THE OPTIMAL PUBLIC EXPENDITURE FINANCING POLICY: DOES THE LEVEL OF ECONOMIC DEVELOPMENT MATTER?

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This paper explores how the optimal mode of public finance depends on the level of economic development. The theoretical analysis suggests that in the presence of capital market imperfection and liquidity shocks, the detrimental effect of inflation on growth is stronger (weaker) at lower (higher) levels of economic development. Consequently, income taxation (seigniorage) is a relatively less distortionary way of financing public expenditure for low-income (high-income) countries. We provide empirical support for our model's predictions using a panel of 21 Organization for Economic Cooperation and Development countries and 40 developing countries observed over the period 1972–1999. (*JEL* E44, E6, H6, O42)

I. INTRODUCTION

Does the growth effect of public expenditures depend on the way these expenditures are financed? Over the years, a substantial volume of theoretical and empirical research has been directed toward identifying the elements of public expenditure (at its aggregated and disaggregated level) that bear significant association with economic growth. In contrast, only a handful of studies have paid particular attention to examine the extent to which the growth effect of public expenditures depends on the method of financing such expenditures (e.g., De Gregorio 1993; Miller and Russek 1997; Palivos and Yip 1995). The consensus appears to be that the two primary modes of financing—income taxation and seigniorage—are distortionary. Opinions, however, are divided as to their relative merits. For example, according to Palivos and Yip (1995), income tax financing is more detrimental to growth than seigniorage financing. At the same time, De Gregorio (1993) suggests that as long as the rate of return on indexed bonds is substantially responsive to changes in the rate of inflation, seigniorage financing of public expenditure is more growth reducing. Pecorino (1997), on the other hand, prescribes a mix of both modes of financing.

Despite these differences, the above mentioned studies share a common characteristic: the optimal mode of financing public expenditure in these studies is viewed as being not contingent on the stages of economic development. Accordingly, there remains little understanding of the process by which public expenditure financing policies shape the prospect of economic growth for developing vis-à-vis developed countries. The primary objective of this paper is to bridge this gap in the existing literature.

It is a long-standing belief among development experts that outcomes of public expenditures and revenue policies are conditional on the state of an economy. Recent evidence

ABBREVIATIONS

GDP: Gross Domestic Product
IMF: International Monetary Fund
OECD: Organization for Economic Cooperation and Development
OLS: Ordinary Least Squares
p.c.: Per Capita

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supports such belief. For example, Miller and Russek (1997) suggest that for developing countries, a deficit-financed increase in public expenditure retards economic growth and a tax-financed increase leads to higher growth. For developed countries, a deficit-financed increase in government expenditure does not affect economic growth and a tax-financed increase leads to a lower growth. In light of these findings and in light of the theoretical controversy about the relative merits of seigniorage versus tax finance, it is meaningful to ask the following question: does the relative merit of seigniorage vis-à-vis tax financing of public expenditure depend on the stage of economic development? This paper seeks an answer to this question using both theoretical and empirical analyses.

The theoretical framework developed in this paper shares many of the characteristics of the models proposed by Espinosa-Vega and Yip (1999, 2000) and Schreft and Smith (1997). In particular, we consider a two-period overlapping-generations model where agents are subjected to stochastic relocations shocks, which act like shocks to their portfolio preferences. These shocks have the same consequence as "liquidity preference shocks" (as in Diamond and Dybvig 1983) and create a role for financial intermediaries who take deposits and make a portfolio decision on behalf of the households. In addition, there is a government that relies on two alternative sources of revenue—seigniorage and tax revenue—to finance its exogenously given expenditure sequence.

The results that we derive are shaped by the portfolio decision of the financial intermediaries. In particular, at each point in time, financial intermediaries are required to allocate their portfolios between a nonproductive liquid asset (money) and a productive illiquid asset. The illiquid asset takes the form of financing risky investment projects, which, in turn, generate productive capital stock for the economy. The financial intermediaries' optimal portfolio allocation rules depend on the relative rate of return of the two available assets. An increase in inflation (equivalently, an increase in the seigniorage revenue) alters the relative rate of return between the two assets in such a way that financial intermediaries shift their portfolios in favor of the liquid asset causing a detrimental effect on the economy's growth. Significantly, such effect varies in magnitude with the level of development. Our analysis suggests that this effect is larger at a low level of economic development where the rate of return on illiquid assets is low due to a higher default risk associated with lending. Accordingly, for low-income countries, tax revenue emerges as a better way of financing public expenditure. It is only when development exceeds a critical level that government expenditure financed with seigniorage retards growth less than if it were financed through taxation.

