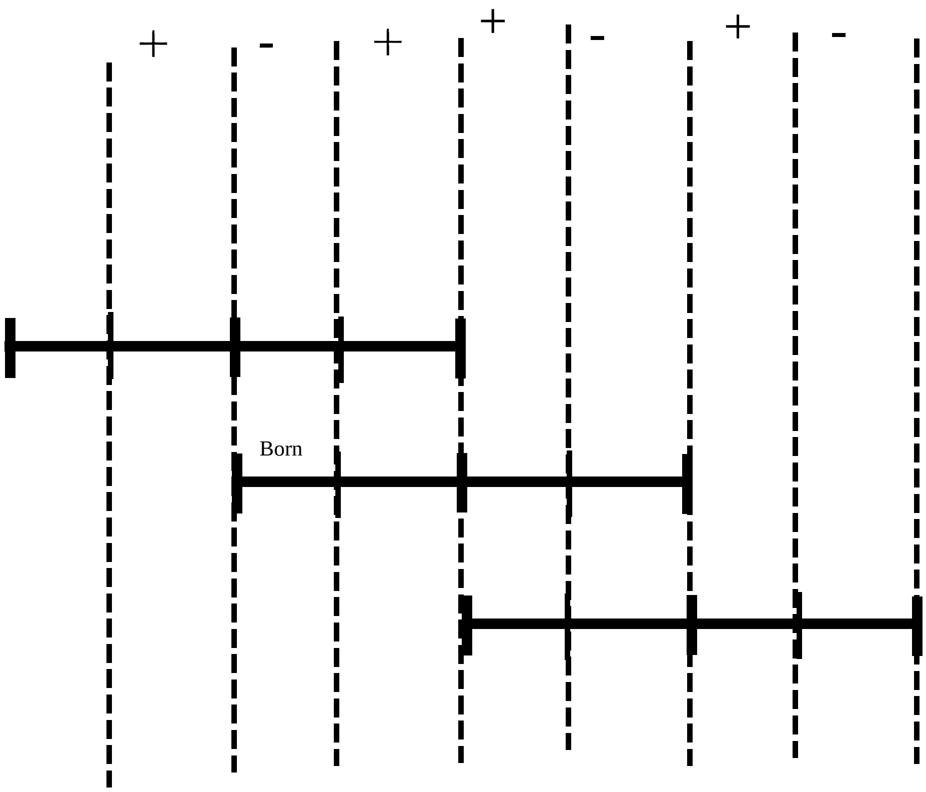

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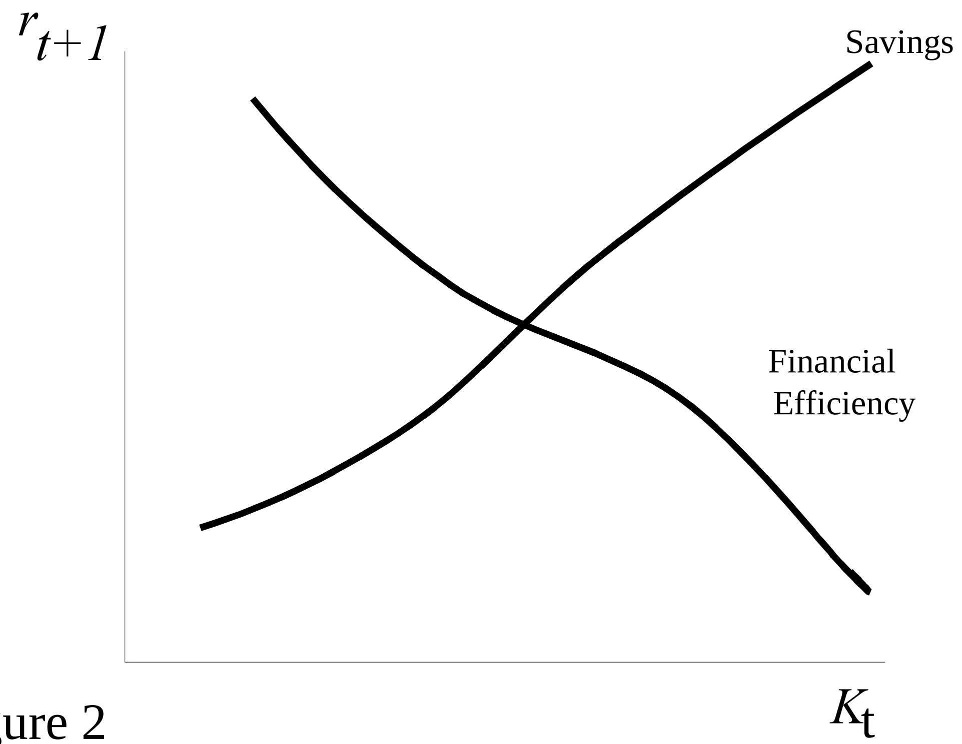

