Fiscal and Monetary Policy Interactions in an Endogenous Growth Model with Financial Intermediaries

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Abstract: We review some inflationary and growth claims surrounding fiscal and monetary policy interactions. While financial intermediation has long been acknowledged as a key mechanism in the transmission of these interactions, only recently have economists incorporated the explicit modeling of such intermediaries in their analyses.

Here we model financial intermediaries explicitly. We find that the relation between growth and inflation depends crucially on the agents' degree of relative risk aversion. Moreover, the degree of relative risk aversion also plays a significant role in the existence and uniqueness of the balanced growth equilibrium.

Another important contribution of the current paper is its investigation into the effects of different government financing methods on economic growth and welfare.

JEL classification: E44, O16, O42

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1. Introduction

In the literature of the new growth theory developed in the past decade, the impact of public policies on the growth performance of the macroeconomy has been one of the major research areas. One strand of the literature examines the role of fiscal policy (especially taxation) on economic growth in a *real* neoclassical environment (e.g., Barro [90] and Rebelo [91]), while another tries to identify the role of monetary mechanisms in the endogenous growth process in the *absence* of fiscal instruments (e.g., Jones and Manuelli [93]). Ironically, there is a long array of claims on growth and inflation surrounding fiscal and monetary policy interactions in exogenous growth models. Moreover, financial intermediation has long been acknowledged as a key mechanism in the transmission of these interactions. However, only recently have economists incorporated the explicit modeling of such intermediaries in their analyses. Instead, the most common tradition has consisted on relying on "shortcuts" to capture key stylized features of financial intermediaries. In a simple endogenous growth model, we tie the fiscal and monetary sides of the economy via the government budget constraint and show that the explicit modeling of financial intermediation produces a rich set of policy results.[1] This in turn suggests a more careful qualification of early fiscal-monetary policy interactions claims in the presence of financial intermediaries.

Authors such as Diamond and Dybvig [83] (D-D) and Townsend [87] laid the foundation for the construction of tractable models depicting key features of financial intermediaries. Authors like Williamson [87] went a step further and looked at the real business cycle impact of explicitly allowing for financial intermediaries. More recently, Bencivenga and Smith [92] (B-S) developed an endogenous growth

[1] There is a couple exceptions who study the interactions between fiscal and monetary policies in endogenous growth models (van der Ploeg and Alogoskoufis [94], and Palivos and Yip [95]). However, neither one considers the impact of financial intermediaries in the analysis.

model with (D-D) intermediaries and show that financial intermediaries can have a positive impact on real economic activity. According to (B-S), there are conditions under which these intermediaries may be altogether irrelevant for economic growth. For example, in their model, if economic agents exhibited a low degree of risk aversion and were subjected to few liquidity shocks, the contribution of financial intermediaries to economic growth would be negligible. Nevertheless, in their analysis, (B-S) abstract completely from monetary issues.

In this paper, we borrow the insights from the above literature on the modeling of financial intermediaries and apply them in an endogenous growth model. We do not look at the feedback between financial intermediaries and the economy like Greenwood and Jovanovich [90]. They review some of the economic development claims regarding the feedback between financial intermediaries, the level of economic activity and its distributional implications.

We focus instead on the impact of fiscal and monetary policy interactions on economic growth and inflation in the presence of financial intermediaries. We consider the enterprise worthwhile because in many of the existing policy claims, financial intermediaries are either neutral or non-existing. In addition, by allowing a positive deficit to be financed and explicitly stating the government budget constraint, our model allows us to review some second-best claims in the literature concerning inflation and economic growth.

Consider for instance the Friedman rule that calls for a zero nominal interest rate. The rule implies a corner solution with full reliance on lump-sum taxes as means of supporting government expenditures. One of the early challenges to this rule came about precisely because of the lump-sum tax assumption. Phelps [73] for example questions the validity of the Friedman's rule in more realistic settings where distortionary taxes are the norm. He shows that in such settings, a combination of both income and inflationary taxes would be more likely. Besides concentrating on distortionary taxes, we argue, it is necessary to incorporate in the debate the explicit modeling of financial intermediaries.[2]

In our model, financial intermediaries hold voluntary reserves in order to satisfy their customers liquidity needs. Since the government enjoys the monopoly in the issuing of fiat money, it can finance its expenditures via seignorage without necessarily having to rely on financial repression unlike in many of the analyses of inflationary government finance[3]. Therefore, the model applies equally well to

[2]We echo McKinnon's ([91], p.56) statement that "any model of inflation tax in LDCs must explicitly take into account how reserve requirements are set." But we go even further and would erase the LDC qualifier in the quote.

[3]see Roubini and Sala-i-Martin [92], for an example.

both developed and developing economies.

A crowding out effect is always present whether government expenditures are financed via income taxes or inflationary finance. In the economic literature (see for example, McKinon [91]), however, there is an implicit belief that faced with different choices of financing government expenditures via distortionary taxes, the policy authority may want to opt for income taxes. Because of its "destabilizing nature", inflation is thought to limit the flow of new credit and consequently growth. Making thus inflation the least desirable choice if the objective is to maximize growth.

Given that ours is an endogenous growth model, we are better equipped to assess the impact of alternative tax policies on both inflation and growth. Here, the corner solution prescription in McKinon and Friedman of zero reliance on inflation tax as means to finance a certain level of government expenditures holds under some conditions. In particular, it holds whenever the initial equilibrium is a high inflation one, financial intermediaries' customers exhibit a low degree of risk aversion and the objective is to maximize growth. The result, however, does not depend on financial repression, the destabilizing nature of inflation or lump-sum tax assumptions. Furthermore, in this context, a move away from seignorage to income taxation, although growth enhancing, is inflationary.

Moreover, there is a claim in the economic development literature that says that expansionary fiscal policies that are financed via seigniorage, are inflationary and reduce growth. Rather than a generality, this is true in our model only if financial intermediaries customers are fairly risk averse..

In most macro policy discussions there is an ingrained belief in an inflation-growth trade off. Here, such trade-off is obtained as a particular case rather than as a generality. The trade-off obtains whenever financial intermediaries' customers exhibit a low degree of risk aversion and the initial equilibrium is a low inflation one.

The organization of the paper is as follows. The next section develops the basic model and section 3 performs a balanced growth analysis. Section 4 introduces productive government spending while section 5 analyzes welfare issues. Finally, section 6 concludes.

2. The Model

In order to improve the review of the earlier claims regarding the interaction between financial intermediaries and government policies and its impact on economic growth, one ought to work in an environment with the following elements. The environment should include financial intermediaries performing a specific stylized role ascribed to financial intermediaries such as liquidity provision and an explicit statement of the alternative government financing sources such as seigniorage and income taxation. To that end we draw on Bencivenga and Smith [91] and Schreft and Smith [94]. In addition, we want growth to arise endogenously to fully address the growth impact of alternative fiscal and monetary policies. Throughout the paper, we assume that banks are free of binding reserve requirements. We further assume, in the first part of the paper that government expenditures are non-productive. Using this environment as a building block, we move latter on to consider productive government expenditures.

