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## Aid, Budgetary Policies, and the Macroeconomy: Growth, Inflation, and Welfare

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# Aid, Budgetary Policies, and the Macroeconomy: Growth, Inflation, and Welfare

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**Abstract**

This paper examines the macroeconomic effects of foreign aid transfers in a small open recipient economy. The focus, however, is not on the impact of foreign aid per se but rather on aid's influence conditional upon the different budgetary financing policies under the discretion of the recipient government. We compare the effects of an aid transfer tied to investment in a public good from a pure aid transfer, under income-tax and/or inflation-tax financing of government expenditures. The effects of each form of aid under each type of public financing are examined with respect to the economic growth rate, the rate of inflation, and the percentage change in welfare of the recipient economy. The economy is analyzed numerically and specific policy recommendations are provided for individual recipient countries.

*JEL Classification*: E6; F35; F43; O11

*Keywords*: Aid; Economic growth; Inflation; Public financing; Welfare

## 1. Introduction

A considerable amount of research has been devoted towards understanding the effects of foreign aid on the macroeconomic performance of the recipient countries (see White 1992 and Hansen and Tarp 2000 for surveys of the literature). Most of this research has been empirical in nature, focusing on the effects of foreign aid on the levels of savings, investment, and economic growth (Papanek 1973, Levy 1987, Boone 1996, Lensink and White 1999, Hansen and Tarp 2000, 2001, Easterly 2003, Dalgaard *et al.* 2004). Much less research has been directed towards

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building theoretical models that would identify the mechanism through which aid affects the macroeconomy. Within this theoretical literature, even less studies pay close attention to the government sector and the impact of aid as being dependent on the government budgetary policies. This is particularly notable given that the macroeconomic consequences of foreign aid are highly influenced by public policies since aid is given primarily to governments in aid-recipient countries. To close this gap, this paper presents an analysis of foreign aid, growth, inflation, and welfare that incorporates the simultaneous interaction of foreign aid receipts and public financing policies within an endogenous growth framework.

Although the empirical literature on the impact of aid has greatly evolved since the early studies of the 1960s, which focused on the Harrod-Domar growth model and viewed aid as an exogenous increment to investment in the recipient country (Svensson 1999, Burnside and Dollar 2000, Guillamont and Chauvet 2001, Roodman 2003, Easterly *et al.* 2004), there remains relatively little theoretical research on the modeling of foreign aid with the view to explaining the mechanism by which aid could be translated into growth. Recent exceptions are the innovative analyses of Hatzipanayotou and Michael (2000) and a series of papers by Chatterjee *et al.* (2003) and Chatterjee and Turnovsky (2004, 2005). The former develop a model in which the effects of aid are examined in a two-country general equilibrium trade environment as a function of two policies the donor uses (income tax and consumption tax) to raise funds for aid purposes. Their focus is on the impact of aid on the terms of trade, on employment, and on national (both donor and recipient) and world welfare. The latter develop a framework in which they capture the diverse effects that permanent and temporary aid transfers have on long-run growth and welfare, as well as on the transitional paths, of the recipient country. Moreover, they distinguish between aid transfers tied to investment in public infrastructure and transfers that are untied (pure) in nature. The main purpose of each of these analyses is to explain the developmental impact of aid transfers in the recipient economy without delving into the question of how the recipient country's policies can influence the effectiveness of aid. In view of the recent empirical evidence, however, there is clearly a need to understand the way by which recipient government policies may affect the macroeconomic performance of aid. Therefore, this paper focuses on the aid-recipient government in seeking to explain how its behavior influences the effectiveness of aid by the use of monetary and fiscal policies.

The analysis builds on two strands of literature: the aid literature and the literature analyzing the role of government policies in the growth process. Within this framework, a model is developed in which a publicly provided good is used as an input in the production process of the private sector. It is assumed that the public good is provided without user charges and is free of congestion effects, in order to keep the analysis as simple as possible. This public good may be financed through domestic taxation and aid inflows. Domestic taxation is in the form of income and/or inflation taxes. Aid inflows are under the discretion of the recipient government and can be tied to the project of financing the public good or be provided as lump-sum transfers to households. Thus the model incorporates the interaction of domestic financing policies and aid inflows, allowing an examination of the macroeconomic impact of aid. The study innovates on several grounds. First, the analysis relies on a nonlinear model in contrast to most theoretical studies which use either static models or linearize their solution around the steady state, thus losing valuable information. Second, we pay particular attention to the government sector by incorporating monetary factors on the revenue side. This allows us to examine the endogenous response of the government budget to resource transfers from abroad, and evaluate their impact on the rate of inflation. Third, we accommodate into our analysis the element of currency substitution, an important characteristic of many small aid-recipient countries that has not received a lot of attention in the aid literature.

The model is solved analytically for a set of equations that express the interaction among the growth rate of the economy, the receipts of foreign aid, the level of currency substitution, and the degree of financial sophistication under inflation-tax and income-tax financing of the public good. These expressions are used to provide insights for the growth rate, welfare, and rate of inflation under each form of domestic finance with increasing levels of foreign aid. The main implication of the analysis is that the impact of aid on the macroeconomy mainly depends upon: i) the type of aid (tied or pure), ii) the quantity of aid, and iii) the domestic financing policy employed by the recipient government. Accordingly, a pure aid transfer is found to have a positive effect on growth only when the government utilizes inflationary finance. By contrast, tied aid raises growth with *both* forms of finance. At the same time, pure aid leads to a higher rate of inflation with seigniorage finance of public spending, while tied aid yields a ranking of the inflation rate that depends on the size of aid. For higher amounts of tied aid, the rate of inflation becomes greater when the government resorts to income taxes as a source of revenue.

The welfare analysis shows that both types of aid transfers entail gains, though of a different magnitude. Furthermore, the analysis depicts, in line with the empirical evidence, that both forms of domestic public finance are associated with diminishing returns to aid.

The remainder of the study is organized as follows. Section 2 describes the economic environment and derives the equilibrium conditions. Section 3 presents the growth equations under the two alternative budgetary policies, while section 4 compares and contrasts the effects of these policies on growth, inflation, and welfare in the presence of aid. Section 5 analyzes the mix of taxes that maximizes the growth rates with tied versus pure aid transfers. Section 6 targets the implications of the model to specific countries. Finally, section 7 offers brief conclusions and directions for future research.

## 2. Analytical Framework

### *2.1. The Economy*

The structure of the model is based on the endogenous growth paradigm, a framework extensively used for the study of fiscal and monetary policies and their effects on growth (Barro 1990, Barro and Sala-i-Martin 1992, and Palivos and Yip 1995). Within this framework, our focus is on an aid recipient small open economy with the view of explaining the impact of aid on growth, inflation, and welfare contingent on different public financing policies.

Consider a world where there exists a small open economy that produces and exports good $x$ to the rest of the world and imports good $y$ from the rest of the world. These transactions lead to balanced trade in every period. From the small open economy's perspective, the relative price of $y$ in terms of $x$ is determined outside its borders. Thus, the small open economy takes its terms of trade ($q$) as constant and exogenous. For simplicity, $q$ is normalized to unity.

There are three decision-making units interacting in this economy: firms, households, and the government. Firms are assumed to produce good x with a Cobb-Douglas production function, which in per capita form looks like:[1]

$$x_t = A k_t^{1-\alpha} G_t^{\alpha}, \quad 0 < \alpha < 1, \tag{1}$$

where $x$ denotes output per capita, $A$ is a technological parameter, $k$ denotes capital per capita, and $G$ is a non-rival and non-excludable input in the production process (Barro and Sala-i-Martin

[1] It is easier to think this economy as consisting of a large but finite number of identical households and firms, where each household owns a firm.

1992). The production function exhibits private diminishing returns, but constant returns to scale in both $k$ and $G$.[2] Each firm takes the level of $G$ as exogenously given when solving its capital accumulation plan. Finally, without any loss of generality, we assume that there is no depreciation of the capital stock.

Households are infinitely-lived and have perfect foresight. They derive utility by consuming the domestically produced good, $x$, and the imported good, $y$. Their instantaneous utility function is of the logarithmic form, where fractions $\psi$ and $(1-\psi)$ of goods $x$ and $y$ respectively, $\psi \in (0,1)$, represent the shares of the two goods in the households total consumption bundle. Households are therefore assumed to maximize a utility function of the form:

$$\max U_0 = \int_0^{\infty} e^{-\rho t}[\psi \ln c_{x_t} + (1-\psi)\ln c_{y_t}]dt, \qquad (2)$$

where $\rho$ is the household's subjective rate of time preference, $c_{xt}$ is per capita consumption of the domestically-produced good, and $c_{yt}$ is per capita consumption of the imported good. We ignore population growth to avoid a scale effect.

Each time period, the households face two constraints. The first is a budget constraint which, in real terms, is:

$$c_{x_t} + c_{y_t} + \dot{k}_t + \dot{m}_t + \dot{n}_t = (1-\tau)Ak_t^{1-\alpha}G_t^{\alpha} - \pi m_t + (\varepsilon - \pi)n_t + T_t, \qquad (3)$$

where $m$ denotes real domestic money balances, $n$ denotes real foreign money balances, $\tau$ is a proportional income tax rate, $\pi$ is the inflation rate, $\varepsilon$ represents the rate of depreciation of the home currency, and $T$ stands for lump-sum government transfer payments. A dot over a variable denotes a derivative with respect to time.

With $P$ denoting the domestic-currency price of the home-produced good, $P^*$ the foreign-currency price of the imported good, and the nominal exchange rate $e$ denoting the relative price of foreign currency in terms of home currency $(P = eP^*)$, the depreciation rate is $\varepsilon = \frac{\dot{e}}{e} = \pi - \pi^* + \frac{\dot{q}}{q}$. Inflation in the rest of the world is given by $\pi^*$, and $\frac{\dot{q}}{q}$ denotes the change over time in the small open economy's terms of trade. The economy under consideration takes

[2] This assumption plays a critical role and enables the analysis of long-run effects of policy without the study of transitional dynamics.

$P^*$ as exogenous and given. With a similar assumption about $q$, this implies that $\pi^* = \frac{\dot{q}}{q} = 0$. Hence, $\varepsilon = \pi$. Subsequently, the next to last term in the right hand side of equation (3) drops out. Moreover, recognize that real domestic money balances grow at the rate of nominal domestic balances less the rate of domestic inflation $(\frac{\dot{m}}{m} = \mu - \pi)$, and the real foreign money balances grow at the rate of nominal foreign money balances less the rate of home inflation plus the rate of depreciation of the home currency $(\frac{\dot{n}}{n} = \mu^* - \pi + \varepsilon = \mu^*)$.

The second constraint is a cash-in-advance (CIA) constraint. It requires all purchases of consumption goods and a fraction, $\varphi \in [0,1]$, of domestic investment be made with a combination of domestic and foreign currencies (Calvo and Végh 1994, Dotsey and Sarte 2000). In real terms this constraint is:

$$c_{x_t} + c_{y_t} + \varphi \dot{k}_t \leq m_t^{\omega} n_t^{1-\omega} \tag{4}$$

where $\omega \in (0,1)$ denotes the share of domestic currency in total liquidity and represents a measure of currency substitution.[3] $\varphi$ can be thought of as a measure of the degree of financial development of the economy, where a lower $\varphi$ represents a higher degree of financial sophistication.[4] The specification of the liquidity aggregator on the right-hand side of the equation indicates that the domestic and foreign currencies are imperfect substitutes, implying that there may be legal restrictions on using the foreign currency in the domestic economy or that there may be higher costs associated with transacting in the foreign, rather than the domestic currency.[5] The choice of a CIA constraint as the method for introducing currency substitution in the model is due to its tractability, its direct focus on the transactions technology, and the simple money demand functions it yields.

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[3] The literature offers several ways to model currency substitution. See Végh (1989), Giovannini and Turtelboom (1992), Sturzenegger (1997), and Tandon and Wang (1999) among others.