The results of our theoretical analysis have direct testable implications. However, to conduct such tests, it is necessary to isolate and contrast the growth effects of public expenditure when financed through taxation versus seigniorage. For this, we turn to the empirical methodology proposed by Bleaney, Gemmell, and Kneller (2001), Kneller, Bleaney, and Gemmell (1999), and Miller and Russek (1997). These studies recognize the fact that the growth effect of public expenditure depends not only on the volume and composition of the public spending but also on how these expenditures are financed. Also, these studies suggest that for measuring the impact of public expenditure, the regression equation must include all but one possible source of finance. The omitted source of finance then becomes the implicit financing variable of public expenditure. Following this methodology, we generate results based on a data set spanning over the period 1972–1999 for 40 developing and 21 developed countries by excluding, in turn, seigniorage and tax revenue from the regression. We find strong support for our theoretical predictions in the data.

The remainder of the paper is organized as follows. In Section 2, we provide the description of the economy and derive some basic results. Section 3 analyzes the balanced growth path and draws a link between the optimal mode of financing public expenditures and the stages of economic development. The results of the baseline empirical analysis and the tests for robustness are reported in Section 4 and Section 5, respectively. Finally, Section 6 concludes with some remarks.

II. DESCRIPTION OF THE ECONOMY

We consider an economy that consists of an infinite sequence of two-period lived overlapping generations and an initial old generation. Newly born agents are divided into three groups of market participants—households, capital-producing firms, and output-producing firms. We normalize the size of each group to 1. All

agents wish to consume only at the end of the second period. We proceed with the formal description with reference to circumstances facing each type of agent of generation t.

A. Households

Each household is endowed with 1 unit of labor when young and $0 < \kappa \leq 1$ units of labor during adulthood. During both periods, labor is supplied inelastically to the market for the ruling wage rates. Households' preferences are represented by the following utility function:

$$U(C_2) = -C_2^{-\gamma}/\gamma, \tag{1}$$

where C_2 denotes the old-age consumption and $\gamma > 0$. In addition, we assume that income tax is levied on the households' income at a rate τ during both periods. Since households derive utility only from the old-age consumption, all first-period disposable income must be saved. In the absence of any investment or storage opportunity, young households deposit their savings with the financial intermediaries. This savings, in turn, constitutes the basis of the capital formation for the economy. Finally, we assume that each young household faces a publicly known probability (ζ) of being relocated during his/her old age.[1] Realizations of these relocation shocks are identically and independently distributed across the household population. We assume that agents who relocate must liquidate all their assets and acquire cash.[2] This relocation shock creates the demand for liquidity and plays an important role in the portfolio allocation of the financial intermediaries.

B. Capital-Producing Firms (Borrowers)

During the first period of life, firms belonging to this sector gain access to an investment project. In the absence of any form of endowment, it is necessary for these firms to acquire external funding for operating such investment project. When external funding is available, an investment project is able to convert 1 unit of time t output into x (>1) units of time $t + 1$ capital. We assume that being an operator of an investment project, a young capital-producing firm acquires valuable experience that enables the firm to develop entrepreneurial skills to be used productively during its adulthood. Such skills determine the probability of success of future endeavors. We also assume that the acquisition of entrepreneurial skills is influenced by the state of the economy in which such skill is acquired. In particular, we follow Gertler and Rogoff (1989) and postulate that the probability of success, $p(\cdot)$, of the entrepreneurial endeavor by adult firms depends on the capital stock per firm, k_t, and that $p(k_t)$ is increasing, strictly concave and twice continuously differentiable, with $p(0) = 0$ and $p(\infty) = 1$. When successful, an adult borrower is able to convert 1 unit of labor (with which he/she is endowed) into output that is proportional to the current market wage, w_{t+1}, and is given by δw_{t+1} ($\delta > 1$). This output is used for final consumption. In an event of failure, such an endeavor yields nothing.

On the one hand, the above account of events implies that it is possible for individuals to transfer skills acquired in one activity to another. On the other hand, the proportionality between the wage rate and the rate of return of the entrepreneurial endeavor indicates that there may exist productivity spillovers from one sector of the economy to another. Both these assumptions require some clarification. Transferring skills is common in practice and is often cited in literature. For example, in the "Stepping Stone" model of Jovanovic and Nyarko (1996), agents are able to transfer skills acquired in one task to other occupations. Such activities can also be justified on the basis of empirical evidence. For example, it has been documented that firms are often able to increase the level of skills and productivity in some of their branches by transferring skills from others (e.g., Blomstrom, Lipsey, and Zejan 1994).

Starting with the work of Eckstein and Wilson (1962), various attempts have been made to establish empirically the existence of wage and productivity spillovers between markets. The hypothesis under investigation is that

1. In practice, the probability of relocation could depend on the state of an economy. We consider this variable to be exogenous (as in Bhattacharya et al. 1997; Champ, Smith, and Williamson 1996; Espinosa-Vega and Yip 1999, 2000; Schreft and Smith 1997) and view its role being simply to capture the liquidity preference shocks. The same shock can be motivated by assuming at the outset that individuals differ (ex post) in their need to hold cash (e.g., Bencivenga and Smith 1991; Diamond and Dybvig 1983).