2.1. Preferences

Consider an economy which consists of an infinite sequence of two-period lived overlapping generations as well as an initial old generation. There is no population growth and each generation contains a continuum of agents. Agents' liquidity needs are generated in this model in the spirit of Champ, Smith and Williamson [92]. Thus, our model is a spatial separation version of an overlapping generation model. Agents are identical with preferences being represented by the following isoelastic utility function:

$$U(C_1, C_2) = -C_2^{-\gamma}/\gamma, \tag{2.1}$$

where C_i denotes age i consumption and $\gamma > -1$. All agents are endowed with one unit of labor which they supply inelastically in their first period for which they get paid the real wage w_t. Since individuals do not derive utility from age one consumption, all wage income is saved.

The only source of heterogeneity among young agents is their ex-post location. During their second life period, agents are transferred with probability π to another location and are allowed to remain in their original location with probability $(1-\pi)$. If transferred to another location, agents are able to consume only if they hold fiat money.

2.2. Technology

In each location of the economy, a perishable consumption good is produced, at each date t, by individual firms using physical capital K_t and labor L_t according to the production function

$$Y_t = A\overline{K_t}^{\,1-\alpha} K_t^{\alpha} L_t^{1-\alpha}, \tag{2.2}$$

where as in Romer [86] $\overline{K_t}$ denotes the "average" positive externality level of capital stock per firm. A unit of capital at $t+1$ is obtained by foregoing a unit of consumption good at t. For simplicity, we assume full depreciation of capital at each date.

Profit maximization of firms implies that factors of production are paid their marginal products. Since $\overline{K_t} = K_t$ and $L_t = 1$ in equilibrium, the rental rate of capital r_t and the real wage rate w_t are given by

$$r_t = \alpha A \overline{K}_t^{1-\alpha} (K_t/L_t)^{\alpha-1} = \alpha A, \tag{2.3}$$

$$\textit{and } w_t = (1-\alpha) A \overline{K}_t^{1-\alpha} (K_t/L_t)^{\alpha} = (1-\alpha) A K_t. \tag{2.4}$$

2.3. Government

The government relies on two revenue sources to finance its expenditures G_t: seigniorage tax $[M_t - M_{t-1}]/P_t$ and income tax τw_t, where M denotes the nominal stock of fiat money and P denotes the price level . The consolidated government budget constraint is then given by

$$G_t = \tau w_t + [M_t - M_{t-1}]/P_t. \tag{2.5}$$

To allow for perpetual growth, we further assume that government spending is a fraction β of total output so that, $G_t = \beta Y_t$, where $\beta \in (0, 1)$ will be the policy parameter that indicates how large government spending is relative to the size of the economy.[4]

2.4. Banks' Portfolio Choice

Notice that the stochastic relocation of young agents in our model serves the same purpose as the "liquidity preference shock" in the (D-D) model which, in turn, creates a role for banks to provide liquidity. Given the laissez-faire environment of

[4]This is a common assumption adopted in endogenous growth models (e.g., Roubini and Sala-i-Martin [92]).

banking in the economy and the fact that by design, financial intermediaries can exploit the law of large numbers whereas individual agents cannot, if banks exist, then all savings are intermediated, as shown in (D-D). Thus, each young agent deposits her entire savings, $(1-\tau)w_t$, in a bank while financial intermediaries hold both fiat money and capital. If banks hold fiat money M_t,which is supplied by the government and the old inelastically, they receive a return $P_t/P_{t+1} \equiv R_t^m$. On the other hand, banks receive r_{t+1} on their capital investment. Finally, banks pay individual depositors moving to *another* location a return R_t^a while they pay R_t^s to those agents *staying* at the original location.

In this model, fiat money is the only means of smoothing consumption in the presence of relocation (liquidity shocks). As in (D-D), banks can be viewed as cooperative entities consisting of coalitions formed by young agents. The banks' portfolio problem consists of maximizing their customers' (young agents') welfare taking into account the possibility that some of their customers face a sudden relocation. To that end, banks hold fiat money which captures the notion that financial intermediaries fulfill a liquidity provision role in the economy. In addition, banks invest in capital to satisfy the needs of their customers that stay at the original location. Banks choose q_t (where q_t denotes the fraction of total savings invested in capital) to maximize the expected lifetime utility of a representative depositor:

$$V(.) \equiv -\pi[(1-\tau)w_t R_t^a]^{-\gamma}/\gamma - (1-\pi)[(1-\tau)w_t R_t^s]^{-\gamma}/\gamma, \qquad (2.6)$$

subject to two resource constraints. First, there are π agents going to another location who must be given fiat money, which is accomplished by using the bank's holdings of currency. Since the return paid to each unit of fiat money is R_t^m, the following condition has to hold:

$$R_t^a = R_t^m(1-q_t)/\pi. \qquad (2.7)$$

Whenever R_t^adominates fiat money, all savings are channelled through financial intermediaries and the only relevant asset choice problem is that depicted by (2.6). So the $(1-\pi)$ agents staying in the same location will be repaid from the banks' capital investments. By diversifying their capital investments, banks guarantee themselves one unit of capital at $t+1$ per unit deposit invested at t. Given the rental rate of capital is r_{t+1}, the choice of R_t^s must satisfy the following second constraint:

$$R_t^s = r_{t+1}q_t/(1-\pi). \tag{2.8}$$

The solution to maximizing (2.6) subject to the resource constraints (2.7) and (2.8) is given by

$$q_t = \frac{\Phi_t}{1+\Phi_t}, \tag{2.9}$$

where $\Phi_t \equiv \left(\frac{1-\pi}{\pi}\right)\left(\frac{R_t^m}{\alpha A}\right)^{\gamma/(1+\gamma)}$. This concludes our description of the model.

3. Balanced Growth Analysis

In order to satisfy the liquidity needs of young agents commuting to a new location, banks hold a fraction $1-q_t$ of the total savings, $(1-\tau)w_t$, in the form of fiat money:

$$m_t \equiv M_t/P_t = (1-q_t)(1-\tau)w_t.$$

Substituting (2.4) and (2.9) into the above expression of m_t, we get a simple expression for the demand for real currency holdings as a function of its return (the inverse of the inflation rate) and after-tax income

$$m_t = \frac{(1-\tau)(1-\alpha)AK_t}{1+\Phi_t(R_t^m)}. \tag{3.1}$$

Since banks invest a portion q_t of the aggregate savings in capital stock at each date, we get the following goods market equilibrium condition:

$$K_{t+1} = q_t(1-\tau)w_t. \tag{3.2}$$

We now define the balanced growth equilibrium for the economy.

Definition Given $M_{-1}, K_{-1}, \beta, \tau$ and π, a balanced-growth equilibrium consists of a set of nonnegative sequences $\{C_t, K_t, M_t, P_t, w_t, R_t^m$ and $r_t\}$ for $t \geq 0$ which satisfies (2.3), (2.4), (2.5), (2.7), (2.8), (3.1) and (3.2). Moreover, along a balanced growth path, all extensive variables $\{C_t, K_t, M_t, Y_t, P_t$ and $w_t\}$ grow at constant rates while all intensive variables $\{R_t^m, R_t^a, R_t^s, r_t\}$ remain constant.