[4] The $\varphi=0$ case describes the Lucas (1980) economy, while $\varphi=1$ depicts the setup in Stockman (1981). Our model captures both situations as polar cases. For simplicity, the fact that $\varphi$ and $\omega$ may themselves be endogenous is not considered. For examples where the degree of financial sophistication may be contingent on inflation, see Boyd, Levine, and Smith (1998).

[5] Any liquidity aggregator, *h(.)*, must be linearly homogeneous, twice-continuously differentiable, and display the following features: $h_M > 0$, $h_N > 0$, $h_{MM} < 0$, $h_{NN} < 0$, and $h_{MN} > 0$. The Cobb-Douglas specification has all of these properties; see Calvo and Végh (1994).

To close the model we need to specify how the government operates. Obstfeld (1999) highlighted the importance of the government sector in fully capturing the effects of aid on the recipient economy. Along this line, we pay detailed attention to the government budget by incorporating productive public spending and two types of distortionary taxes – income and seigniorage. The inclusion of seigniorage allows us to analyze the endogenous response of the inflation-tax rate and the inflation-tax base to resource inflows (*TR*). In addition, in order to focus on the effects of aid conditional on the collection and use of domestic resources, we assume that the government can neither borrow nor lend. Small aid-recipient countries frequently have very limited access to international and domestic borrowing due to extremely high levels of debt. As a result both domestic private agents and foreign financial institutions believe that there is a large incentive for these governments to default on their debt obligations. Under these conditions, the governments will be unable to acquire any domestic or international borrowing (Roubini and Sala-i-Martin 1995). Therefore, the government budget constraint is given by:

$$G_t + T_t = \tau x_t + \mu m_t + TR_t. \tag{5}$$

The government finances its activities of providing the public input, *G*, and transfer payments, *T*, through domestic income taxation, and/or domestic inflation taxation, along with foreign aid transfers, in such a way that it runs a balanced budget in every period. [6]

Furthermore, it is assumed that the entire income-tax and inflation-tax revenue is spent by the government on the provision of the public good *G*. Moreover, the foreign aid transfers may be tied or untied to investment in the public good.[7] These imply:

$$G_t = \tau x_t + \mu m_t + \zeta TR_t, \quad 0 \leq \zeta \leq 1 \tag{6}$$

where $\zeta$ represents the degree to which the aid transfers from abroad are tied to investment in the provision of the public good. When $\zeta = 1$, transfers are completely tied to investment in the public input, implying a productive transfer. With $\zeta = 0$, incoming aid transfers are not tied to the production of *G*, representing a pure or untied transfer.[8]

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[6] The foreign aid transfers (*TR*) and the rates of income taxation ($\tau$) and money growth ($\mu$) are required to be non-negative and constant for the existence of a balanced growth equilibrium path.

[7] Foreign development assistance can be tied in various forms. "Firstly, aid may be linked to a specific development project or programme. Secondly, the donor country can encourage the recipient either directly or indirectly to use aid to finance specific commodities and/or services. Thirdly, the recipient can be required to effect procurement in specific countries or regions, usually including the donor country itself" (Jepma 1994). We restrict our discussion to the first method of tying aid.

[8] This public financing specification assumes that foreign aid inflows do not motivate the recipient government to relax its citizen's tax burden. Empirical evidence for this consideration is provided by Boone (1996) and Cohen and

Combining equations (5) and (6), it is observed that government transfer payments amount to the pure aid transfers:

$$T_t = (1 - \zeta)TR_t, \qquad 0 \le \zeta \le 1. \tag{7}$$

When aid transfers are tied ($\zeta = 1$) domestic transfer payments are zero, whereas when aid transfers are pure ($\zeta = 0$) domestic transfer payments are equivalent to the full amount of the aid inflows. Regardless of the type of aid, however, the representative household considers the government transfer payments as exogenous when solving its optimization problem.

Finally, to sustain an equilibrium of on-going growth, the flow of aid transfers from abroad must be tied to the scale of the recipient economy. Specifically:

$$TR_t = \beta x_t, \qquad \beta > 0, \tag{8}$$

*2.2. The Equilibrium Path and the Money Demand Equations*

The representative agent's optimization problem is to choose the levels of consumption of the two goods, and the rates of accumulation of capital and of the two forms of money, to maximize intertemporal utility (2) subject to the flow budget constraint (3) and the CIA constraint (4). In performing this optimization, the representative agent takes the initial capital stock $k(0)$, the public good in the private production process $G$, the government transfer payments $T$, and the paths of inflation and money supply as given. The current-value Lagrangian is:

$$\begin{aligned} L_c = {} & \psi \ln c_x + (1-\psi)\ln c_y + \lambda_1\{(1-\tau)Ak^{1-\alpha}G^{\alpha} - \pi m + T - c_x \\ & - c_y - s - f\} + \lambda_2\{m^{\omega}n^{1-\omega} - c_x - c_y - \varphi s\} + \lambda_3 s + \lambda_4 f \end{aligned} \tag{9}$$

where $\lambda_1$, $\lambda_3$, and $\lambda_4$ denote costate variables, $\lambda_2$ is a Lagrange multiplier, and $s$ and $f$ represent slack variables $(s \equiv \dot{k}, f \equiv \dot{n})$. The optimality conditions with respect to the control variables are:

$$\psi / c_x = \lambda_1 + \lambda_2 \tag{10}$$

$$(1-\psi)/c_y = \lambda_1 + \lambda_2 \tag{11}$$

$$\dot{\lambda}_1 = \rho\lambda_1 + \pi\lambda_1 - \omega m^{\omega-1}n^{1-\omega}\lambda_2 \tag{12}$$

$$\dot{\lambda}_3 = \rho\lambda_3 - (1-\tau)A(1-\alpha)k^{-\alpha}G^{\alpha}\lambda_1 \tag{13}$$

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Werker (2004), who find that aid has no impact on tax revenues in general, and inflation-tax revenues and income-tax revenues in particular.

$$\dot{\lambda}_4 = \rho\lambda_4 - (1-\omega) m^{\omega} n^{-\omega}\lambda_2 \tag{14}$$

$$\lambda_1 = -\varphi\lambda_2 + \lambda_3 \tag{15}$$

$$\lambda_1 = \lambda_4 \tag{16}$$

$$\lambda_2 \geq 0,\ (m^{\omega} n^{1-\omega} - c_x - c_y - \varphi s) \geq 0,\ \lambda_2 (m^{\omega} n^{1-\omega} - c_x - c_y - \varphi s) = 0. \tag{17}$$

Equilibrium allocation in this economy is described by equations (10)-(17), the private budget constraint, the government budget constraint, the binding CIA constraint, both money market clearing conditions, and the following transversality conditions:[9]

$$\lim_{t\to\infty} m_t \lambda_{1_t} e^{-\rho t} = \lim_{t\to\infty} k_t \lambda_{3_t} e^{-\rho t} = \lim_{t\to\infty} n_t \lambda_{4_t} e^{-\rho t} = 0. \tag{18}$$

As in Palivos and Yip (1995), the model lacks transitional dynamics because the economy instantaneously adjusts to the balanced growth path (BGP). Intuitively, if the initial capital is not on the BGP originally, the representative agent adjusts his stock of real money balances and initial consumption so that the BGP is obtained instantaneously. Therefore the focus is on the balanced growth equilibrium path, which is defined as the path along which $c_x$, $c_y$, $k$, $m$, $n$, $x$, $G$, $\lambda_1$, $\lambda_2$, $\lambda_3$, and $\lambda_4$ grow at a constant rate.

To solve for the economy's growth rate, rewrite equation (12) as:

$$\omega (n/m)^{1-\omega} \lambda_2 / \lambda_1 = \rho + \pi - \dot{\lambda}_1 / \lambda_1. \tag{19}$$

It will be shown below that $(n/m)$ is constant on the BGP. With $\omega, \rho,$ and $\pi$ being constants, and $\dot{\lambda}_1/\lambda_1$ constant on the BGP, equation (19) implies that $\lambda_2/\lambda_1$ is constant on the BGP. That is, $\lambda_1$ and $\lambda_2$ grow at the same rate.

Next, rewrite equation (11) as $(1-\psi)/c_y = \lambda_1(1+\lambda_2/\lambda_1)$. Taking logarithms and the time derivative, yields:

$$\dot{\lambda}_1 / \lambda_1 = -\vartheta \tag{20}$$

where $\vartheta$ denotes the growth rate of $c_y$ on the BGP. This result implies that on the BGP[10]:

$$\dot{c}/c = \dot{k}/k = \dot{m}/m = \dot{n}/n = \dot{x}/x = \dot{G}/G = \vartheta. \tag{21}$$

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[9] To ensure the existence of a positive economic growth rate and bounded lifetime utility, the following parameter restrictions are imposed: $A^{1/(1-\alpha)}(1-\alpha)^2 \alpha^{\alpha/(1-\alpha)} > \rho > 0$ (Barro 1990).

[10] Define composite consumption as $c_t = cx_t^{\psi} cy_t^{1-\psi}$. All the derivations that follow use composite consumption rather than its separate components.

Moreover, the domestic and foreign money market equilibrium conditions imply that $\pi = \mu - \vartheta$ and $\vartheta = \mu^*$.

Combining equations (13), (15), (19), and (20), yields

$$\rho + \vartheta = \frac{\omega (n/m)^{1-\omega}}{\omega (n/m)^{1-\omega} + \varphi(\rho + \vartheta + \pi)}(1-\tau) A (1-\alpha)\left(\frac{G}{k}\right)^{\alpha}, \qquad (22)$$

which is a modified Keynes-Ramsey rule determining capital accumulation when domestic capital is purchased with domestic currency. To obtain the modified Keynes-Ramsey rule that determines capital accumulation when domestic capital is purchased with foreign currency, combine equations (13), (14), (15), (16), and (20):

$$\rho + \vartheta = \frac{(1-\omega)(m/n)^{\omega}}{(1-\omega)(m/n)^{\omega} + \varphi(\rho + \vartheta)}(1-\tau) A (1-\alpha)\left(\frac{G}{k}\right)^{\alpha}. \qquad (23)$$

Both equations (22) and (23) reveal that the marginal rate of intertemporal substitution (left hand side) is equal to the marginal rate of transformation (right hand side), or equivalently that the rate of return on consumption is equal to the after-tax return on investment, adjusted in each equation by the currency used to conduct the investment transaction.[11]

Equations (22) and (23) describe how the growth rate of the small developing economy depends on foreign aid inflows, domestic income taxation, domestic inflation taxation, the provision of the government input, and currency substitution. They also describe the demand functions for domestic and foreign currencies and the mechanism of currency substitution. In any equilibrium, the two equations must be equal. Setting equation (22) equal to equation (23) and simplifying yields

$$n/m = [(1-\omega)/\omega][(\rho + \vartheta + \pi)/(\rho + \vartheta)]. \qquad (24)$$

This equation reveals that the marginal rate of substitution between domestic and foreign currencies equals the ratio of their opportunity costs. In particular, any increase in the relative opportunity cost of the domestic currency (i.e., an increase in the domestic inflation rate) causes the representative agent to substitute out of the domestic currency and into the foreign currency. Thus, equation (24) captures currency substitution.

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[11] In the special case of $\varphi = 0$ (highest degree of financial sophistication of the economy), both equations reduce to $\rho + \vartheta = (1-\tau)A(1-\alpha)(\frac{G}{k})^{\alpha}$, which is the standard Keynes-Ramsey rule in an economy that uses a non-excludable publicly provided input with no population growth and no depreciation.