2. We also assume that there is limited communication across locations, which prevents agents who are relocated from trading privately issued claims. For detailed discussion, refer to Bhattacharya et al. (1997) and Espinosa-Vega and Yip (1999).

wages in a specific sector are affected not only by market forces but also by wage developments elsewhere. Both Brechling (1973) and Thomas and Stoney (1971) find empirical support for this hypothesis in the United States and in the United Kingdom. More recently, Drewes (1987) finds evidence of significant spillover effects in the case of Canada. In the light of new growth theory, dynamic productivity spillover effects from the core sectors to the peripheral sectors have been established as one of the important mechanisms for driving growth. This mechanism has been subjected to a large number of empirical investigations (e.g., Chuang and Lin 1999; Piazolo 1996; Van Meijl 1997) as well. These studies have put forward additional evidence in favor of sectoral spillover in an economy. Here we appeal to the foregoing empirical literature to justify the labor productivity spillover assumption in our model.

C. Output-Producing Firms

Output-producing firms born at time t are active only during period $t + 1$ when they produce output by combining capital (produced during the time period t) and labor (supplied by the young and some old households). In particular, a firm employing k_{t+1} units of capital and L_{t+1} units of labor produces y_{t+1} units of output according to

$$y_{t+1} = B\bar{k}_{t+1}^{\theta} k_{t+1}^{\alpha} L_{t+1}^{1-\alpha}, \tag{2}$$

where $\bar{k}_{t+1}$ denotes the average per firm capital stock that acts as an externality in the production of output, similar to the types of externality considered by Romer (1986) and Shell (1966). For simplicity, we assume $\theta = 1 - \alpha$. This allows us to reduce our model to the simplest form of endogenous growth model in which the externality effects exactly offset the diminishing marginal returns to capital in the production process (i.e., the *Ak* model).[3]

3. In our case, the use of *Ak* technology can be justified on a number of grounds. First, it is often argued (e.g., Barro and Sala-i-Martin 1995) that in the face of slow cross-country convergence, the growth effects that appear in an *Ak* model provide a satisfactory approximation to the effects on the average growth rate over a long interval in the neoclassical model. Second, recent research (e.g., Turnovsky 2004) suggests that the growth effects of fiscal policy may last a long period of time—a feature that is consistent with the *Ak* model. Finally, it is also possible to justify the absence of diminishing returns by interpreting "capital" in a broader sense.

In the presence of complete factor mobility, all firms producing output must employ equal amounts of labor and capital in equilibrium. Accordingly, we obtain $\bar{k}_{t+1} = k_{t+1}$, and since there are $(1 + \kappa)$ measure of labor supplied by young and old households at each time period, the labor employed by each output-producing firm is given by $L_{t+1} = (1 + \kappa)$. Given the above, the competitively determined wage rate and the rental rate of capital facing each producer of output are, respectively, given by

$$w_{t+1} = B(1 - \alpha)k_{t+1}(1 + \kappa)^{-\alpha} \equiv A(1 - \alpha)k_{t+1}, \tag{3}$$

and

$$r_{t+1} = B\alpha(1 + \kappa)^{1-\alpha} \equiv A\alpha(1 + \kappa). \tag{4}$$

Finally, to reduce notational clutter, we assume that capital depreciates fully in the production of output.

D. Financial Intermediaries

As in Diamond and Dybvig (1983), we view financial intermediaries as cooperative entities consisting of coalitions formed by (young) agents.[4] At each time period, financial intermediaries receive deposits from young households and make portfolio decisions about how to allocate the received funds between the two available assets—lending to the capital-producing firms and holding the deposits in the form of liquidity (money). As indicated earlier, a fraction (ζ) of the depositors face the possibility of relocation. If such event is realized, they must acquire cash by liquidating all their deposits with financial intermediaries. Keeping such contingencies in mind, financial intermediaries make their optimal portfolio decisions as discussed below.

Optimal Portfolio Decision. In drawing up contracts with the depositors and the borrowers, financial intermediaries specify the borrowing and the lending rates together with the circumstances under which such rates are

4. As in Diamond and Dybvig (1983), financial intermediation arises endogenously since, unlike individual agents, the financial intermediaries are able to make a better allocation of funds by way of exploiting the law of large numbers.

applicable. Let financial intermediaries pay individual depositors a gross real return, R_t^a, when they move to another location, while they pay a gross real return R_t^s to those agents staying at the original location.[5] Also, let q and $(1 - q)$ denote the fraction of the deposit a financial intermediary lends to the capital-producing firms and holds in the form of real money balances, respectively. Finally, let ρ_t denote the gross real lending rate that a financial intermediary charges to the capital-producing firms. To keep our exposition transparent, we consider ρ_t as given for the time being. The determination of ρ_t is taken up later during the analysis.