Substituting (2.4) and (2.9) into (3.2), we obtain the equilibrium gross growth rate of the capital stock[5]:

$$\theta = K_{t+1}/K_t = \frac{(1-\tau)(1-\alpha)A\Phi}{1+\Phi}. \tag{3.3}$$

Since (2.2) implies that $Y_t = AK_t$ along a balanced growth path, θ is also the equilibrium rate of output growth. Next, we rewrite the government budget constraint (2.5) as

$$\beta Y_{t+1} - \tau w_{t+1} = m_{t+1} - m_t P_t / P_{t+1}. \tag{3.4}$$

From (3.1), m_t is growing at the same rate θ as capital so that $m_{t+1} = \theta m_t$. Together with (2.4) and (3.3), equation (3.4) can be written as

$$Y_{t+1}[\beta - (1-\alpha)\tau] = \underbrace{\frac{(1-\tau)(1-\alpha)}{1+\Phi}Y_t}_{\chi_1} \; \underbrace{(\theta - R^m)}_{\chi_2},$$

where χ_1 can be interpreted as the inflation tax base and χ_2 can be interpreted as the inflation tax rate. Dividing both sides by Y_t, the government budget constraint

[5]Since intensive variables remain unchanged at the balanced growth equilibrium, we henceforth supress the time subscript for these variables.

can be written as

$$\beta = \underbrace{(1-\alpha)\tau}_{\omega_1} + \underbrace{\frac{(1-\tau)(1-\alpha)}{1+\Phi}\left(1-\frac{R^m}{\theta}\right)}_{\omega_2}. \tag{3.5}$$

The right hand side of equation (3.5) clearly spells out the share of the tax burden necessary to finance β. Namely, ω_1 denotes the income tax share and ω_2 denotes the seignorage tax share. Equations (3.3) and (3.5) yield a two-equation system for θ and R^m and we are thus ready to characterize the equilibria. Also, here thereof, we will assume that government deficits are not big enough that they cannot be financed exclusively with income taxes, that is, we assume $(1-\alpha) > \beta$. Before proceeding, note that substituting (3.3) into (3.5) to eliminate θ, we obtain

$$\beta - (1-\alpha)\tau + \frac{R^m}{\Phi A} = \frac{(1-\tau)(1-\alpha)}{1+\Phi}. \tag{3.6}$$

For convenience in future reference, define $\Psi(R^m)$ and $\Gamma(R^m)$ to be the left hand side and right hand side of (3.6), respectively. Note also that one can solve for the equilibrium R^m in (3.6) and for the equilibrium θ in (3.3).

We are now equipped to review alternative equilibria. The next two propositions show that whether we face a unique or multiple equilibria depends on the agents' degree of risk aversion. In particular, uniqueness of a non-trivial equilibrium is guaranteed if agents are sufficiently risk averse. This in turn has important policy implications. For instance, it is possible for a government to finance additional government expenditures via seignorage but without stirring up inflation if agents exhibit a low degree of risk aversion.

Proposition 3.1. *(Uniqueness of equilibrium) There exists a unique non-trivial balanced growth equilibrium if and only if agents are "fairly" risk averse, i.e.* $\gamma > 0$, *and* $(1-\alpha) > \beta > (1-\alpha)[1-(1-\pi)(1-\tau)-\alpha\pi/(1-\alpha)(1-\pi)]$.

Proof. We start by noting that for $\gamma > 0$, $\Psi(0) = \beta - (1-\alpha)\tau$ and $\Gamma(0) = (1-\tau)(1-\alpha)$. Further, $\Psi' > 0$ and $\Gamma' < 0$ *for* $R^m \in (0,r)$. This together with the other assumption in the proposition guarantee a graphical representation for Ψ and Γ as displayed in figure 1.Ψ and Γ intersect only once in the interval $R^m \in (0,r)$ implying a unique R^m equilibrium which by (3.3), in turn, determines the unique positive equilibrium growth rate θ.

Proposition 3.2. *(Multiple equilibria) If the coefficient of the relative risk aversion is low enough* $(\gamma < 0)$, *then multiple equilibria may occur.*

Proof. For $0 > \gamma > -1$, then $\Psi(0) = \beta - (1-\alpha)\tau, \Gamma(0) = 0, \Psi' > 0, \Psi'' > 0, \Gamma' > 0$ and $\Gamma'' < 0$ *for* $R^m \in (0, r)$. This, in turn. implies a graphical representation for Ψ and Γ, for the case of a positive deficit to be financed and $\beta > (1-\alpha)[1-(1-\pi)(1-\tau) - \alpha\pi/(1-\alpha)(1-\pi)]$, as that displayed in figure 2. When $[\beta-(1-\alpha)\tau)]/[(1-\tau)(1-\alpha)] \neq [1+(1+\gamma)\Phi]/(1+\Phi)^2$, there will be two equilibria[6].□

Clearly, the above propositions show that uniqueness of equilibrium cannot always be guaranteed. This implies the potential for different inflationary and growth outcomes arising from otherwise identical policy experiments as stated above. Furthermore, as we explain below, a key consideration on any policy prescription is whether the original equilibrium is on the upward or downward side of the seigniorage Laffer curve.

Most previous policy analyses contain implicit (and many times ad-hoc) assumptions that cause them to concentrate on one side of the seignorage Laffer curve, thus neglecting potentially interesting cases. The detailed specification of intermediaries here, allows us to obtain the complete spectrum of the seigniorage Laffer curve. Indeed, the unique equilibrium in proposition 1 and the low-inflation

[6]It is evident from figures 1 and 2 that trivial unique equilibria arise whenever (i) $0 > \gamma > -1$ and $[\beta-(1-\alpha)\tau)]/[(1-\tau)(1-\alpha)] = [1+(1+\gamma)\Phi]/(1+\Phi)^2$ or (ii) when $\gamma > 0$ and $(1-\alpha) = \beta$.

equilibrium of proposition 2 depict the downward sloping portion of the Laffer curve. Proposition 2 high inflation equilibrium, on the other hand, depict the upward portion of the Laffer curve. Stated differently, whenever agents exhibit a high degree of risk aversion all equilibria are located along the downward sloping side of the seigniorage Laffer curve. If on the other hand, agents exhibit a low degree of risk aversion. alternative equilibria can be located on either side of the seignorage Laffer curve. With this in mind. the following proposition and results provide a characterization of the different outcomes.

Proposition 3.3. *A sufficient condition for a seigniorage financed expansionary spending policy to lead to higher inflation is for financial intermediaries' customer to be fairly risk averse (i.e., $\gamma > 0$).*

Proof. Without fiscal accommodation, i.e. $d\tau = 0$, increases in government expenditures as a fraction of output, $d\beta > 0$, will have to be financed exclusively via seigniorage and it can be verified from (3.6) that whenever $\gamma > 0, dR^m/d\beta < 0$.□

For the case of multiple equilibria, as depicted in figure 3, the inflationary impact of an expansionary fiscal policy depends on the original equilibrium. If the original equilibrium is a low-inflation (high-inflation) one, then the expansionary policy will be inflationary (deflationary), i.e. $dR^m/d\beta < (>)0$. To understand the intuition behind this result notice that regardless of γ's sign, without fiscal accommodation, i.e. $d\tau = 0$, increases in government spending share, $d\beta > 0$, will have to be financed via additional seigniorage.