Combining equation (24) with the binding CIA constraint, we obtain the money demand functions for both forms of currency:

$$m = [cx + cy + \varphi \vartheta k] \left[ \frac{\rho + \vartheta + \pi}{\rho + \vartheta} \frac{1 - \omega}{\omega} \right]^{\omega - 1}, \tag{25}$$

$$n = [cx + cy + \varphi \vartheta k] \left[ \frac{\rho + \vartheta + \pi}{\rho + \vartheta} \frac{1 - \omega}{\omega} \right]^{\omega}. \tag{26}$$

Equations (25) and (26) show that the demand for $m$ and $n$ depends positively on real expenditures that require liquidity, such as $c_x$, $c_y$, and $k$. Notice also that $\rho + \vartheta$ is the domestic *real* interest rate and $R \equiv \rho + \vartheta + \pi$ denotes the domestic *nominal* interest rate. Hence, real domestic money demand $m$ is a negative function of the domestic nominal interest rate (the opportunity cost of holding it), whereas real foreign money demand $n$ is a positive function of the domestic nominal interest rate. Finally, observe that both money demand functions are negatively related to the level of financial development of the domestic economy: a higher $\varphi$ (lower level of financial development) requires higher currency holdings of both types. This reflects the idea that financial development lowers the transaction cost of transforming non-liquid to liquid assets.[12]

## 3. Alternative Modes of Financing Public Spending

This section solves for the growth rate of the economy that emerges in the presence of foreign aid inflows under the exclusive use of each domestic budgetary method (income taxation versus inflationary taxation) to finance the public good. Additionally, in each case the growth effect of tied aid is distinguished from its respective pure form. The objective is to show that the choice of the type of aid and of the domestic financing policy jointly has implications for the efficiency of foreign assistance.

### *3.1. The Growth Rate under Income Taxation and Aid*

This part examines the effects on the growth rate of the economy when the government receives aid and finances domestically its productive input exclusively with income taxes. Let $\vartheta_T$ denote the growth rate of the economy under income-tax financed government expenditures.

[12] Roubini and Sala-i-Martin (1995) provide several economic reasons of how a lower degree of financial development (higher $\varphi$) increases money demand for a given level of interest rates, as it appears in equations (25) and (26).

To derive the expression for the growth rate under this financing policy, combine equations (22) and (24), along with the following conditions.[13] First, when the government derives all of its revenue from income taxation, $\mu = 0,$ which implies that equation (6) reduces to $G = \tau x + \zeta TR.$ Second, define the size of government as $\gamma \equiv G/x.$ Third, note that when $\mu = 0,$ the nominal interest rate becomes $R \equiv \rho.$ Then, the growth rate under income-tax financing is given by:

$$\rho + \vartheta_T = \frac{\omega(1-\gamma+\beta\zeta)A^{\frac{1}{1-\alpha}}(1-\alpha)\gamma^{\frac{\alpha}{1-\alpha}}}{\omega + \varphi\rho^{\omega}\left[(\rho+\vartheta_T)\left(\frac{\omega}{1-\omega}\right)\right]^{1-\omega}}. \qquad (27)$$

This equation indicates that there are four factors in the model that alter the rate of economic growth relative to an economy without frictions and aid inflows. First, the existence of a distortionary income tax ($\tau$) has an unclear effect on the net marginal product of capital. This is illustrated by the opposing signs of $\gamma$. Second, the presence of a liquidity constraint on investment expenditures (represented by $\varphi$) can be perceived as a tax on investment that reduces the rate of return on capital, causing a lower rate of growth. Third, currency substitution moderates the size of the previous two effects on the growth rate since $\omega < 1$. Fourth, the inflow of aid funds raises the net marginal product of capital, and hence has a positive effect on growth, only when the funds are tied to productive investment on the public input, $\zeta = 1$. When $\zeta = 0$ aid transfers are neutral with respect to economic growth; they only have a level effect on consumption.[14]

### *3.2. The Growth Rate under Inflation Taxation and Aid*

Let $\vartheta_M$ denote the growth rate of the economy when the government relies solely on seigniorage from its domestic resources as a source of revenue. In this case, $\tau = 0,$ implying that $G = \mu m + \zeta TR.$ Recall, also, that $\gamma \equiv G/x$ denotes the size of the government. Finally, note that the nominal interest rate becomes $R \equiv \rho + \mu$ in this case. Therefore, under inflation-tax financing, equations (22) and (24) yield:

[13] Since equations (22) and (23) reveal similar information, the discussion in the following sections employs equation (22).

[14] Accordingly, any level of aid that is "partially" tied, $0 < \zeta < 1$, also has a positive growth effect and a direct welfare effect; the latter by raising consumption.

$$\rho + \vartheta_M = \frac{\omega A^{\frac{1}{1-\alpha}}(1-\alpha)\gamma^{\frac{\alpha}{1-\alpha}}}{\omega + \varphi(\rho+\mu)^{\omega}\left[(\rho+\vartheta_M)\left(\frac{\omega}{1-\omega}\right)\right]^{1-\omega}}. \tag{28}$$

The domestic money growth rate ($\mu$) that appears in equation (28) responds endogenously to changes in $\gamma$ (and hence to changes in $\vartheta_M$). Combining the representative households' flow budget constraint (equation (3)) with the transfer payments equation ((7) along with (8)) and the two money demand functions (equations (25) and (26)) yields the equation for the endogenous money-growth rate:

$$\mu = \frac{(A\gamma)^{\frac{1}{1-\alpha}}\left(1-\frac{\beta\zeta}{\gamma}\right)}{(A\gamma)^{\frac{1}{1-\alpha}}\left(\frac{1+\beta}{\gamma}-1\right)-(1-\varphi)\vartheta_M}\left[\left(\frac{1-\omega}{\omega}\frac{\rho+\mu}{\rho+\vartheta_M}\right)^{1-\omega} + \vartheta_M\left(\frac{1-\omega}{\omega}\frac{\rho+\mu}{\rho+\vartheta_M}\right)\right]. \tag{29}$$

In equation (29), the presence of currency substitution is captured by the second term in brackets, which indicates how the domestic money-growth rate responds to changes in the opportunity costs of holding the two currencies. This term exceeds unity, at least for a Cobb-Douglas liquidity aggregator, implying that the presence of currency substitution raises the domestic money-growth rate required to finance a given level of government spending.

Equations (28) and (29) describe the complex effect of inflation-tax financing on growth. Specifically, there are five factors that deserve attention. First, the existence of the CIA constraint imposes a negative effect on investment and growth similar to equation (27). Second, recognize that an increase in the size of government requires an increase in the domestic money-growth rate, which raises the domestic inflation rate and erodes the value of the domestic currency. Abstracting from the fact that agents can substitute between home and foreign currencies, the increase in the domestic money-growth rate causes the CIA constraint to become more restrictive to investment goods. Thus, an increase in the size of government hinders economic growth.

Third, the presence of currency substitution permits domestic inflation-tax evasion. Recall that domestic and foreign currencies are imperfect substitutes, implying that the representative agent cannot completely evade the domestic inflation tax by transacting only in the foreign currency. Therefore, ceteris paribus, currency substitution moderates any negative effect of an increase in $\gamma$ on $\vartheta_M$ as in equation (27). Fourth, because the representative agent can evade a portion of the inflation tax, the government must implement an even higher money-growth rate (relative to a world without currency substitution) in order to finance a given increase in government expenditures. Thus, the CIA constraint is even more restrictive, implying that the negative effect of an increase in $\gamma$ on $\vartheta_M$ is even larger than previously described. Fifth, aid inflows increase the rate of return on investment, and hence have a positive effect on growth, through two channels. They have a direct impact through an increase in $\gamma$ when tied, and they also remove the pressure from the government of printing more currency regardless of the type of aid. Equation (28) captures the former channel, while equation (29) shows the latter, where the inflow of aid decreases the money growth rate and this effect is larger for tied aid, $\zeta = 1$. The latter channel, in essence, captures the endogenous response of seigniorage revenue to aid inflows, and hence the adjustment of the government budget constraint.

Notice that when liquidity is necessary only to consumption purchases, ($\varphi=0$), a rise in the domestic money-growth rate and/or an inflow of tied aid funds increase the net marginal product of capital. Consequently, when $\varphi=0$, an increase in seigniorage-financed government expenditures and/or aid inflows tied to the project have a direct positive effect on the growth rate of the economy. Thus, when investment is a credit good, the Tobin effect emerges and money is not superneutral regardless of the agent's ability to engage in currency substitution.[15] That is, increases in the growth rate of money affect positively the steady state growth rate of the economy.

## 4. Comparison of the Two Financing Methods in the Presence of Aid

This section examines the relative benefits of the two forms of aid transfers into the recipient economy in combination with the domestic public financing schemes. The comparison undertaken is based primarily on three macroeconomic features: the economic growth rate, the inflation rate, and the percentage change in welfare. Due to the nonlinearity of the model we employ numerical techniques. We begin by describing the parameter values for the benchmark non-aid-receiving economy and compare the growth rates achieved by the domestic budgetary policies. Then we evaluate the government financing policies in the presence of pure versus tied

[15] This result is due to the specification of the production function. With a production function of the *Ak* form, the money growth rate would be superneutral under $\varphi=0$. A similar result is found in Stockman (1981), Palivos and Yip (1995), and Roubini and Sala-i-Martin (1995).

aid transfers. Next we illustrate the phenomenon of decreasing returns to aid by allowing the amounts of aid inflows to rise from 20 to 60 percent of the recipient's GNP per capita. A comparison of the size of the inflation rate under the two aid-enhanced domestic budgetary methods follows. Finally, we examine the welfare implications.

*4.1. Numerical Analysis of the Benchmark Economy*

The parameter values, shown in Table 1 are representative of a small open economy that starts out from an equilibrium of zero aid transfers (implying both $\beta = \zeta = 0$). The value of the preference parameter $\rho$ is standard, while the technological parameter $A$ is chosen to reproduce growth rates that reflect the recent experience of a sample of developing countries (see Section 6). The share of government input in private production ($\alpha$) is adopted from Barro (1990), while the size of the government ($\gamma$) as a fraction of domestic GNP is set at 0.3.[16] The fraction of domestic currency in total domestic liquidity ($\omega$) ranges from 0.5 to 0.9 in order to capture the effect of currency substitution. Finally, the parameter $\varphi \in [0,1]$ reflects the level of sophistication of the domestic financial markets (the higher the $\varphi$, the less developed the markets).

Calibration of equations (27), (28), and (29) with the conventional parameter values described, yields the benchmark equilibrium illustrated in Figure 1. The benchmark economy is examined with respect to the growth rate achieved under the two domestic financing methods, income taxation ($\vartheta_T$) in Figure 1a, and inflation taxation ($\vartheta_M$) in Figure 1b. The equilibrium is parameterized for different levels of financial development ($\varphi$) and shares of domestic currency in total liquidity ($\omega$). The numerical results reveal plausible rates of growth for a small developing economy. Figure 1c combines the first two figures, allowing a comparison between the two domestic financing methods. When cash is required only for consumption goods purchases ($\varphi = 0$), government expenditures financed by domestic income taxes are more distortionary than government expenditures financed by domestic inflation taxes, regardless of the level of $\omega$. To explain that result analytically focus first on inflation-tax financed government expenditures. With $\varphi = 0$, equation (28) reveals that an increase in the government size ($\gamma$) enhances the growth rate of the economy, although less than one-to-one, implying that liquidity

[16] To determine how sensitive the results of the numerical analysis are to the chosen government size, the numerical exercises are repeated with $\gamma$ equal to 0.1, 0.2, and 0.4. Although, the growth rate under each tax policy differs in size with different $\gamma$, the qualitative implications remain the same as with a government size of 0.3. The results are available upon request from the author.

is not superneutral. Now concentrate on income-tax financed government expenditures. With $\varphi = 0$, equation (27) indicates that an increase in the size of government has two opposing effects. As a consequence, a government size increase distorts the economy more in this case than under seigniorage finance. Therefore, when investment purchases do not require cash of either type, inflation-tax financing leads to higher growth.