Figure 2

Equilibrium determination

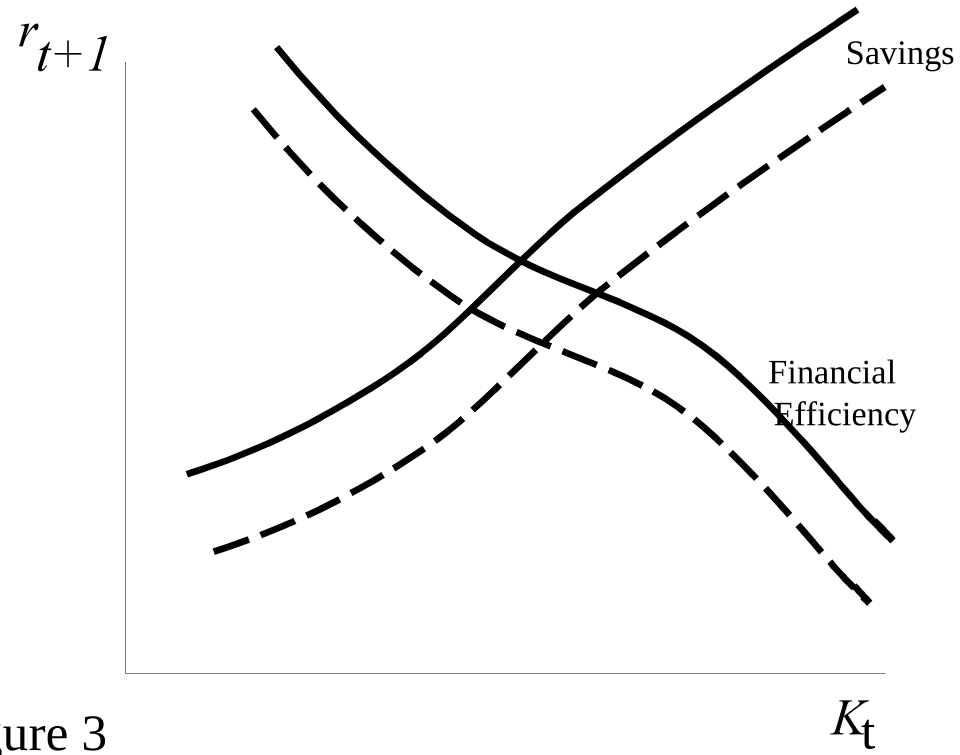

Figure 3

Impact of an increase in public debt