Suppose for example that the original equilibrium is the high-inflation one. Such equilibrium would be on the upward-sloping portion of the Laffer seigniorage curve. In this case, a small drop in the inflation rate will lead agents to hold a proportionally larger amount of monetary base. So that on net, total seigniorage would go up, and a fiscal expansionary policy could take place without stirring up inflation.

To close this section, we provide the following results on the growth and inflation trade-off.

Result 1 When agents are fairly risk averse, i.e., $\gamma > 0$, a seigniorage-financed expansionary fiscal policy will lower the equilibrium rate of growth.

Proof. It follows from the fact that whenever $\gamma > 0, \Phi'(R^m) > 0$ which by (3.3) leads to $d\theta/dR^m > 0$.

This result says that on net, whenever intermediaries customers exhibit a high degree of risk aversion, higher inflation leads to larger holdings of real balances for precautionary reasons having as a consequence a drop in capital and growth. Thus, this result together with proposition 1, lends some support to a prominent claim in the LDC literature; that in an economy with high inflation, fiscal expansionary policy leads to higher inflation while retarding growth. Here, however, the result does not depend on the original equilibrium being a high inflation one. The only qualification is the degree of risk aversion.

Result 2 Whenever savers exhibit a low degree of risk aversion, a seignoirage-financed expansionary fiscal policy will lead to an inflation-growth trade-off in the balanced growth equilibrium.

Proof. Whenever $0 > \gamma > -1, \Phi'(R^m) < 0$ and from (3.3), we obtain $d\theta/dR^m < 0$.□

If the original equilibrium is a low-inflation one, a fiscal expansionary policy will be financed with more seigniorage brought about by a higher rate of inflation which will lead to a flight from real holdings of fiat money into capital leading thus to higher growth. This result replicates a version of the Tobin effect. It is important, however, to emphasize that here, the result holds for economies with low-inflation and agents displaying a low degree of risk aversion. If on the other hand, the original equilibrium was a high inflation one, an inflation-growth trade-off would still take place. The difference, however, is that in such equilibrium, a fiscal expansionary policy can be financed with a lower rate of inflation at the expense of lower growth.

These findings highlight the need for identifying the environment in which a policy experiment is to be performed. In particular, we have shown that the inflation and growth implications of an expansionary policy in the presence of financial intermediaries, depend on the degree of an agent's risk aversion. For example, it has been claimed that a drop in inflation comes at the expense of lower growth. The claim, as we show above, is true if banks' customers exhibit a low degree of risk aversion and the economy is at the low-inflation equilibrium. There is also a claim in the economic development literature that asserts that an expansionary policy will lead to higher inflation and lower growth. In this model, we show that the claim is true only if the financial intermediaries' customers are fairly risk averse.

3.1. The Tax Mix

Given a government deficit to be financed, one would like to know the implications of a move away from seigniorage tax financing towards income tax financing. In the context of developing economies. As mentioned in the introduction, McKinnon [91] and others have suggested that faced with the need to finance government expenditures, income taxation is the lesser of the evils given the destabilizing nature of seigniorage. Choosing monetization over income taxation will only lead to higher inflation and lower growth. Our analysis does not support this conventional wisdom. Proposition 4 lists the conditions under which a switch of financing method from seigniorage to income taxation can be deflationary but it further suppresses economic growth[7]. The corollary to this proposition spells the conditions under which such a switch in financing scheme actually increases growth but at the cost of higher inflation.

Proposition 3.4. *For a given level of government expenditures as a proportion of output, β, if (i) agents are fairly risk averse or if (ii) they exhibit a low degree of risk aversion, but the initial equilibrium is a low-inflation one, a switch of financing method from inflation to income taxation is deflationary but growth reducing.*

[7]The algebric details can be found in the appendix.

Proof. The situation studied can be characterized by $d\beta = 0$ and $d\tau > 0$. It can be verified from (3.3) and (3.6) that, whenever (i) $\gamma > 0$ or (ii) $0 > \gamma > -1$, and the initial equilibrium is a low inflation one, $dR^m/d\tau > 0$ and $d\theta/d\tau < 0$.□

The intuition of this proposition is straightforward. The original equilibria in the proposition are located on the upward-sloping portion of the seigniorage Laffer curve, so that moving away from seigniorage finance reduces the rate of inflation. On the other hand, taxing income reduces savings, capital accumulation and growth. Thus, a move from income to seigniorage taxation will result in lower rates of inflation at the expense of lower rates of growth.

Corollary 3.5. *For a given level of government expenditures as a proportion of output, β, if agents exhibit a low degree of risk aversion and the initial equilibrium is a high-inflation one, a switch of financing method from seigniorage to income taxation is inflationary but growth enhancing.*

Proof. Again, $d\beta = 0$ and $d\tau > 0$. It can be verified from (3.3) and (3.6) that, whenever $0 > \gamma > -1$ and the initial equilibrium is a high-inflation one, $dR^m/d\tau < 0$ and $d\theta/d\tau > 0$.□

4. Productive Government

Government involvement in private economic activity has often been acknowledged to work as an engine of growth. The development of railroads at the turn of the century and the development of strategic industries during WWII in the US have often been quoted as such examples. The underlying notion has been that governments are better equipped to undertake large investment projects which in turn have substantial positive spill over effects. If, as suspected government investments yield positive externalities, government investment, even at the cost of crowding out private investment, may under some conditions make sense.

Save for a few exceptions (e.g. Barro [90]), the formal analysis of government intervention treats government expenditures as pure consumption. Furthermore, even when government expenditures have been treated as providing positive externalities, not much attention has been paid to government budgetary considerations. For the most part, proponents of direct government intervention have paid little attention to the impact that alternative financing schemes would have on economic growth.

Here, we try to overcome these deficiencies by explicitly allowing for income tax and seignorage financing (a main tool of government financing in some economies), introducing government expenditures directly in the production process and retaining the liquidity provision assumption on the part of the financial intermediaries. We find, however, that a formal attempt evaluating the impact of specifically introducing government expenditures in the production function, on inflation and growth, is rather limited.

To capture the notion that government expenditures contribute with positive externalities to the production process, we adopt the following specification on the production technology.

$$Y_t = AG_t^{1-\alpha}K_t^{\alpha}L_t^{1-\alpha}. \tag{4.1}$$

Proceeding as before and after several substitutions, we are able to obtain analogs of equations (3.3) and (3.6).

$$\theta_G = \frac{(1-\tau)(1-\alpha)\Phi_G A^{1/\alpha}\beta^{(1-\alpha)/\alpha}}{1+\Phi_G}, \tag{4.2}$$

$$\beta - (1-\alpha)\tau + \frac{(1-\alpha)(1-\tau)R_G^m}{(1+\Phi_G)\theta_G} = \frac{(1-\tau)(1-\alpha)}{1+\Phi_G}, \tag{4.3}$$

where $\Phi_G \equiv \left(\frac{1-\pi}{\pi}\right)\left(\frac{R_G^m}{\alpha A^{1/\alpha}\beta^{(1-\alpha)/\alpha}}\right)^{\gamma/(1+\gamma)} > 0$ and θ_G and R_G^m denote the rate of growth and inflation. respectively, under productive government spending. Equations (4.2) and (4.3) yield a two-equation system in θ_G and R_G^m (see the appendix for algebraic details).