When cash is required for both consumption goods and (at least) a fraction of investment goods, the numerical analysis implies that the dominant domestic policy depends heavily on the extend of currency substitution and especially the degree of development of domestic financial markets. For smaller currency substitution (higher ωs), inflation-tax finance distorts the economy less than income-tax finance. This is indicated by the higher growth rates achieved under inflation-tax finance than under income-tax finance across the same level of financial sophistication ($\varphi$). This result is due to a rise in the inflation-tax base. Consequently, the government imposes a lower inflation-tax rate to raise the same amount of revenue. Moreover, the more financially developed the economy is (lower $\varphi$s), the growth rates under inflation taxation dominate in magnitude the respective growth rates under income taxation for any level of $\omega$. This makes sense since at lower $\varphi$s the tax on investment good purchases decreases, encouraging the representative agent to hold more cash balances (of which part is domestic), and hence raise once again the inflation-tax base. Finally, the plots clearly demonstrate a point made in section 3, namely that the more financially advanced the economy is, the higher the growth rate it reaches with either government policy. It is worth mentioning, however, that the growth rates under inflationary finance are more sensitive to the level of financial sophistication than the growth rates under income-tax finance. Intuitively, as $\varphi$ increases, the CIA constraint becomes more restrictive to capital goods, and the distortions associated with inflation-tax financing worsen.

*4.2. Pure and Tied Aid Transfers*

The set of plots in Figure 2 illustrate the different steady-state growth equilibria the economy can attain when it receives aid funds that are pure in nature ($\zeta = 0$) versus funds that represent productive transfers ($\zeta = 1$), under domestic inflation taxation versus income taxation respectively. In other words, the purpose of this section is to compare the effectiveness of each type of aid under the two domestic budgetary modes of financing. As in the previous subsection, these long-run equilibria depend on the levels of $\varphi$ and $\omega$ inherent in the economy. The amount by which aid increases, in either form, is 5% of the recipient's GNP per capita.[17] Starting with the domestic income tax policy, Figure 2a shows the attained growth rates under (i) the benchmark non-aid-receiving economy (reproduced from Figure 1a), (ii) the inflow of pure aid funds, and (iii) the receipt of tied aid transfers. The general features of Figure 1a are reproduced in this figure as well. However, although the growth rates increase when aid is tied compared to the benchmark case, they remain unchanged under pure aid. This can be explained by looking at equation (27), which with $\beta = 0.05$ and $\zeta = 0$ reduces to the one used to derive the growth rate in the benchmark economy. Intuitively, untied aid under income-taxation is distributed to the representative household through transfer payments, and hence represents a pure wealth effect.[18]

Figure 2b illustrates the steady-state growth rates achieved with the use of domestic inflation taxation by the government in the benchmark case of no aid (reproduced from Figure 1b), and in the cases of pure and tied aid inflows. This graph, in contrast to Figure 2a, shows that at the new possible steady state the growth rates increase under *both* types of aid inflows. Equations (28) and (29) demonstrate that an aid transfer, regardless of its nature, by reducing the pressure on the government to print more domestic currency, relaxes the negative effect of the CIA constraint on capital. This effect, however, is more pronounced with tied aid.[19]

In comparing the effects of pure aid under each mode of domestic financing, Figure 2c is helpful. It also incorporates the benchmark non-aid income- and inflation-tax financing planes from Figure 1c. Since pure aid transfers do not have any effect on growth under income-tax finance, and at the same time they have a mild positive effect under inflationary finance, the plot exhibits a budgetary preference in favor of seigniorage financing for most $\varphi$ and $\omega$ parameterizations. In any effect, the preference of inflationary finance is stronger than in the benchmark non-aid case.

Figure 2d describes the economic growth rates under the two modes of financing when aid is fully tied to the productive government input. For comparison, the growth rates under the benchmark case are reproduced from Figure 1c. Section 3 explained the channels through which

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[17] We choose this share because it is close to the average aid-to-GNP share in Table 4.

[18] This result is in accordance with Obstfeld (1999) and Chatterjee *et al.* (2003).

[19] This result is in striking contrast to the results obtained by Boone (1996), Obstfeld (1999), and Chatterjee *et al.* (2003), who find, within a similar infinitely-lived agents model, that pure aid has *no* impact on long-run growth. They do not take into account, however, the endogenous response of the recipient government's budget constraint to aid inflows, as we do.

the effects of tied aid take place. Intuitively, tied aid generates a wave of investment in the public good that increases the marginal productivity of investment in the privately produced good $x$, with both forms of domestic budgetary finance, thereby leading to a positive accumulation of private capital. This is clearly illustrated by the graph.

*4.3. Diminishing Returns to Aid*

A substantial number of recent empirical studies that investigate the relationship between aid and growth, have included a quadratic aid term on the right hand side of their growth regression equations in order to examine whether aid is associated with decreasing returns (Hadjimichael *et al.* 1995, Lensink and White 1999, Hansen and Tarp 2000, 2001, Dalgaard and Hansen 2001). In what follows, we employ our theoretical model to establish numerically that aid flows are subject to diminishing returns. We confirm this result for both pure and tied aid transfers, by continuously increasing the recipient's share of aid from 20 to 60 percent of its GNP.

Figures 3 and 4 depict the achieved growth rates under income and inflation tax financing with pure and tied aid, respectively. In both figures aid is increasing from 20 to 40 and to 60 percent of GNP. We have also reproduced the benchmark non-aid-receiving case for comparison. Figure 3 shows clearly that increasing amounts of pure aid are associated with diminishing returns (for $\varphi \neq 0$) with respect to the inflationary method of finance only.[20] Figure 4, on the other hand, illustrates the increasing tied aid inflows and predicts decreasing returns to aid associated with *both* budgetary policies.[21] This result implies that tied aid has the same marginal effect on growth under both domestic government financing schemes.

*4.4. Inflation Rates Comparison*

Apart from comparing the economic growth rates attained with pure and tied resource transfers, it is also of interest to rank the rates of inflation that occur under such transfers. Let $\pi_T$

[20] While for $\varphi = 0$ (regardless of the value of $\omega$) we observe zero returns to aid, for $\varphi = 0.5$ (with $\omega = 0.5$) the growth rate rises to 0.0240, 0.0277, and 0.0305 as aid rises. For $\varphi = 1$ (with $\omega = 0.5$), the respective growth rate becomes 0.0149, 0.0188, and 0.0218. A similar pattern is followed with the rest values of $\omega \in (0.5, 0.9)$.

[21] For example, the growth rate with $\omega = 0.5$ under inflationary finance becomes: for $\varphi = 0$, 0.0637, 0.0748, and 0.0840, for $\varphi = 0.5$, 0.0263, 0.0317, and 0.0361, for $\varphi = 1$, 0.0164, 0.0211, and 0.0250. Under income tax finance: for $\varphi = 0$, 0.0356, 0.0434, and 0.0498, for $\varphi = 0.5$, 0.0328, 0.0401, and 0.0461, for $\varphi = 1$, 0.0304, 0.0373, and 0.0429.

and $\pi_M$ denote the domestic inflation rates under an income tax and an inflation tax, respectively. Also, let $\mu_T$ and $\mu_M$ denote the growth rates of domestic money balances under income-tax finance and seigniorage finance, respectively. The generic expression for domestic inflation is given by $\pi = \mu - \vartheta$. Recognize that $\mu_M > \mu_T = 0$. Then, $\pi_T = -\vartheta_T$ and $\pi_M = \mu_M - \vartheta_M$. The numerical results reported in Figures 1, 2, 3, and 4 indicate that $\vartheta_T$ and $\vartheta_M$ are ranked differently in magnitude (that is, there are cases where $\vartheta_T$ exceeds or falls below $\vartheta_M$). Hence, in general $\pi_T$ and $\pi_M$ will be ranked differently. Nevertheless, there is a set of conditions under pure and tied transfers that allow the ranking of the inflation rates achieved by the domestic budgetary policies. These conditions are derived below.

*4.4.1 Pure Aid Transfers*

**Proposition 1**: *If* $A^{\frac{1}{1-\alpha}}(1-\alpha)\gamma^{\frac{\alpha}{1-\alpha}}(1+\beta-\gamma) < H,$ *then* $\pi_M > \pi_T$.[22]

**Proof**: Notice from equations (27), (28), and (29) that $\frac{d\vartheta_T}{d\varphi} < 0,\ \frac{d\vartheta_M}{d\varphi} < 0,\ \frac{d\mu_M}{d\varphi} < 0.$ Hence,

$$(\pi_M)_{MIN} = \mu_M\big|_{\varphi=1} - \vartheta_M\big|_{\varphi=0} = \frac{H\gamma}{1+\beta-\gamma} - A^{\frac{1}{1-\alpha}}(1-\alpha)\gamma^{\frac{\alpha}{1-\alpha}} + \rho.$$

$$(\pi_T)_{MAX} = -\vartheta_T\big|_{\varphi=0} = -(1-\gamma)A^{\frac{1}{1-\alpha}}(1-\alpha)\gamma^{\frac{\alpha}{1-\alpha}} + \rho.$$

Thus,

$$\pi_M - \pi_T \geq (\pi_M)_{MIN} - (\pi_T)_{MAX} = \gamma\left(\frac{H}{1+\beta-\gamma} - A^{\frac{1}{1-\alpha}}(1-\alpha)\gamma^{\frac{\alpha}{1-\alpha}}\right).$$

Given $\gamma > 0,$ the result follows. When $\gamma = 0,$ then $\pi_M = \pi_T$. In the special case where $\gamma \geq \beta$, the first term inside the brackets in the last expression is greater than one. If the second term is less than one, then the necessary condition for Proposition 1 reduces to $(A\gamma)^{\frac{1}{1-\alpha}}(1-\alpha) < \gamma.$ For the parameter values postulated in Table 6, however, $\pi_M$ is always greater than $\pi_T$ regardless of the

[22] Where $H = \left[\left(\frac{1-\omega}{\omega}\frac{\rho+\mu}{\rho+\vartheta_M}\right)^{1-\omega} + \vartheta_M\left(\frac{1-\omega}{\omega}\frac{\rho+\mu}{\rho+\vartheta_M}\right)\right] > 1,$ as explained in part 5.2. for a Cobb-Douglas liquidity aggregator.

value of aid. That is, even for $\beta = 0.6 > \gamma,$ the left hand side of the first inequality in Proposition 1 is always less than unity.

*4.4.2 Tied Aid Transfers*

**Proposition 2**: *If* $\begin{cases} \gamma > \beta \text{ and } A^{\frac{1}{1-\alpha}}(1-\alpha)\gamma^{\frac{\alpha}{1-\alpha}}(1+\beta-\gamma) < H \\ or \\ \gamma < \beta \text{ and } A^{\frac{1}{1-\alpha}}(1-\alpha)\gamma^{\frac{\alpha}{1-\alpha}}(1+\beta-\gamma) > H, \end{cases}$ *then* $\pi_M > \pi_T$.

**Proof**: It is,

$$(\pi_M)_{MIN} = \mu_M\big|_{\varphi=1} - \vartheta_M\big|_{\varphi=0} = \frac{H(\gamma-\beta)}{1+\beta-\gamma} - A^{\frac{1}{1-\alpha}}(1-\alpha)\gamma^{\frac{\alpha}{1-\alpha}} + \rho.$$

$$(\pi_T)_{MAX} = -\vartheta_T\big|_{\varphi=0} = -(1-\gamma+\beta)A^{\frac{1}{1-\alpha}}(1-\alpha)\gamma^{\frac{\alpha}{1-\alpha}} + \rho.$$

Thus,

$$\pi_M - \pi_T \geq (\pi_M)_{MIN} - (\pi_T)_{MAX} = (\gamma-\beta)\left(\frac{H}{1+\beta-\gamma} - A^{\frac{1}{1-\alpha}}(1-\alpha)\gamma^{\frac{\alpha}{1-\alpha}}\right).$$

The result follows accordingly. Again, in the special case where $\gamma \geq \beta,$ the first term inside the brackets in the last expression is greater than one so that the necessary condition for Proposition 2 reduces to $(A\gamma)^{\frac{1}{1-\alpha}}(1-\alpha) < \gamma.$ As stated earlier, with the parameter values used in our numerical exercises, $A^{\frac{1}{1-\alpha}}(1-\alpha)\gamma^{\frac{\alpha}{1-\alpha}}(1+\beta-\gamma) < H$. Therefore, the ranking of the inflation rate between the two domestic modes of finance depends on the magnitudes of $\gamma$ and $\beta$. Specifically, $\begin{cases} \pi_M > \pi_T, \text{ if } \gamma > \beta \\ \pi_M = \pi_T, \text{ if } \gamma = \beta \\ \pi_M < \pi_T, \text{ if } \gamma < \beta. \end{cases}$

In sum, the analysis in this section shows that the government that utilizes a pure aid inflow, although, it is better off with respect to growth (for most parameterizations of $\varphi$ and $\omega$, and especially for higher aid) by using inflationary finance, it has to pay the burden of higher inflation. On the other hand, when the aid transfers are tied to the government's productive input, the government may be able to achieve the highest possible growth rate with the lowest possible inflation rate. For aid inflows smaller than the government size, less developed countries would be better off in terms of both growth and inflation with the use of an income-tax policy. The same countries, however, for high aid inflows (greater than the government size) would still obtain higher growth rates under an income-tax policy but only with accompanying higher inflation. So, pure aid creates a tradeoff between growth and inflation in the sense that higher growth is achievable only with higher inflation, whereas tied aid has this implication only for higher amounts of aid. For smaller tied aid, the growth-inflation tradeoff disappears.