We assume that financial intermediaries operate as an extension of households, acting as a cooperative.[6] Accordingly, the financial intermediaries' portfolio problem consists of maximizing depositors' welfare by choosing a vector of deposit returns and a portfolio allocation, while satisfying a set of resource constraints. In doing so, the financial intermediaries take the gross rate of return on money holdings, $P_t/P_{t+1} = R_t^m$, as given. More specifically, a financial intermediary's problem reduces to choosing q_t, R_t^a, and R_t^s in order to maximize the expected utility of the depositors given by

$$V_t \equiv -\zeta[w_t(1-\tau)R_t^a]^{-\gamma}/\gamma - (1-\zeta)[w_t(1-\tau)R_t^s]^{-\gamma}/\gamma, \tag{5}$$

subject to

$$\zeta R_t^a = R_t^m(1 - q_t), \tag{6}$$

and

$$(1-\zeta)R_t^s = \rho_t q_t. \tag{7}$$

The resource constraint in Equation (6) ensures that the financial intermediaries are able to meet the liquidity needs of those depositors who are required to move to another location. Equation (7) indicates that the fraction $(1 - \zeta)$ of households staying in the same location must be repaid from the income generated by financial intermediaries from lending to capital-producing firms.

The solution to the financial intermediaries' problem is given by

$$q_t = \Phi_t(R_t^m, \rho_t)/[1 + \Phi_t(R_t^m, \rho_t)], \tag{8}$$

where

$$\Phi_t(R_t^m, \rho_t) = ((1-\zeta)/\zeta)(R_t^m/\rho_t)^{\frac{\gamma}{1+\gamma}}. \tag{9}$$

It is easy to verify from Equations (8) and (9) that $\partial q_t/\partial R_t^m > 0$ and $\partial q_t/\partial \rho_t < 0$. Intuitively, an increase in the rate of inflation decreases the relative rate of return (R_t^m/ρ_t) of the two assets. This, on the one hand, induces intermediaries to allocate a larger fraction of funds to lending. On the other hand, an increase in inflation causes intermediaries to increase money holding in their portfolio in order to guarantee adequate provision of liquidity services to those agents for whom the relocation shock has realized. The latter effect dominates the former when the degree of risk aversion is large enough (i.e., $\gamma > 0$). Following a similar line of argument, it is straightforward to explain the inverse relationship between q_t and ρ_t.

Information Friction and the Lending Rate. We assume that there exists an informational friction between the capital-producing firms and the financial intermediaries that takes the form of a moral hazard problem. In particular, after receiving a loan, a capital-producing firm may wish not to undertake the project and instead run away with a fraction $0 < \lambda \leq 1$ of the loan, which can be stored for future consumption. In such circumstance, it is possible for the lender to track the borrower down only at a prohibitively high cost. To avoid apprehension and the penalty, a firm must remain underground for the rest of its life. Thus, by absconding, a firm loses opportunities of either running its own project or supplying labor to the market during adulthood. Evidently, while designing a contract, a financial intermediary must take into account the fact

5. Note that the agents who relocate do keep their deposits with the financial intermediary for a shorter time period than those agents for whom the shock has not realized. It is a common practice among the financial intermediaries to link the rate of returns on deposits with their maturity. In our model, the two rates of returns on deposits reflect such a practice.

6. Alternately, one may think of a widely used framework (e.g., Bencivenga and Smith 1993; Bose and Cothren 1996) where financial intermediaries compete for the depositors. In such case, any contract that yields extra economic profits to the financial intermediaries is unlikely to survive in the market because financial intermediaries would compete with each other to win the depositors by offering part or all of the extra economic profits. This amounts to saying that, in equilibrium, competition drives the financial intermediaries to do what is best for the depositors.

that the expected payoff to firms from defaulting must be no greater than the expected payoff from not defaulting, if defaulting is not, in fact to occur. That is, $(xr_{t+1} - \rho_t)l_t + p(k_t)\delta w_{t+1} \geq \lambda l_t$, where l_t denotes the loan amount. Given that financial intermediaries are maximizing depositor's utility, it is easy to establish that such incentive compatibility constraint would always bind. Hence, the real rate of return that the financial intermediaries are able to enjoy from lending is given by

$$\rho_t = xr_{t+1} + [p(k_t)\delta w_{t+1}/l_t] - \lambda = Aa(1+\kappa)x + [p(k_t)\delta A(1-\alpha)k_{t+1}/l_t] - \lambda. \quad (10)$$

It is worth noting that among other things ρ_t is influenced by the state variables. It is this feature that we exploit in our analysis for establishing the linkage between the stages of development and the relative merits of seigniorage vis-à-vis tax financing of public spending.

E. Government

In this economy, the government relies on two sources of revenue to finance its nonproductive expenditure, G_t. The first source of revenue comes from levying proportional taxes on wage earnings. Recall that at each time period, a unity measure of young and κ measure of old households earn wage incomes. Accordingly, the total tax revenue collected during period t is given by $(1 + \kappa)\tau w_t$. The second source of the government's revenue is through seigniorage. Let M_t and P_t denote the time t money supply and price level, respectively. Then, the government's budget constraint is given by

$$G_t = (1+\kappa)\tau w_t + (M_t - M_{t-1})/P_t. \quad (11)$$

Finally, to ensure balanced growth, we assume $G_t = \beta Y_t$. That is, the government spends a constant fraction (β) of the total output, where β is viewed as a policy parameter.