It can be shown that, as in proposition 1, whenever $\gamma > 0$ and $(1-\alpha) > \beta$, there is a non-trivial unique equilibrium pair (θ_G, R_G^m). In the non-productive government expenditures case that we analyzed above, an expansionary policy financed by seigniorage will always be inflationary when agents are fairly risk averse. The same may not be true, however, when government expenditures are productive.

Productive government expenditures have a positive net impact on growth which in turn boosts the seigniorage tax base (real holdings of fiat money). Thus one could observe an expansionary fiscal policy associated with a lower rate of inflation, i.e. a lower seignorage tax rate and still on net, larger seigniorage revenues and higher rate of growth.

As can be derived from (4.2)and (4.3), if seigniorage financing of an expansionary policy can be financed with a lower rate of inflation, it must be growth enhancing, i.e., $\widehat{R}_G^m/\widehat{\beta} > 0 \Rightarrow \widehat{\theta}_G/\widehat{\beta} > 0$.

To end this section, recall that when government expenditures are not productive, from a growth perspective, whenever $\gamma > 0$ or $\gamma < 0$ but the original equilibrium is a high-inflation one, a pure financing scheme is preferred over a mix financing scheme. The same is true for the case of productive government expenditures whenever $\gamma > 0$.[8]

Proposition 4.1. *Whenever government expenditures are productive and* $\gamma > 0$, *a move from income tax financing to seigniorage financing is growth enhancing.*

Proof. If government spending is productive and $\gamma > 0$, it is straightforward to show that $\widehat{\frac{\theta_G}{\tau}} < 0.\square$

Note that the characteristics specified in the proposition sets the initial equilibrium at the upward-sloping portion of the seigniorage Laffer curve. A move from income taxation to seignorage taxation generates higher inflation, while the lower income tax rate encourages savings and capital accumulation leading thus to faster growth.

[8]This extends the findings of Palivos and Yip [95] to the case of productive government expenditures.

5. Welfare

In this section, we review some of the claims surrounding fiscal and monetary policy interactions from a welfare perspective.[9] To that end, we adopt the standard practice of identifying the discounted lifetime indirect utility of the representative agent as the welfare criterion:

$$\Omega = \sum_{0}^{\infty} \rho^t V_t,$$

where V_t is the indirect utility function given in (2.6).[10] To insure boundeness we follow Barro [90] in assuming $\rho < \theta^{\gamma}$.

We start by first showing that for the case of non-productive government spending, both higher economic growth and lower inflation improve welfare in this model.

Result 3 The welfare indicator, Ω, is an increasing function of θ and R^m.

[9] For examples of related analyses in the context of exogenous growth and no financial intermediaries, see Turnovsky's work. One such example is Turnovsky [92].

[10] Since our main concern is allocative efficiency, we follow the conventional practice to ignore the initial old's utility in the evaluation of social welfare. For further details on competitive efficiency of overlapping generations, see Wang [93].

Proof. Expressing Ω as a function of the rates of economic growth and inflation, we have

$$\Omega = -\frac{[(1-\tau)(1-\alpha)AK_{-1}]^{-\gamma}\Upsilon(R^m)}{\gamma(\theta^{\gamma}-\rho)} \tag{5.1}$$

where $\Upsilon(R^m) \equiv \pi^{1+\gamma}(\frac{R^m}{1+\Phi})^{-\gamma} + (1-\pi)^{1+\gamma}(\frac{\alpha A\Phi}{1+\Phi})^{-\gamma} > 0$.[11] It can be shown via straightforward differentiation that regardless of γ,

$$\partial\Omega/\partial\theta > 0 \textit{ and } \partial\Omega/\partial R^m > 0. \square$$

Result 3, together with result 1, imply that whenever $\gamma > 0$ and government expenditures are non-productive, $\beta = 0$ maximizes Ω for any given τ. This is *not* to say, however, that the optimal monetary policy is one of maintaining a constant stock of fiat money in the economy. This is illustrated in the next result.

Result 4 Given $\gamma > 0$, if the government's expenditures are non-productive, for a given τ, the government should use the current income tax revenues to support a deflation.

[11] Tedious algebra yields $\Upsilon'(R^m) = -\frac{\gamma\pi^{1+\pi}(1+\Phi)^{\gamma}}{(R^m)^{1+\gamma}} \gtrless 0$ iff $\gamma \lessgtr 0$.

Proof. Directly differentiating Ω with respect to β, we have

$$\frac{d\Omega}{d\beta} = -\frac{[(1-\tau)(1-\alpha)AK_{-1}]^{-\gamma}}{\gamma}\frac{dR^m}{d\beta}\left[\frac{\Upsilon'}{\theta^\gamma-\rho} - \frac{\Upsilon\gamma\rho^{(\gamma-1)}}{(\theta^\gamma-\rho)^2}\frac{d\theta}{dR^m}\right] < 0,$$

which implies that given τ, $\beta = 0$ maximizes Ω. It follows from (3.3) that the available income taxes will be used to support a deflation.$\square$

Since result 3 implies that deflation improves welfare, devoting the existing income tax revenues (given a τ) to deflate the economy is Pareto superior to using the income tax proceeds to support non-productive government spending.

Next, recall from result 2 that whenever government expenditures are non-productive and $-1 < \gamma < 0$, there is a growth-inflation trade-off. Specifically, with a constant τ, if the initial equilibrium is the high-inflation one, an expansionary policy will be financed via a deflationary policy (since we are on the upward-sloping portion of the seigniorage Laffer curve) at the expense of lower growth. If on the other hand, the original equilibrium is the low-inflation equilibrium, an expansionary policy will be financed with an inflationary policy but it will also attain a higher rate of growth. It follows that unlike in the $\gamma > 0$ case, for a given τ, $\beta = 0$ may not maximize Ω due to the growth-inflation trade-off.

Finally, we have concentrated so far on the case where government expenditures are non-productive. We now explore some welfare implications of considering productive government expenditures.

Result 5 Regardless of γ, if a larger government expenditures share can be financed via a deflationary policy, it will be welfare enhancing.