*4.5. Welfare Analysis*

In the aid literature the effectiveness of aid has been a synonym to a positive aid-growth relationship. Aid, however, affects other aspects of everyday life in recipient countries apart from growth. One of these aspects is the well being of the country's citizens. To address this issue, we investigate in this section the welfare effects of increasing aid transfers under each mode of public finance. This is done by comparing the percentage change in welfare that corresponds to each budgetary scheme. To determine how sensitive the results are to different mixtures of investment financing with cash, degrees of currency substitution, and size of aid inflows, the numerical exercises are repeated for alternative values of $\varphi$ (0.1, 0.5, and 0.9), $\omega$ (0.5 and 0.9), and $\beta$ (0.05, 0.2, 0.4, and 0.6). To compute the welfare implications of aid inflows, the country's welfare benefit from an increase in the aid funds received is measured as the percentage change in composite goods consumption ($c$) required to leave the representative agent as well off as under the benchmark steady state. With $\tilde{U}$ being the level of utility attained at the benchmark steady-state, the welfare benefit is defined as $W = \Delta c/c$, where $\Delta c$ solves the equation $\tilde{U} = c + \Delta c$.[23]

Table 2 presents the welfare gains associated with increasing pure aid inflows as compared to the benchmark non-aid-receiving economy. These gains are described for the two alternative domestic methods of financing the public good. The first thing to note is that higher aid inflows provide higher welfare under both domestic policies. Furthermore, it is shown that income-tax finance gives rise to higher welfare gains compared to inflation-tax finance for every level of aid inflow when the financial markets in the aid recipient country are poorly developed or not well established (high or medium values of $\varphi$). When the financial markets are highly sophisticated, however, seigniorage finance yields both higher growth rates and welfare benefits.

[23] For a more detailed discussion see Holman and Neanidis (forthcoming).

These results follow from the fact that with income-tax financing, welfare (along with growth) is insensitive to the development level of financial institutions, while inflation-tax financing is heavily affected since financial development largely determines government revenues. Finally, note that the extent of currency substitution has welfare implications especially under inflation-tax financing where for less developed financial markets more of the domestic currency is linked with higher welfare gains.

Table 3, on the other hand, describes the welfare implications of increasing amounts of tied aid under the two financing schemes. It is shown that inflation-tax finance yields higher welfare gains than income-tax finance when financial markets are poorly developed. Although this result may seem surprising at first, note that the higher long-run productive capacity stimulated by the tied aid transfer has a greater effect on output when the financial markets are highly integrated. In this case, output is used mostly for investment purposes and less for consumption. Hence, welfare benefits are smaller in magnitude (or even negative). As in Table 2, the welfare effects are more sensitive to the degree of financial development under inflation-tax finance. Finally, comparing Table 3 to Table 2, it becomes clear that for income-tax finance the welfare gains are in all cases larger when aid represents a pure transfer. Inflation-tax finance, on the other hand, yields mixed results. For more developed financial markets and especially for higher aid receipts, pure aid transfers have a greater welfare impact than tied aid transfers. However, for lower aid receipts and poorly developed financial markets the welfare benefits are larger when aid transfers are tied to the productive government input.[24]

## 5. The Growth-Maximizing Tax Structure in the Presence of Aid

The analysis of the paper, thus far, has focused entirely on situations where the government receives its domestic revenue from only one source: seigniorage or income taxes. This section examines the growth effects of foreign aid in the recipient economy when the government has access to both forms of finance simultaneously. The basic question addressed is: given the type and size of foreign aid the recipient government has at its disposal, what is the mix of domestic budgetary policies that yields the highest growth rate?

[24] Chatterjee and Turnovsky (2004) reach a similar result, although they use a different measure of a country's development (the elasticity of substitution between public and private capital in production instead of the development of financial markets). They find that a country with low elasticity (poor country) has a larger welfare gain with tied aid, whereas a country that has a high degree of substitutability benefits more from aid programs that are pure in nature.

Allowing the government to use both income and inflation taxes to finance its expenditures requires some modification of the equations in the model. Recall that the government's budget constraint is: $G = \tau x + \mu m + \zeta\beta x$. Dividing the budget constraint by domestic output ($x$) gives $\gamma = \tau + \gamma_M + \zeta\beta$, where $\tau$ denotes the fraction of government expenditures financed by income taxes, $\gamma_M$ denotes the fraction of government expenditures (as a share of domestic output) financed by inflation taxes, and $\zeta\beta$ denotes foreign aid, which if tied ($\zeta = 1$) is used for financing the public input in addition to domestic sources. Solving this expression for $\tau$ and substituting into equation (22) gives the growth rate of the economy when the government has access to both sources of revenue and aid inflows[25]:

$$\rho + \bar{\vartheta} = \frac{\omega\left[1 - (\gamma - \gamma_M) + \beta\zeta\right] A^{\frac{1}{1-\alpha}} (1-\alpha)\gamma^{\frac{\alpha}{1-\alpha}}}{\omega + \varphi(\rho+\mu)^{\omega}\left[(\rho+\bar{\vartheta})\left(\frac{\omega}{1-\omega}\right)\right]^{1-\omega}}. \tag{30}$$

The domestic endogenous money-growth rate now becomes:

$$\mu = \frac{(A\gamma)^{\frac{1}{1-\alpha}}\left(\frac{\gamma_M}{\gamma}\right)}{(A\gamma)^{\frac{1}{1-\alpha}}\left(\frac{1+\beta}{\gamma} - 1\right) - (1-\varphi)\bar{\vartheta}}\left[\left(\frac{1-\omega}{\omega}\frac{\rho+\mu}{\rho+\bar{\vartheta}}\right)^{1-\omega} + \bar{\vartheta}\left(\frac{1-\omega}{\omega}\frac{\rho+\mu}{\rho+\bar{\vartheta}}\right)\right]. \tag{31}$$

Equations (30) and (31) are used to calculate the growth rate, $\bar{\vartheta}$, that emerges under alternative tax combinations in the presence of aid. The effects of variations in the tax mix on $\bar{\vartheta}$ are captured by changing the values of $\tau$ and $\gamma_M$ for a given level and type of foreign aid. To provide a framework for comparing the different growth rates that emerge under the alternative tax structure, the size of government is held constant at $\gamma$ = 0.3. Moreover, the analysis is presented for the two extreme values of $\omega$ reported in the previous section (0.5 and 0.9), and for two increasing levels of foreign aid (0.05 and 0.2).

[25] The Appendix shows how equations (30) and (31) reduce to equations (27) and (28)-(29) when $\gamma_M = 0$ and $\tau = 0$ respectively.

*5.1. Pure Aid Transfers*

Figure 5 depicts the values of the growth rate for different tax combinations under the alternative levels of pure aid receipts for $\omega$ equal to 0.5 and 0.9. Note that the tax mix is expressed in terms of the fraction of government spending financed with inflation tax, $\gamma_M$. The two extreme forms of tax mix ($\gamma_M = 0.3,\ \tau = 0$ and $\gamma_M = 0,\ \tau = 0.3$) represent the methods of finance explained in section 4 where the government could rely *either* on seigniorage *or* on income taxation as a domestic source of revenue.

There are a number of interesting features in Figure 5. First, as $\varphi$ increases the value of $\bar{\vartheta}$ falls for every combination of $\tau$ and $\gamma_M$. Second, the growth rate of the economy does not have a monotone response to monotonic variations in the tax mix. This implies that the nonlinearities in the model are important for the numerical results. Third, depending on the degree of financial sophistication of the economy under consideration, the growth-maximizing tax mix may rely on both inflation and income taxes. Fourth, as more aid flows into the economy, the growth rate remains unchanged across $\varphi$s when the government uses exclusively income-tax finance, $\gamma_M = 0$. Fifth, when more of the domestic currency is used in the economy (Figures 5d-5f) the growth rate attained is greater for every possible tax mix (apart from $\varphi = 0$, where the economy reaches the highest possible growth rates for every policy mix regardless of the level of aid). In general, the results in Figure 5 suggest that the growth-maximizing tax mix relies much more heavily on inflation taxation than on income taxation as aid receipts increase (this becomes more pronounced for higher values of $\omega$).

*5.2. Tied Aid Transfers*

Figure 6 illustrates the equivalent of Figure 5 but for inflows of aid tied to the production of the public good. The features described in the case of pure aid in Figure 5 also appear when aid is tied. There is one difference however. In comparison to the above fourth characteristic, now as more aid flows into the economy the growth rate increases across $\varphi$s for any tax structure (even with the sole use of income taxation, $\gamma_M = 0$). Overall, Figure 6 suggests that the growth-maximizing tax mix depends heavily on the amount of domestic currency used in transactions compared to the foreign currency, regardless of the level of tied aid. When the same share of the two currencies is used ($\omega = 0.5$), the growth-maximizing tax mix relies much more heavily on income taxation than on inflation taxation (especially for less financially sophisticated economies). When the domestic currency almost completely dominates the foreign currency ($\omega = 0.9$), however, the growth-maximizing tax mix relies almost solely on inflation taxes.

## 6. Country-Specific Recommendations

The analysis and the policy recommendations of the model described in this paper is based on two sets of parameters: (i) values used widely in the theoretical literature ($\rho, A, \alpha, \gamma$), and (ii) parameters that cover a reasonable range of values ($\omega, \varphi, \beta$). As a next step, we would like to examine the recommendations of our model with specific countries in mind. In trying to link the predictions of the model to specific countries, we use a sample of twenty-two developing nations for which values for $\omega$, $\gamma$, $\varphi$, and $\beta$ were possible to obtain. The sample is shown in Table 4 with the parameter values representing averages over the 1990s.[26]

Consider, for example, Albania and Mongolia which receive aid transfers of more than 15% of their GNP. A pure aid program would be growth maximizing under an inflation-tax policy (with rates of 2.2% vs. 2.1% for Albania and 2.5% vs. 2.3% for Mongolia; see Figure 5f). This policy, however, is accompanied with a higher inflation rate. In terms of welfare, the gains would not differ substantially from the gains under an income-tax policy (as Table 2 shows). A tied aid program, on the other hand, would yield even higher growth rates but the policy choice would depend on how perfectly the financial system functions. Since both Albania and Mongolia have very poor financial markets, income taxation would be preferred (with rates of 3.3% vs. 3.2% for Albania and 3.9% in each case for Mongolia; see Figure 6f). The choice of an income-tax policy would also result in relatively lower rates of inflation, while the welfare gains between the two policies would be roughly the same.

Targeting the predictions of the model to smaller aid recipients (less than 6%), we find that countries that do not suffer from extensive currency substitution (e.g., Czech Rep., Mexico, Slovak Rep., Pakistan, and Hungary) would be better off in terms of growth by choosing inflation taxation as a financing policy for both pure and tied resource transfers (see Figures 5d-5f and 6d-6f). Conversely, the remaining countries would benefit more by utilizing income taxation (see Figures 5a-5c and 6a-6c).

[26] The calculation of the parameters is discussed at great length in Holman and Neanidis (forthcoming).