III. BALANCED GROWTH PATH

The economy's capital at time $t + 1$ originates from the project run by the capital-producing firms at time period t. Each of these firms converts l_t amount of time t output (obtained from the financial intermediaries in the form of a loan) into xl_t amount of $t + 1$ capital. Making use of Equation (3) and noting that $l_t = q_t(1 - \tau)w_t$ and that there is unity measure of output-producing firms at each time period, we express the growth rate of the capital stock per firm as

$$\theta \equiv k_{t+1}/k_t = A(1-\alpha)(1-\tau)xq(R_t^m, \rho_t), \quad (12)$$

where q_t is given by Equation (8). Due to the Ak technology in output production, θ also represents the growth rate of output per capita (p.c.), y_t.

As noted earlier, the demand for liquidity in our model originates from the relocation needs of the depositors. A financial intermediary makes provisions for such needs by allocating $(1 - q_t)$ fraction of the deposit to real money balances. Accordingly, for a given value of q_t, the aggregate stock of real balances at time t satisfies

$$m_t \equiv M_t/P_t = [1 - q_t(R_t^m, \rho_t)](1-\tau)w_t = [1 - q_t(R_t^m, \rho_t)](1-\tau)(1-\alpha)Ak_t, \quad (13)$$

implying that m_t grows at the same rate as k_t (and hence y_t). Next, a time lead of the government's budget constraint in Equation (11) together with the fact that $G_t = \beta Y_t$ yields

$$\beta Y_{t+1} = (1+\kappa)\tau w_{t+1} + m_{t+1} - m_t(P_t/P_{t+1}). \quad (14)$$

Finally, making use of Equations (3), (12), (13), and the facts that $m_{t+1} = \theta m_t$ and that $Y_t = A(1 + \kappa)k_t$, we rewrite Equation (14) as

$$\beta = (1-\alpha)\tau + \{[1 - q_t(R_t^m, \rho_t)]/Axq_t(R_t^m, \rho_t)(1+\kappa)\}(\theta - R_t^m). \quad (15)$$

Recognize that the first term on the right hand side of Equation (15) represents the fraction of government spending financed with income tax revenue, while the second term denotes the fraction of the revenue collected through seigniorage. Moreover, the second term can be further decomposed into the inflation tax base $[1 - q_t(R_t^m, \rho_t)]/Axq_t(R_t^m, \rho_t)(1 + \kappa)$ and the inflation tax rate $(\theta - R_t^m)$. For evaluating the growth effects of government expenditure, we consider Equations (12) and (15)

jointly and present our results in the following propositions.[7]

PROPOSITION 1. *For a given ρ_t, an increase in government expenditures financed either through an increase in income taxes or seigniorage reduces the rate of economic growth.*

Proof. See Appendix A.

The intuition underlying the above proposition is straightforward. An increase in the income tax rate lowers the growth rate of capital formation by directly decreasing the volume of deposited funds and the volume of lending. In contrast, the effect of an increase in seigniorage on the growth rate is obtained through portfolio choice of the financial intermediaries. Given that $q'(R^m) > 0$, an increase in inflation induces financial intermediaries to shift their portfolios in favor of real balances (and hence against lending). This, in turn, lowers the rate of growth of the economy.

The result that both methods of financing generate distortionary effects on growth is not surprising and has been widely established in previous works (e.g., Espinosa-Vega and Yip 1999, 2000; Palivos and Yip 1995). The question of interest here is which of these two methods generates relatively less distortionary effects? In answering this question, we depart from the existing views by claiming that the appropriate choice of the financing method depends significantly on the level of economic development.

PROPOSITION 2. *For a large (small) enough k_t, an increase in government expenditure financed through seigniorage generates relatively less (more) distortionary effects on growth.*

Proof. Given that $l_t = q_t(1 - \tau)w_t = q_t(1 - \tau)A(1 - \alpha)k_t$, Equations (10) and (12) together imply $\rho_t = Ax[\alpha(1 + \kappa) + (1 - \alpha)\delta p(k_t)] - \lambda$. From Equations (A3) and (A4), a direct comparison of the growth effects yields that seigniorage is relatively less (more) distortionary when $[1/(1 + \kappa)](1 + R_t^m/\gamma\theta_t) > (<) 1$. Further, Equations (8), (9), and (12) together imply that θ_t is decreasing in ρ_t and hence in k_t. Accordingly, when k_t is large enough (equivalently, for a small enough θ_t), financing through seigniorage produces relatively less distortionary growth effects than what is obtained under tax financing. The opposite is true when k_t is small. ■

Recall that the growth effect of seigniorage depends on the portfolio choices of the financial intermediaries, which are determined by the relative rate of return of the two assets. For a developed country where the return from investment (ρ_t) is high due to low default risk, the relative return (R_t^m/ρ_t) is less sensitive to the movement in R_t^m, resulting in a smaller negative growth effect of seigniorage compared to what is obtained in the case of a developing country.