Proof. Denote Ω_G as the lifetime utility under productive government spending. Directly differentiating Ω_G with respect to β, we have

$$\frac{d\Omega_G}{d\beta} = -\frac{[(1-\tau)(1-\alpha)AK_{-1})]^{-\gamma}}{\gamma}\left[\frac{\Upsilon'}{\theta^{\gamma}-\rho}\frac{dR_G^m}{d\beta} - \frac{\Upsilon\gamma\theta^{(\gamma-1)}}{(\theta^{\gamma}-\rho)^2}\frac{d\theta_G}{d\beta}\right]$$

It can be shown (as in the appendix) that $\frac{dR_G^m}{d\beta} > 0 \Rightarrow \frac{d\theta_G^m}{d\beta} > 0$, which in turn implies $\frac{d\Omega_G}{d\beta} > 0$.□

6. Concluding Remarks

This paper has studied the impact of fiscal and monetary policies interactions on inflation, growth and welfare in an economic environment with financial intermediaries. It bridged the money-endogenous-growth literature and the fiscal-policy-endogenous-growth literature. We reviewed several of the claims surrounding these interactions in the context of an explicit model of financial intermediation. We found that the relation between growth and inflation depends crucially on the agents' degree of risk aversion. In our paper, several of the conventional claims are found to be special cases. For example, when agents are fairly risk averse, stagflation occurs in the sense that higher inflation rates are correlated with lower rates of economic growth. If the agents' degree of risk aversion is low enough, then a Phillips-curve type trade-off between inflation and growth emerges. Moreover, the magnitude of the degree of risk aversion also plays a significant role on the existence and uniqueness of the balanced-growth equilibrium. The fundamental role of risk aversion is explained by the fact that risk aversion is key in the composition of the intermediaries' portfolio.

Another important contribution of this paper is its investigation on the impacts on growth and welfare of different government financing methods. From a growth perspective, when government spending is non-productive, we find that the growth maximizing financing structure is always pure rather than mix scheme. Pure seigniorage financing is always preferred except in the case of multiple equilibria and when we are at the high-inflation equilibrium initially. From a welfare perspective, we conjecture that mix-financing schemes may dominate although its analytical complexity limits our further exploration. Finally, our paper also sheds light on the issue of the desirability of government expenditures. When government spending is productive, we find that if such expenditures can be financed in a deflationary fashion, they will also be growth enhancing.

Before closing the paper, it is worth mentioning that one of our major assumptions is that financial intermediaries are free of restrictions such as binding reserve requirements. We are, therefore, unable to address the consequences of financial repression, which are commonly observed in developing countries.[12] In a companion paper of this one (Espinosa and Yip [95]), we relax this assumption and investigate the effects of financial repression on the endogenous growth process of the aggregate economy with explicit specification of financial intermediaries.

7. Appendix on Comparative Statics

7.1. Non-Productive Government Expenditures

Since $\Phi \equiv \left(\frac{1-\pi}{\pi}\right)\left(\frac{R^m}{\alpha A}\right)^{\gamma/(1+\gamma)}$, direct differentiation implies

[12] See, for example, Bencivenga and Smith [92] for an analysis within a neoclassical exogeneous growth framework.

$$\partial\Phi/\partial R^m = [\gamma/(1+\gamma)](\Phi/R^m) \ > 0, \tag{7.1}$$

$$\partial\Phi/\partial\pi = -[1/\pi^2](R^m/\alpha A)^{\gamma/(1+\gamma)} < 0. \tag{7.2}$$

Total differentiation of (3.3) and (3.5) yields the following matrix equation:

$$\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} d\theta \\ dR^m \end{bmatrix} = \begin{bmatrix} 0 & a_{14} & a_{15} \\ a_{23} & a_{24} & a_{25} \end{bmatrix} \begin{bmatrix} d\beta \\ d\tau \\ d\pi \end{bmatrix},$$

where

$a_{11} = 1 \quad a_{12} = -\frac{(1-\alpha)(1-\tau)A}{(1+\Phi)^2}\frac{\partial\Phi}{\partial R} < 0, \quad , a_{14} = -\frac{(1-\alpha)A\Phi}{1+\Phi} < 0,$

$a_{15} = \frac{(1-\alpha)(1-\tau)A}{(1+\Phi)^2}\frac{\partial\Phi}{\partial\pi} < 0, \quad a_{21} = \frac{(1-\alpha)(1-\tau)R^m}{(1+\Phi)\theta^2} > 0,$

$a_{22} = -\frac{(1-\alpha)(1-\tau)}{1+\Phi}\left[\frac{(1-R^m/\theta)}{1+\Phi}\frac{\partial\Phi}{\partial R} + \frac{1}{\theta}\right] < 0, \quad a_{23} = 1,$

$a_{24} = -(1-\alpha)\left(1 - \frac{1-R^m/\theta}{1+\Phi}\right) < 0, \quad a_{25} = \frac{(1-\alpha)(1-\tau)(1-R^m/\theta)}{(1+\Phi)^2}\frac{\partial\Phi}{\partial\pi} < 0.$

First, let $\Delta \equiv a_{11}a_{22} - a_{12}a_{21}$ be the determinant of the LHS 2×2 of the above matrix equation. It can be shown that

$$\Delta = -\frac{(1-\alpha)(1-\tau)}{1+\Phi}\left[\frac{1-R^m/\theta}{1+\Phi}\frac{\gamma}{1+\gamma}\frac{\Phi}{R^m} - \frac{\frac{\gamma}{1+\gamma}-(1+\Phi)}{(1-\alpha)(1-\tau)A\Phi}\right] < 0.$$

Applying Cramer's rule then yields the following comparative statics expressions reported in Results 1-3:

$$\frac{d\theta}{d\beta} = \frac{(1-\alpha)(1-\tau)}{(1+\Phi)\Delta}\left[\frac{(1-R^m/\theta)}{1+\Phi}\frac{\partial\Phi}{\partial R^m} + \frac{1}{\theta}\right] < 0,$$

$$\frac{dR^m}{d\beta} = \frac{1}{\Delta} < 0,$$

$$\frac{d\theta}{d\tau} = \frac{(1-\alpha)^2(1-\tau)AR}{(1+\Phi)^2\gamma\theta\Delta}\frac{\partial\Phi}{\partial R^m} < 0,$$

$$\frac{dR^m}{d\tau} = -\frac{(1-\alpha)\Phi}{(1+\Phi)\Delta} > 0,$$

$$\frac{d\theta}{d\pi} = -\frac{(1-\alpha)^2(1-\tau)^2A}{(1+\Phi)^3\theta\Delta}\frac{\partial\Phi}{\partial\pi} < 0,$$

$$\frac{dR^m}{d\pi} = \frac{(1-\alpha)(1-\tau)}{(1+\Phi)\Phi\Delta}\frac{\partial\Phi}{\partial\pi}\left(\frac{\Phi}{1+\Phi} - \frac{R}{\theta}\right) \gtrless 0.$$