## 7. Conclusions

This paper investigated the theoretical linkages between foreign aid, government budgetary policies, and the macroeconomy in a simple one-sector endogenous growth model. It is found that the distinction of aid in pure and tied transfers and their use conditional upon the domestic methods of financing public spending introduce some new insights on the mechanism through which aid affects the macroeconomic performance of the recipient country. The main implication that draws from the analysis is that aid may be both growth and welfare enhancing. At the same time, the analysis makes clear that there is not such a thing as a universal recipe or a unique policy to harness these positive effects. A basic finding, however, is that aid recipient governments *do* have the power to affect the effectiveness of aid.

The analysis herein is to a certain extent too simple. This simplicity is reflected, for instance, in the absence of such phenomena as bureaucratic corruption and fungibility of aid. Both notions have been found to be important elements of the economic assistance process, and it would be interesting to see if their presence affects the main results of the paper (see Feyzioglu, Swaroop, and Zhu 1998, World Bank 1998, Hjertholm, Laursen, and White 2000). Moreover, the paper does not address the issue of domestic co-financing arrangements, a feature common to most bilateral aid flows for public investment purposes. These and other shortcomings are intended to be overcome in future research.

## Appendix

**Relation between equations (30) and (31) with equations (27), (28), and (29).** The government budget constraint expressed as a fraction of domestic output is: $\gamma = \tau + \gamma_M + \zeta\beta$. Under exclusive use of income-tax finance $\gamma_M = 0$, so that equation (31) implies $\mu = 0$ and equation (30) reduces to equation (27). Under the sole use of inflation-tax finance $\tau = 0$, which implies that the government budget constraint becomes $\gamma_M = \gamma - \zeta\beta$. Substituting this expression to equations (30) and (31), they reduce to equations (28) and (29) respectively.

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**Table 1:** Benchmark economy parameter values

| Description | Parameter | Value |
|---|---|---|
| Rate of time preference | $\rho$ | 0.03 |
| Technological parameter | $A$ | 0.25 |
| Share of government input in production | $\alpha$ | 0.25 |
| Government size | $\gamma$ | 0.30 |
| Share of domestic currency in domestic liquidity | $\omega$ | [0.5,0.9] |
| Degree of financial development | $\varphi$ | [0,1] |
| Fraction of transfer tied to public investment projects | $\zeta$ | 0 |
| Aid transfer as % of recipient GNP per capita | $\beta$ | 0 |

**Table 2:** Welfare effects of increases in *pure* aid under income and inflation taxation (% changes)

| *Increase in pure aid as % of GNP* | | 5 | 20 | 40 | 60 |
|---|---|---|---|---|---|
| **Income-tax finance ($\tau$)** | | | | | |
| $\varphi = 0.1$ | $\omega = 0.5$ | 10.79 | 43.16 | 86.32 | 129.48 |
| | $\omega = 0.9$ | 10.82 | 43.30 | 89.03 | 129.90 |
| $\varphi = 0.5$ | $\omega = 0.5$ | 10.45 | 41.83 | 83.67 | 125.51 |
| | $\omega = 0.9$ | 10.61 | 42.44 | 85.05 | 127.33 |
| $\varphi = 0.9$ | $\omega = 0.5$ | 10.16 | 40.64 | 81.28 | 121.92 |
| | $\omega = 0.9$ | 10.42 | 41.70 | 81.33 | 125.11 |
| **Inflation-tax finance ($\mu$)** | | | | | |
| $\varphi = 0.1$ | $\omega = 0.5$ | 14.79 | 65.14 | 141.67 | 223.58 |
| | $\omega = 0.9$ | 14.78 | 61.58 | 127.10 | 194.22 |
| $\varphi = 0.5$ | $\omega = 0.5$ | 7.84 | 33.56 | 71.63 | 112.63 |
| | $\omega = 0.9$ | 9.96 | 40.99 | 84.74 | 130.18 |
| $\varphi = 0.9$ | $\omega = 0.5$ | 6.13 | 26.02 | 55.38 | 86.77 |
| | $\omega = 0.9$ | 8.43 | 34.80 | 71.95 | 110.58 |

**Table 3:** Welfare effects of increases in *tied* aid under income and inflation taxation (% changes)

| *Increase in tied aid as % of GNP* | | 5 | 20 | 40 | 60 |
|---|---|---|---|---|---|
| **Income-tax finance ($\tau$)** | | | | | |
| $\varphi = 0.1$ | $\omega = 0.5$ | 9.78 | 31.39 | 46.67 | 49.65 |
| | $\omega = 0.9$ | 9.70 | 31.68 | 47.43 | 50.11 |
| $\varphi = 0.5$ | $\omega = 0.5$ | 10.14 | 33.66 | 52.27 | 59.11 |
| | $\omega = 0.9$ | 9.83 | 33.00 | 50.41 | 55.27 |
| $\varphi = 0.9$ | $\omega = 0.5$ | 10.25 | 35.18 | 56.72 | 66.45 |
| | $\omega = 0.9$ | 10.17 | 34.20 | 53.13 | 60.56 |
| **Inflation-tax finance ($\mu$)** | | | | | |
| $\varphi = 0.1$ | $\omega = 0.5$ | 7.76 | 25.55 | 35.60 | 27.28 |
| | $\omega = 0.9$ | 9.73 | 31.35 | 28.39 | -13.44 |
| $\varphi = 0.5$ | $\omega = 0.5$ | 9.94 | 34.61 | 57.60 | 71.08 |
| | $\omega = 0.9$ | 10.04 | 33.02 | 48.56 | 48.72 |
| $\varphi = 0.9$ | $\omega = 0.5$ | 10.43 | 37.35 | 64.24 | 83.12 |
| | $\omega = 0.9$ | 10.19 | 33.89 | 52.15 | 58.69 |

**Table 4:** Summary of country parameters

| Country | Share of domestic currency in total liquidity ($\omega$) | Government size[1] ($\gamma$) | Index of financial development ($\varphi$) | Aid as a fraction of recipient's GNP ($\beta$) |
|---|---|---|---|---|
| Albania | 0.8055 | 0.3520 | 0.9786 | 0.1588 |
| Argentina | 0.5705 | 0.1449 | 0.8816 | 0.0007 |
| Bolivia | 0.3005 | 0.2147 | 0.7116 | 0.0964 |
| Bulgaria | 0.6790 | 0.4144 | 0.7934 | 0.0173 |
| Costa Rica | 0.6962[6] | 0.2199 | 0.9174 | 0.0097 |
| Croatia | 0.4021[3] | 0.4213 | 0.7998 | 0.0033[4] |
| Czech Rep. | 0.9088[3] | 0.3754 | 0.5930 | 0.0045[4] |
| Egypt | 0.7110 | 0.2911 | 0.7683 | 0.0547 |
| Estonia | 0.8635[4] | 0.2982 | 0.8971 | 0.0137[7] |
| Hungary | 0.8613[5] | 0.4944 | 0.8331 | 0.0051 |
| Lebanon | 0.4679[7] | 0.2676[4] | - | 0.0230 |
| Mexico | 0.9034 | 0.1561 | 0.8535 | 0.0006 |
| Mongolia | 0.8011 | 0.2487 | 0.9458 | 0.2395[3] |
| Pakistan | 0.8671 | 0.2301 | 0.8541 | 0.0190 |
| Philippines | 0.7099 | 0.1902 | 0.7580 | 0.0166 |
| Poland | 0.8008[5] | 0.3959 | 0.8758 | 0.0162 |
| Romania | 0.7658 | 0.3308 | 0.9481 | 0.0086 |
| Russian Fed. | 0.7474[3] | 0.2647 | 0.9442 | 0.0044 |
| Slovak Rep. | 0.8739[3] | 0.4062 | 0.7136 | 0.0062 |
| Turkey | 0.6061 | 0.2685 | 0.9019 | 0.0026 |
| Vietnam | 0.7749[2] | 0.2460 | 0.9073 | 0.0418 |
| Yemen Rep. | 0.7774 | 0.2939 | 0.9699 | 0.0564 |

*Sources*: International Monetary Fund's IFS (on-line), and World Bank's WDI (2003).
[1] For selected years measured from the website www.worldinfigures.org
[2] Over the period 1992-99, [3] 1993-00, [4] 1992-00, [5] 1990-99, [6] 1990-98, [7] 1991-00.