Finally, we note that it is necessary to assume that $\rho_t > R_t^m$ holds throughout our analysis. In its absence, lending to the capital-producing firms is not a preferred option. At the same time, since $p(k_t) \to 1$ as $k_t \to \infty$, the upper bound of ρ_t is set at $Ax[\alpha(1 + \kappa) + (1 - \alpha)\delta] - \lambda$. For our story to be meaningful, the value of ρ_t for which the growth effects of seigniorage and taxation financing are equal (i.e., the relation $[1/(1 + \kappa)](1 + R_t^m/\gamma\theta_t) = 1$ holds) must lie in the domain of ρ_t specified above. In Table A1 (Appendix A), we have listed three parameter constellations for which the above requirement is satisfied both in the case of an inflationary and a deflationary situation. Part of these parameter constellations (e.g., the values of γ, τ, A, and α) has been chosen on the basis of previous studies and is indicated clearly in the table.

IV. EMPIRICAL ANALYSIS

The theoretical analysis yields a direct testable implication. The analysis suggests that, for the high-income economies, an expansion in government expenditures financed with taxes retards growth more than if it were financed through seigniorage. An opposite result holds in the case of low-income countries. In this section, we proceed to test this hypothesis using a panel data set of 21 Organization for Economic Cooperation and Development (OECD) countries and 40 developing countries for the period 1972–1999. For isolating and contrasting the growth effects of public expenditure when financed through taxation vis-à-vis seigniorage, we base our methodology on the previous works by Bleaney, Gemmell, and Kneller (2001), Kneller, Bleaney, and Gemmell (1999), and Miller and Russek (1997). These papers express the view that an evaluation of the effects of taxes, expenditures,

7. We skip the formal proof of the fact that the economy is characterized by a unique nontrivial balanced growth path. The proof is available upon request. Alternately, refer to Espinosa-Vega and Yip (1999).

and budget deficit/surplus on economic growth is meaningful only when both the sources and the uses of government funds are included simultaneously in the analysis. Keeping in line with this argument, we employ the following model specification:

$$g_{it} = \alpha + \sum_{i=1}^{m} \beta_i M_{it} + \sum_{j=1}^{n} \gamma_j N_{jt} + u_{it}, \quad (16)$$

where g_{it} denotes growth in country i at time t, M_{it} represents nonfiscal conditioning variables that commonly appear in growth regressions. These conditioning variables include initial gross domestic product (GDP), investment, population growth rate, initial secondary schooling, trade, and the terms of trade growth rate.[8] N_{jt} describes the government budget elements. To make the analysis consistent with our theory counterpart, we decompose the consolidated government budget into four elements:

$$E_{it} = R_{it} + S_{it} + D_{it}. \quad (17)$$

The left hand side (E_{it}) consists of government expenditure on goods, services, and transfers plus interest payments on the outstanding debt, and the right hand side consists of tax revenue and grants (R_{it}) plus the seigniorage (S_{it}) used to finance the budget plus the rest of the budget financing (D_{it}) of which new issues of interest-bearing debt (held by public) constitute a significant part. Since $S_{it} = E_{it} - R_{it} - D_{it}$, we further rewrite Equation (16) as

$$g_{it} = \alpha + \sum_{i=1}^{m} \beta_i M_{it} + \gamma_1 E_{it} + \gamma_2 R_{it} + \gamma_3 \underbrace{(E_{it} - R_{it} - D_{it})}_{S_{it}} + \gamma_4 D_{it} + u_{it}. \quad (18)$$

This yields our final reduced form as

$$g_{it} = \alpha + \sum_{i=1}^{m} \beta_i M_{it} + \delta_1 E_{it} + \delta_2 R_{it} + \delta_3 D_{it} + u_{it}, \quad (19)$$

where $\delta_1 = \gamma_1 + \gamma_3$, $\delta_2 = \gamma_2 - \gamma_3$, and $\delta_3 = \gamma_4 - \gamma_3$. Equation (19) is equivalent to the specification considered by Miller and Russek (1997), which we follow in our analysis. The estimated coefficient of public expenditures (δ_1) captures the effect on economic growth of an increase in government expenditure through seigniorage, assuming no changes in the tax revenue or other forms of financing. In other words, when the excluded element is a source of government revenue, it becomes the implicit financing element of government expenditure. We capture the growth effects of tax-financed government expenditure in the following ways. First, as per above analysis, we capture the effect by summing up the estimates of δ_1 and δ_2 in Equation (19) and construct a confidence interval for their sum.[9] As an alternative procedure, we focus on the estimate of the expenditure coefficient in a regression where (instead of seigniorage) the omitted variable is the tax revenue. For completeness, we have chosen to report the results obtained by both methods.