7.2. Productive Government Expenditures

Next, we consider the case where government spending is productive as studied in section 4. Totally differentiating (4.2) and (4.3),

$$\begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}\begin{bmatrix} \widehat{\theta}_G \\ \widehat{R}_G \end{bmatrix} = \begin{bmatrix} b_{13} \\ b_{23} \end{bmatrix}\widehat{\beta} + \begin{bmatrix} b_{14} \\ b_{24} \end{bmatrix}\widehat{\tau},$$

where the hat notation "ˆ" denotes proportional change of a variable. The coefficients, b's, are given as follows:

$$b_{11} = 1, \quad b_{12} = -\frac{\gamma}{(1+\Phi_G)(1+\gamma)} < 0, \quad b_{13} = \frac{1-\alpha}{\alpha}\left(1 - \frac{\gamma}{1+\gamma}\frac{1}{1+\Phi_G}\right) > 0, \quad b_{14} = -\frac{\tau}{1-\tau} < 0,$$

$$b_{21} = \frac{(1-\alpha)(1-\tau)R_G^m}{(1+\Phi_G)\theta_G} > 0, \quad b_{22} = -\frac{(1-\alpha)(1-\tau)}{1+\Phi_G}\left[\frac{R_G^m}{\theta_G} + \left(1 - \frac{R_G^m}{\theta_G}\right)\frac{\gamma}{1+\gamma}\frac{\Phi_G}{1+\Phi_G}\right] < 0,$$

$$b_{23} = \beta - [\beta - (1-\alpha)\tau]\frac{1-\alpha}{\alpha}\frac{\gamma}{1+\gamma}\frac{\Phi_G}{1+\Phi_G}, \quad b_{24} = \tau(1-\alpha)\left[\frac{1-R_G^m/\theta_G}{1+\Phi_G} - 1\right] < 0.$$

Let $\Delta_G \equiv b_{11}b_{22} - b_{12}b_{21}$ be the determinant of the LHS 2×2 of the above matrix equation. It can be shown that

$$\Delta_G = -\frac{(1-\alpha)(1-\tau)}{1+\Phi_G}\left[R_G^m\left(1 - \frac{\gamma}{1+\gamma}\frac{1}{1+\Phi_G}\right) + \left(1 - \frac{R_G^m}{\theta_G}\right)\frac{\gamma}{1+\gamma}\frac{\Phi_G}{1+\Phi_G}\right] < 0.$$

Applying Cramer's rule, we obtain the following comparative statics results

$$\frac{\widehat{\theta_G}}{\widehat{\beta}} = \frac{\frac{\gamma}{1+\gamma}\frac{\beta}{1+\Phi_G} - \Lambda}{\Delta_G}, \quad \frac{\widehat{R_G^m}}{\widehat{\beta}} = \frac{\beta - \Lambda}{\Delta_G},$$

where

$$\Lambda \equiv \frac{1-\alpha}{\alpha}\frac{(1-\alpha)(1-\tau)}{1+\Phi_G}\left[\frac{R_G^m}{\theta_G}\left(1 - \frac{\gamma}{1+\gamma}\frac{1}{1+\Phi_G}\right) + \left(1 - \frac{R_G^m}{\theta_G}\right)\frac{\gamma}{1+\gamma}\frac{\Phi_G}{1+\Phi_G}\right] > 0.$$

Further, we have

$$\frac{\widehat{\theta_G}}{\widehat{\tau}} = \frac{\frac{1-\alpha}{1+\gamma}\frac{\tau}{1+\Phi_G}\frac{R_G^m}{\theta_G}}{\Delta_G} < 0, \quad \frac{\widehat{R_G^m}}{\widehat{\tau}} = \frac{\tau}{\Delta_G}\left[\frac{1}{1+\Phi_G}\left(1 - \frac{R_G^m}{\theta_G}\right) - 1 - \frac{\tau}{1-\tau}\frac{\gamma}{1+\gamma}\frac{1}{1+\Phi_G}\right] > 0.$$

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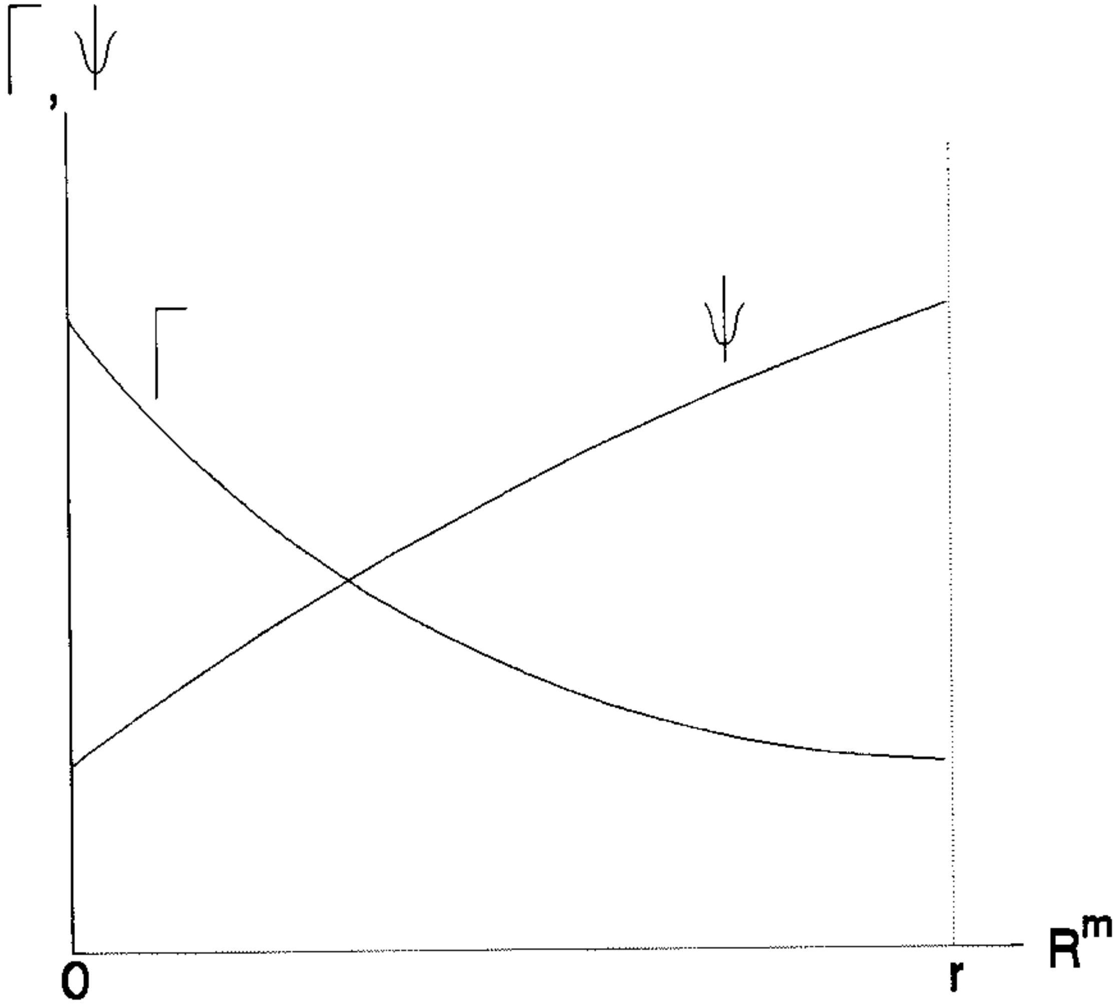

Figure 1 ($\gamma > 0$)