**Figure 1a**: Growth rate under income taxation

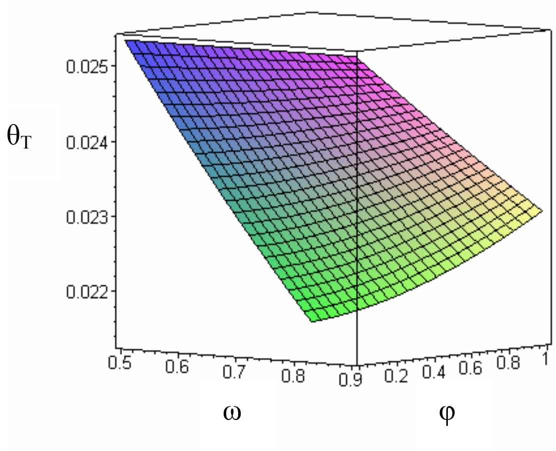


**Figure 1b**: Growth rate under inflation taxation

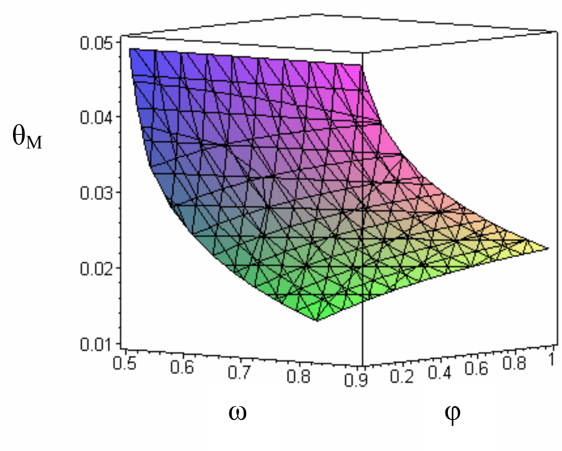


**Figure 1c**: Growth rates under income taxation vs. inflation taxation

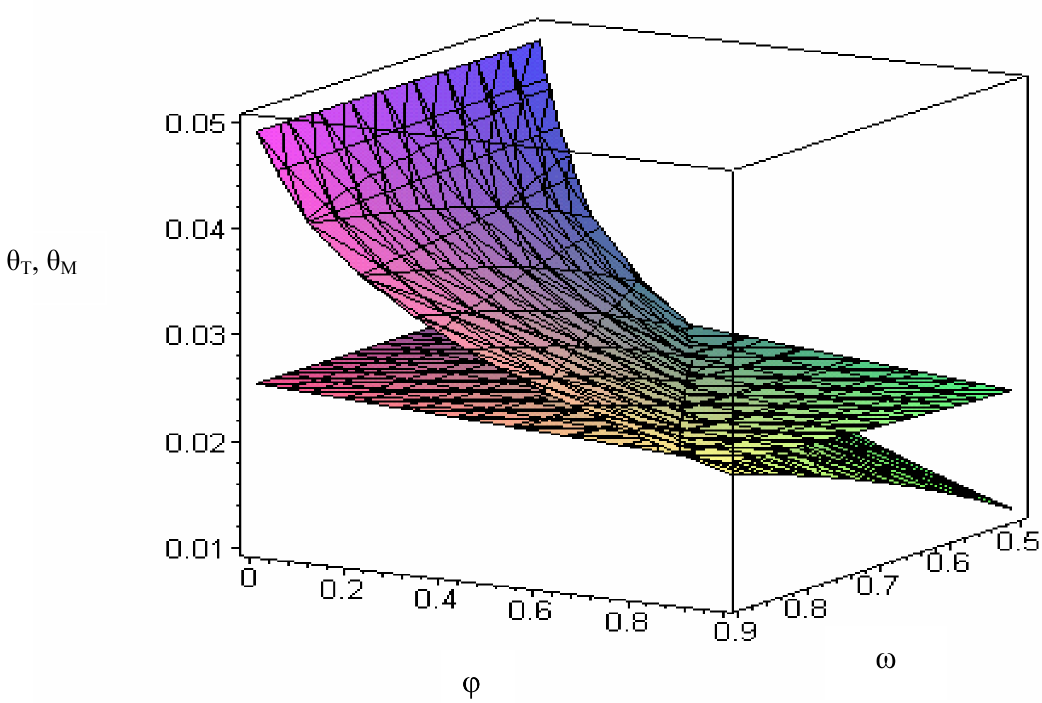

**Figure 2a**: Growth rates under income taxation with no aid and aid of 5%

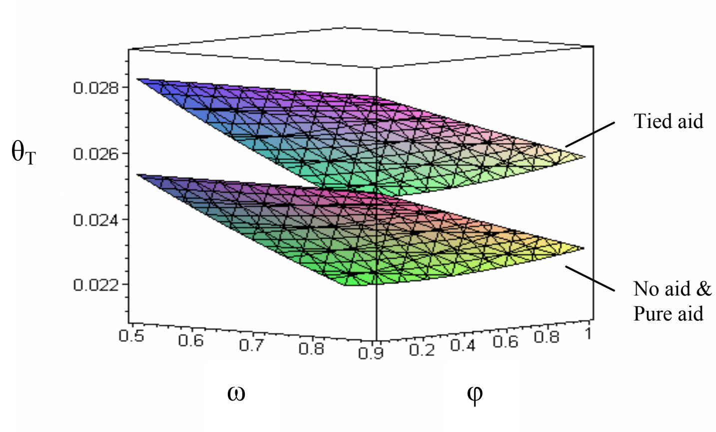


**Figure 2b**: Growth rates under inflation taxation with no aid and aid of 5%

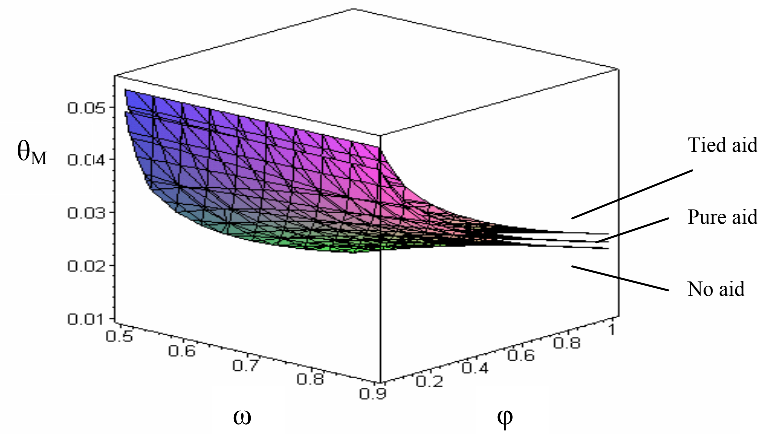


**Figure 2c**: Growth rates under income vs. inflation taxation with no aid and *pure* aid of 5%

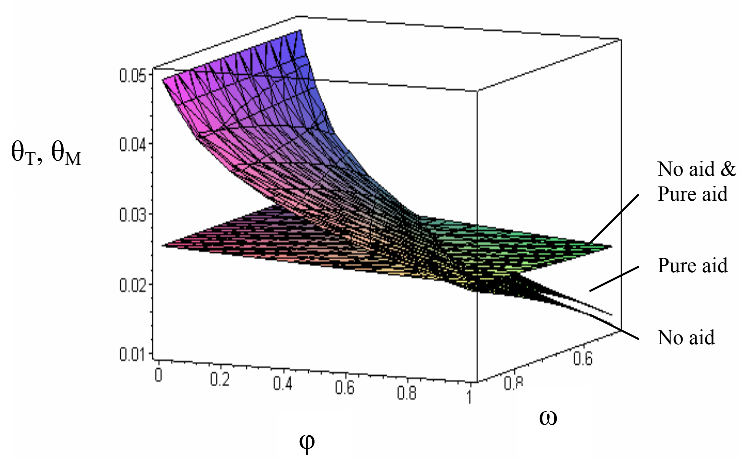


**Figure 2d**: Growth rates under income vs. inflation taxation with no aid and *tied* aid of 5%

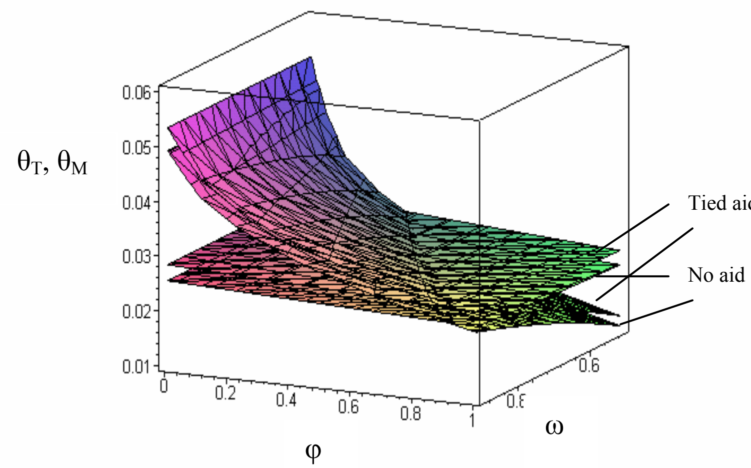

**Figure 3a**: Growth rates under income vs. inflation taxation with no aid and *pure* aid of 20%

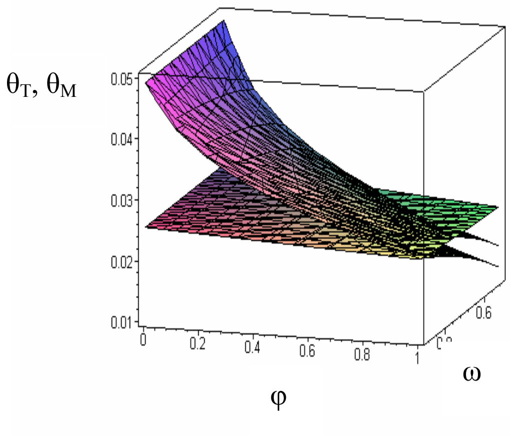


**Figure 3b**: Growth rates under income vs. inflation taxation with no aid and *pure* aid of 40%

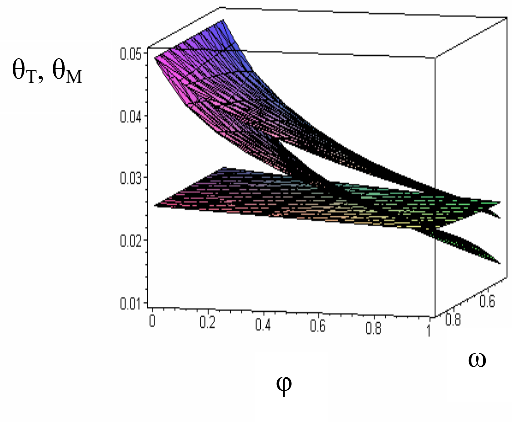


**Figure 3c**: Growth rates under income vs. inflation taxation with no aid and *pure* aid of 60%

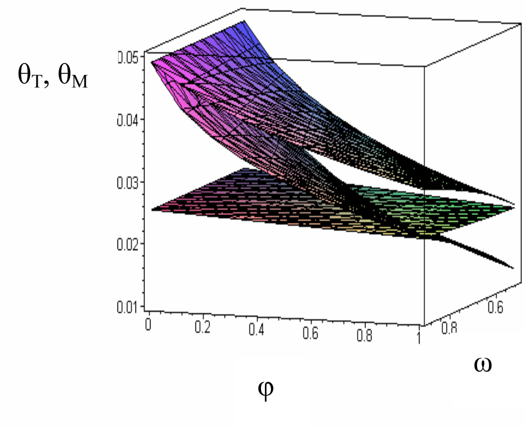


**Figure 4a**: Growth rates under income vs. inflation taxation with no aid and *tied* aid of 20%

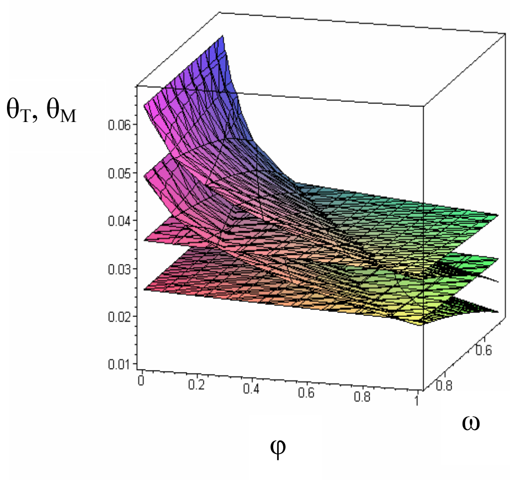


**Figure 4b**: Growth rates under income vs. inflation taxation with no aid and *tied* aid of 40%

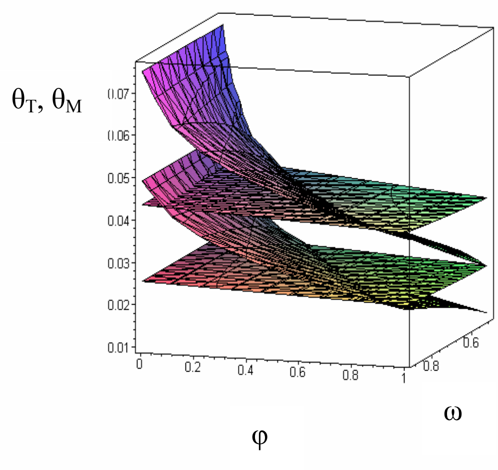