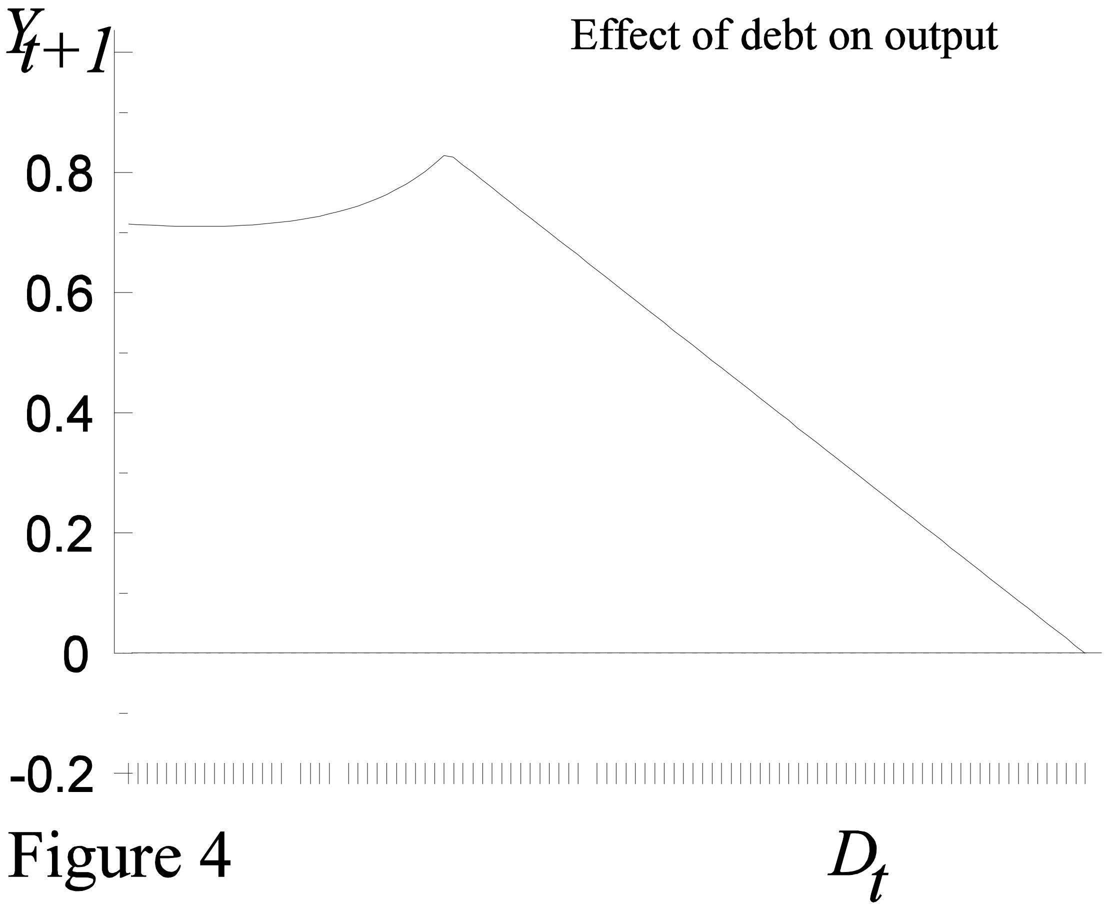

Figure 4

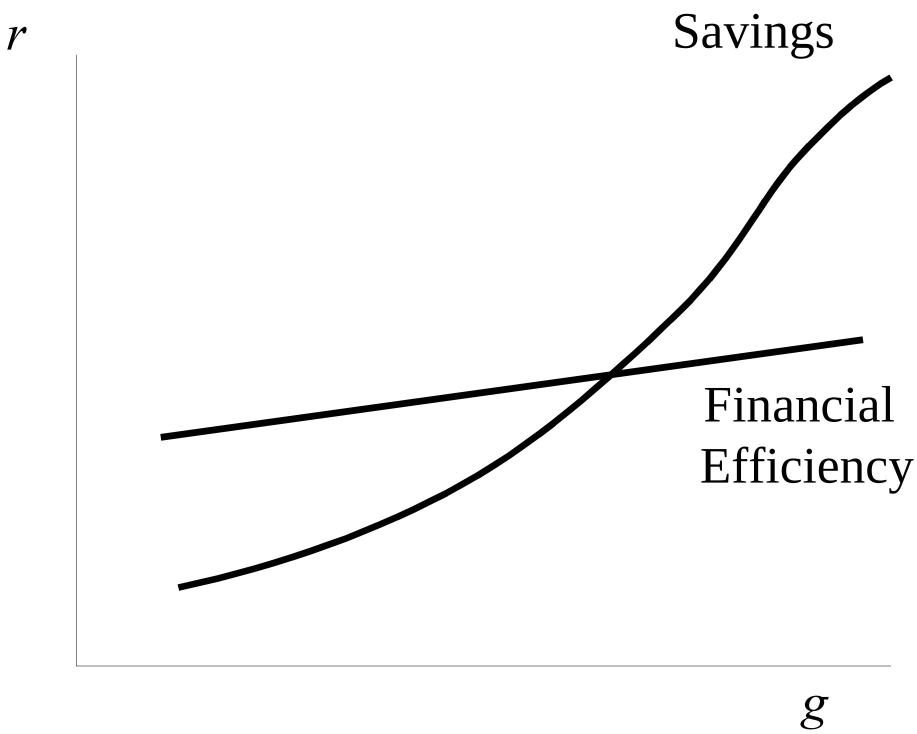

Figure 5
long-run growth

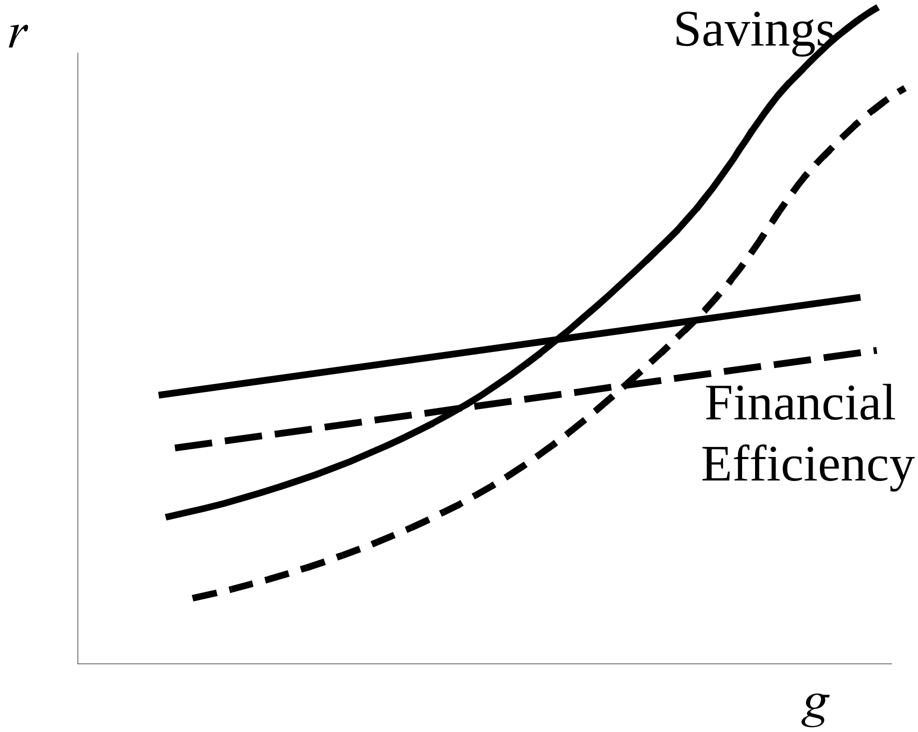