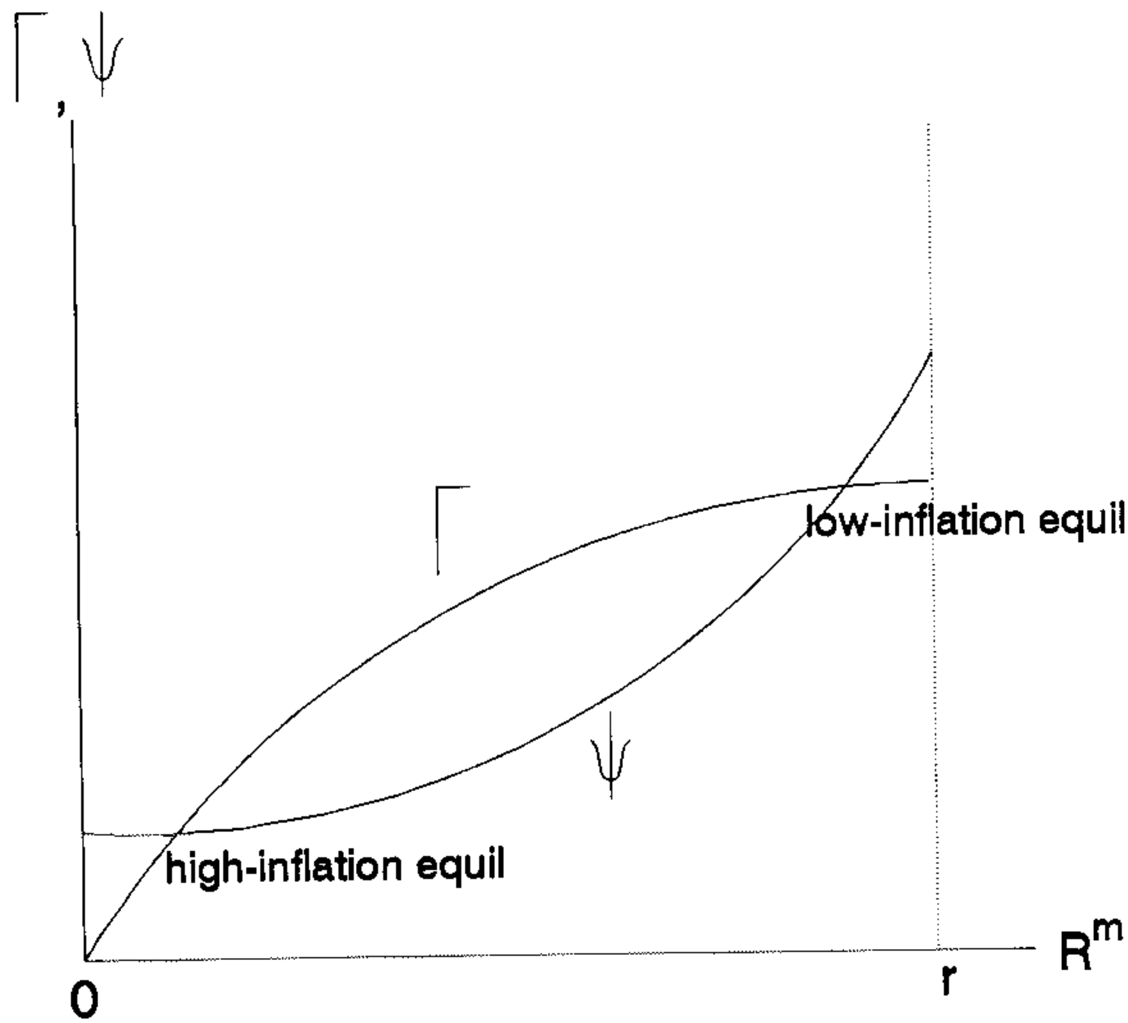

Figure 2 ($-1 < \gamma < 0$)

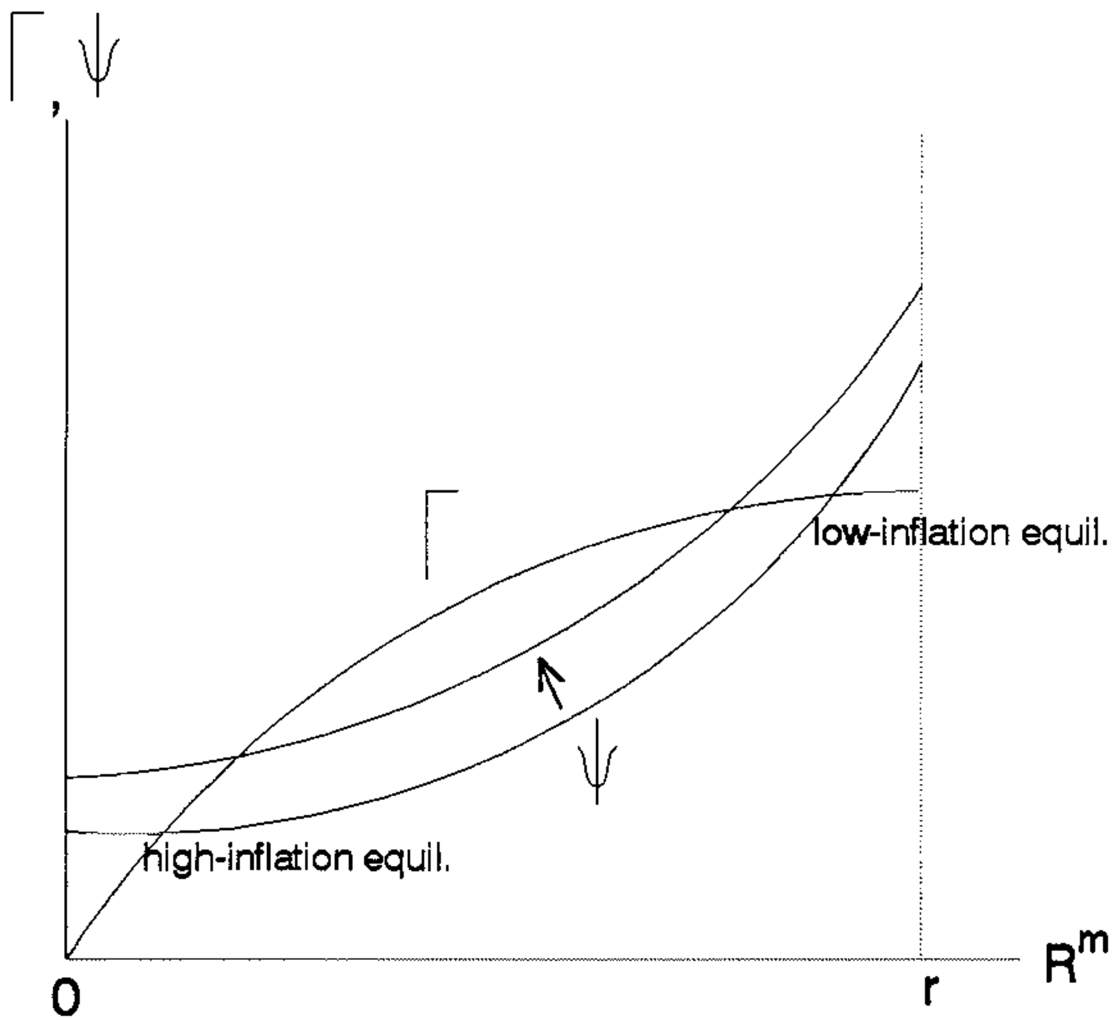

Figure 3 (an expansionary fiscal policy)