**Figure 4c**: Growth rates under income vs. inflation taxation with no aid and *tied* aid of 60%

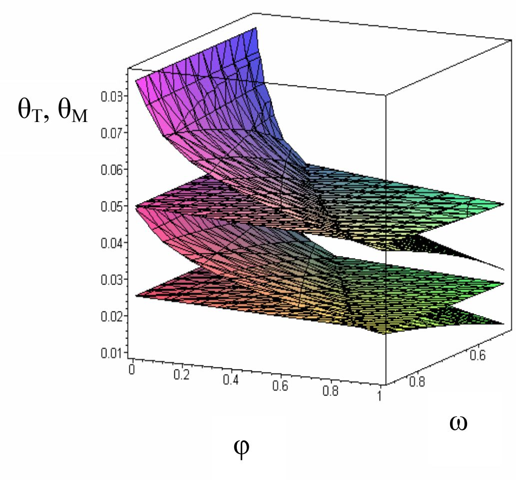

**Figure 5a**: Growth rates under a tax mix with $\omega = 0.5$ and *no* aid

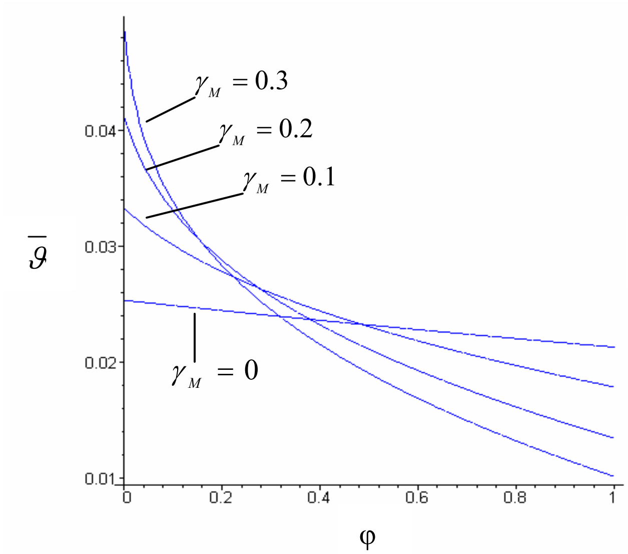


**Figure 5b**: Growth rates under a tax mix with $\omega = 0.5$ and *pure* aid of 5%

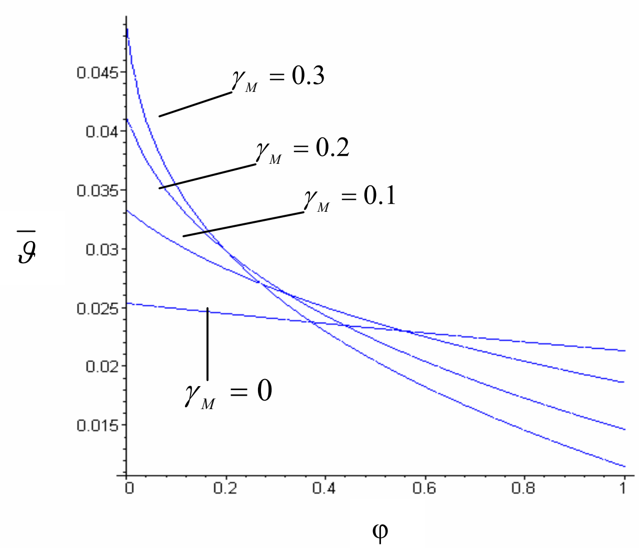


**Figure 5c**: Growth rates under a tax mix with $\omega = 0.5$ and *pure* aid of 20%

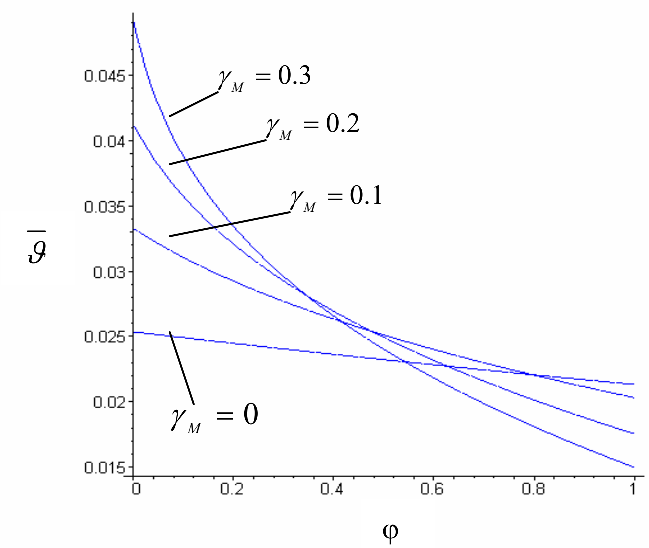


**Figure 5d**: Growth rates under a tax mix with $\omega = 0.9$ and *no* aid

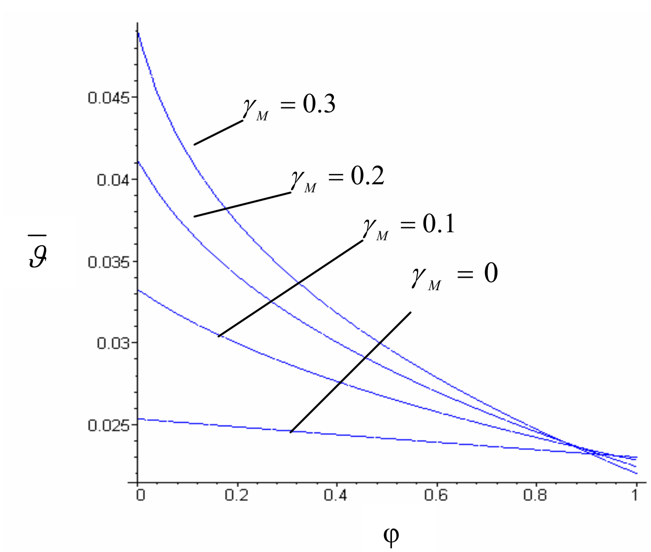


**Figure 5e**: Growth rates under a tax mix with $\omega = 0.9$ and *pure* aid of 5%

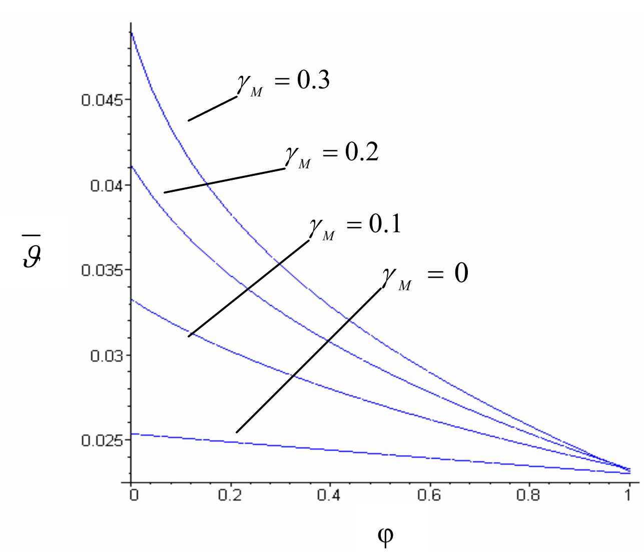


**Figure 5f**: Growth rates under a tax mix with $\omega = 0.9$ and *pure* aid of 20%

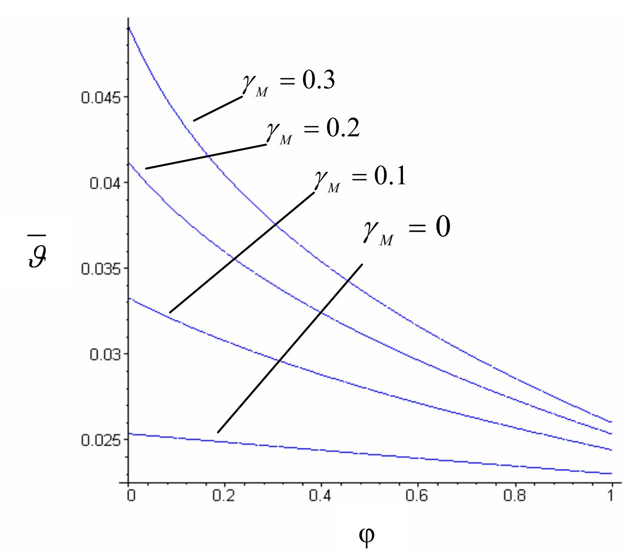

**Figure 6a**: Growth rates under a tax mix with $\omega = 0.5$ and *no* aid

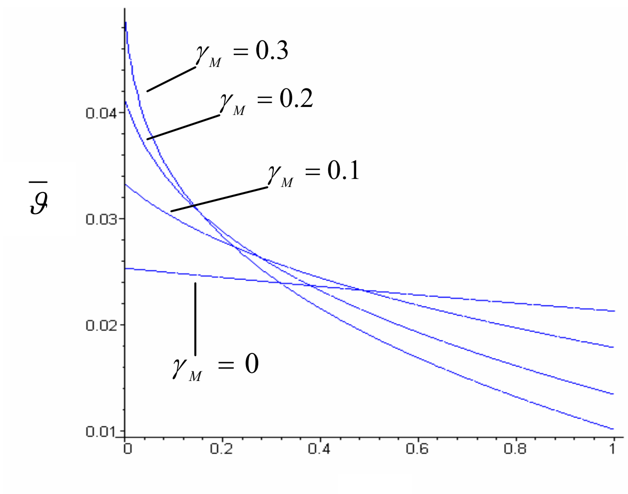


**Figure 6b**: Growth rates under a tax mix with $\omega = 0.5$ and *tied* aid of 5%

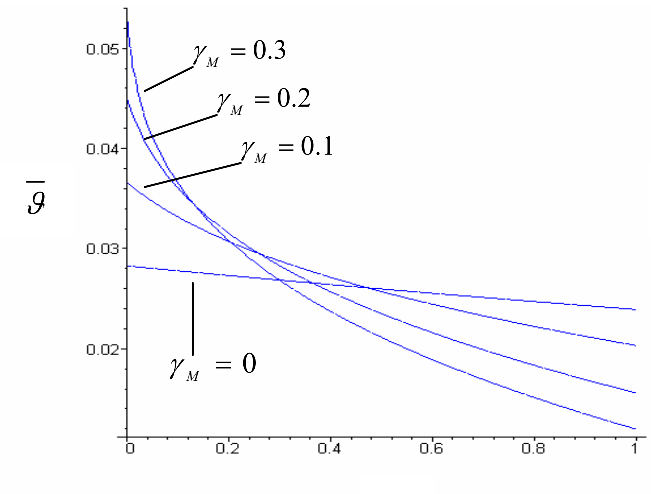


**Figure 6c**: Growth rates under a tax mix with $\omega = 0.5$ and *tied* aid of 20%

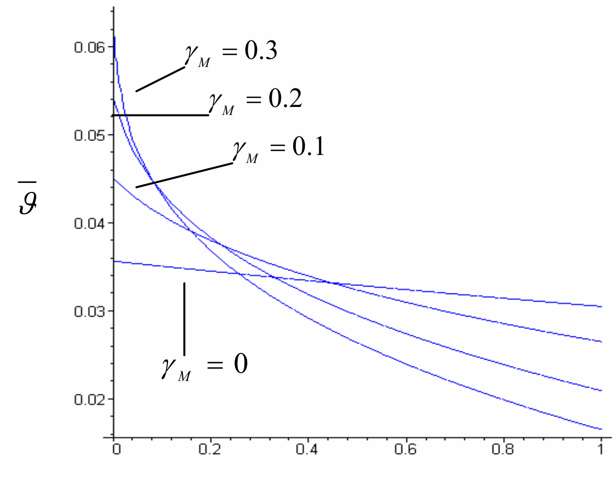


**Figure 6d**: Growth rates under a tax mix with $\omega = 0.9$ and *no* aid

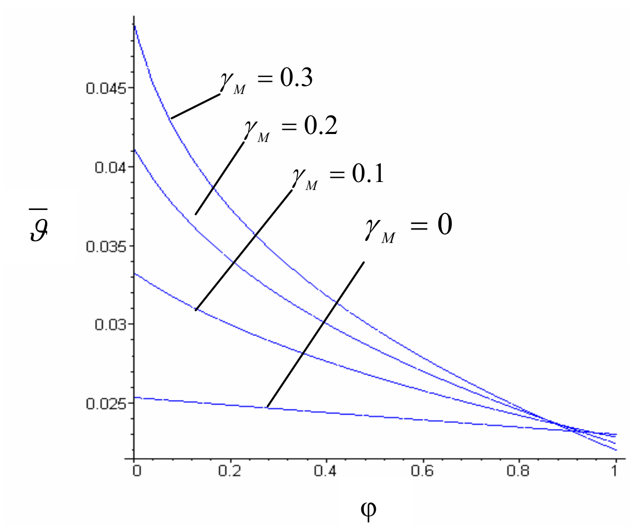


**Figure 6e**: Growth rates under a tax mix with $\omega = 0.9$ and *tied* aid of 5%

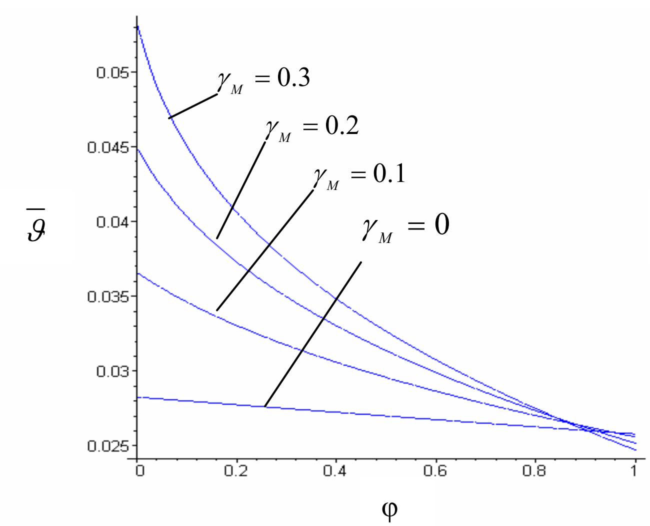


**Figure 6f**: Growth rates under a tax mix with $\omega = 0.9$ and *tied* aid of 20%