A. The Data

Our data set consists of panel data for 21 developed OECD member countries and 40 developing countries over the period 1972–1999. Observations are drawn from three different sources. Government budget data and the seigniorage measures have been drawn from the International Monetary Fund's (IMF) *Government Finance Statistics* and the *International Financial Statistics*, respectively. The data on the rest of the variables have been drawn from the World Bank's *World Development Indicators*. Unless we state otherwise, the observations correspond to a three-year average for the time interval 1972–1974 and five-year average values of the variables in the time interval 1975–1999. We follow this approach to capture the long-run trends by eliminating business cycle effects.[10] It is often difficult to obtain a direct measure of government borrowing that is used to finance its expenditure. Following Rodriguez (1994), we have used the difference between two series—the deficit of

8. The initial level of income has consistently been used in growth regressions to capture conditional convergence to the steady state, while controlling for human capital (schooling) allows for proxying the divergence of the initial income level from its steady-state level (Cashin 1995). The rest of the conditioning variables have been widely used and found significant in a number of Barro-type regressions.

9. Refer to Bleaney, Gemmell, and Kneller (2001), Kneller, Bleaney, and Gemmell (1999), and Miller and Russek (1997) for a more detailed discussion.

10. A similar approach has been adopted in Bleaney, Gemmell, and Kneller (2001), Cashin (1995), Kneller, Bleaney, and Gemmell (1999), and Mendoza, Milesi-Feretti, and Asea (1997).

TABLE 1
Descriptive Statistics

Variable \ Country Set	Mean		Standard Deviation		Minimum		Maximum	
	developed	developing	developed	developing	developed	developing	developed	developing
GDP p.c. growth (%)	0.0236	0.0189	0.0069	0.0186	0.0089	−0.0166	0.0412	0.0599
Initial p.c. GDP (1995 U.S. dollars)	20,726	2,085	7,300	2,435	7,976	97.86	40,787	13,344
Investment	0.2326	0.2297	0.0257	0.0579	0.1892	0.1207	0.2837	0.3960
Population growth (%)	0.0059	0.0216	0.0035	0.0073	0.0017	−0.0007	0.0141	0.0346
Government revenues	0.3296	0.2242	0.0780	0.0838	0.1930	0.1028	0.4821	0.4881
Government expenditures	0.3538	0.2463	0.0808	0.0889	0.2168	0.1077	0.5088	0.5228
Seigniorage	0.0101	0.0249	0.0099	0.0174	0.0036	0.0014	0.0385	0.0798
Rest of budget financing	0.0230	0.0059	0.0225	0.0299	−0.0253	−0.0685	0.0833	0.0689
Initial secondary schooling	0.8980	0.3980	0.1103	0.2054	0.6391	0.3741	1.0505	0.8482
Trade	0.6921	0.6324	0.3867	0.5207	0.1897	0.1592	1.9769	3.4418
Terms of trade growth (%)	−0.0007	−0.0573	0.0030	0.0099	−0.0061	−0.2336	0.0055	3.924

Notes: Descriptive statistics for the variables used in baseline regressions as time interval average values. Variables are expressed as fractions of GDP except where noted. Seigniorage measured as Seigniorage1 described in Appendix B. Missing three-year and five-year averages for 1972–1974 (Portugal, Cameroon, Egypt, Iran, Singapore, Syrian Arab Republic, Venezuela, and Zimbabwe), 1972–1979 (Argentina, Hungary, Indonesia, and Lesotho), 1972–1984 (Bolivia), 1972–1989 (Germany, Romania, and South Africa), 1975–1979 (Brazil), 1985–1989 (Switzerland and Burundi), 1985–1999 (Senegal), 1990–1999 (Zambia), 1995–1999 (Austria, Burkina Faso and Paraguay), 1972–1984 and 1995–1999 (Ethiopia), 1985–1989 and 1995–1999 (Gambia).

the consolidated public sector and the revenue from money creation—as a proxy of the part of the total expenditure that is financed by issuing interest-bearing debt. In Table 1, we summarize the descriptive statistics of the variables used in the baseline regressions. Appendix B provides the detailed description and the sources of the variables used in the analysis.

B. Baseline Results

We consider five special forms of panel data estimation: pooled ordinary least squares (OLS), one-way and two-way fixed effects, and one-way and two-way random effects models. In all cases, the random effects specification received the greatest support from the diagnostic tests for both the developed and the developing country samples.[11] Accordingly, in Table 2, we report the results of the random effects model run on the basis of the specification (Equation 19), in which seigniorage has been considered as the implicit financing element of the public expenditure. The first and the second columns of the table describe the results for the developed and the developing countries, respectively.

We open the discussion with the results for the nonfiscal variables. Many of these results are in accordance with the results obtained by previous studies. For example, as in Barro (1991), Kneller, Bleaney, and Gemmell (1999), Mankiw, Romer, and Weil (1992), and Miller and Russek (1997), we find evidence of conditional convergence in both samples, suggesting that countries with low initial income levels grow faster than countries with higher initial income levels. Similarly, we find that the investment and the population variables are significantly associated with economic growth with a positive and a negative coefficient, respectively. Such associations are more pronounced for the developing than for the developed countries. Surprisingly, we find that the coefficient of the initial schooling to be insignificant for both sets of countries. This result is supported by many previous findings. Examples include Cashin (1995) and Levine and Renelt (1992), and more recently Gupta et al. (2005). Finally, although the trade and the terms of trade variables appear with the predicted signs in both the samples, the

11. The selection of the model between pooled OLS and fixed effects relies on an *F*-test of the joint significance of the cross section and/or time dummies present in the fixed effects model. Model selection between the fixed and random effects has been based on the Hausman model specification test. Our bias toward the random effects model is shared by a number of authors (e.g., Cashin 1995; Wooldridge 2002).