Figure 6
Growth effects of a change in debt/gdp ratio

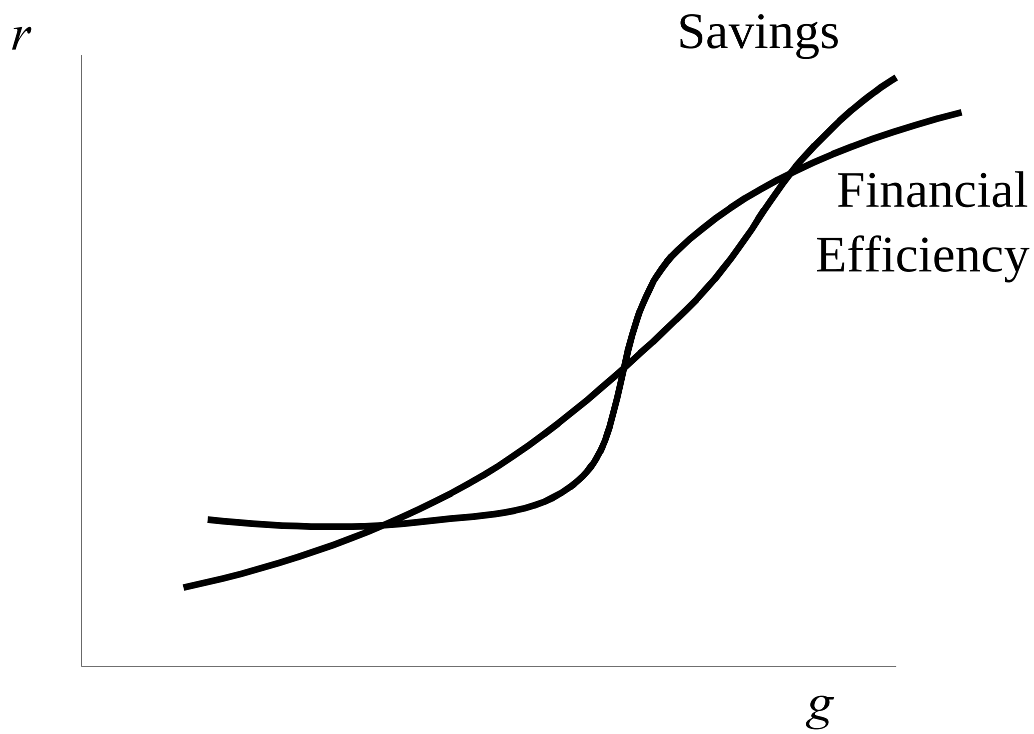

Figure 7
multiple growth paths