TABLE 2
Regression Results with Total Government Revenues

Dependent Variable: GDP p.c. Growth		
Country Set	**Developed**	**Developing**
Log of initial p.c. GDP	−0.017** (2.26)	−0.014** (2.51)
Investment	0.117*** (3.03)	0.195*** (4.63)
Population growth	−0.584** (2.09)	−0.684* (1.66)
Government expenditures	−0.089 (1.08)	−0.165** (2.39)
Government revenues	−0.028 (0.33)	0.091 (1.06)
Rest of budget financing	−0.032 (0.42)	0.103 (1.59)
Initial secondary schooling	0.007 (0.80)	−0.012 (0.65)
Trade	0.038*** (4.96)	0.004 (0.48)
Terms of trade growth	0.125 (1.34)	0.146** (2.19)
R^2	0.3722	0.2095
No. of observations	119	199
F-test	15.77***	2.94*
Hausman specification test	10.12	14.06
Confidence interval at 95%	(−0.167, −0.069)	(−0.144, −0.003)
Test of policy equivalence	0.11	1.12
Estimated effect of tax finance	−0.119*** (4.09)	−0.100** (2.39)

***, **, *: Significant at 1%, 5%, and 10% level, respectively. t-statistics in parentheses.

trade variable is significant only in the case of developed countries, whereas the terms of trade appears to be significant only in the case of developing countries.[12]

Turning our attention to the fiscal variables, we find strong evidence in support of our theoretical predictions. Given that seigniorage is the implicit financing element, the coefficient of total expenditure captures the growth effects of public expenditure when financed through seigniorage. The table indicates that the growth effect is large and significantly negative in the case of developing countries. In contrast, the same coefficient is found to be insignificant for developed countries. To obtain the growth effect of public expenditure when financed through taxes, we calculate the sum of the estimated coefficients on government revenues and expenditures. As the results indicate, the *F*-test of their joint significance cannot be rejected for either set of countries. The 95% confidence interval also suggests that tax-financed government expenditures have a significantly negative growth effect on both sets of countries. Further, to verify that the growth effects of tax-financed and seigniorage-financed public expenditure are statistically different within the same-country sample, we perform a test of policy equivalence. This test compares the estimated coefficient of public expenditure with the sum of the estimated coefficients on government revenues and expenditures. The test indicates that the null is rejected, implying the different impact of the two financing methods on growth.

As an alternative procedure, we also estimate growth regressions by excluding tax revenues from and by including seigniorage in Equation (19) so that tax financing now becomes the implicit financing element of government expenditures.[13] In this case, we report the coefficient of public expenditures in the last row of the table. As before, we find that the results are in accordance with the predictions of our theoretical model.

To obtain further insights, we repeat the above exercises after decomposing total public revenues.[14] The results are reported in Table 3. The first two columns of the table report the results for the two sets of countries where revenue has been decomposed into distortionary taxes, nondistortionary taxes, and other revenues. In the next two columns, the distortionary tax revenues have been further disaggregated into income tax revenues and

12. In addition to the above nonfiscal conditioning variables, we have also run regressions that include the rate of inflation as an explanatory variable in order to disentangle the effect of seigniorage finance of spending on growth from any possible effect of inflation on growth. Although inflation is found to be negatively associated with growth for both sets of countries in a significant way, the effects of the remaining fiscal and nonfiscal variables remain similar to those reported in Table 2. A similar result is also obtained when we include a dummy variable for Latin American countries to control for their different growth experiences during the period under consideration.

13. To economize on space, we do not report the entire results. They are available upon request.

14. We follow Kneller, Bleaney, and Gemmell (1999) in classifying government revenues into distortionary taxes, nondistortionary taxes, and other revenues. Definitions and summary statistics on these and the rest of the new variables used in the sensitivity analysis section are reported in Appendix B.

other distortionary tax revenues. As before, the last row in Columns 1 and 2 reports the estimated growth effects of public expenditure when it is financed by distortionary taxes (instead of seigniorage). Similarly, the last row in Columns 3 and 4 provides the estimated growth effects of public expenditure when income tax is the implicit financing element. As the estimated coefficients indicate, the essence of our results remains intact (if not improves) when we disaggregate the revenue data.

V. SENSITIVITY ANALYSIS

This section examines the robustness of our baseline results by conducting the following four exercises. Our theory suggests that there exists a critical level of development such that for a level of development below (above) this critical level, financing public expenditure through income taxes (seigniorage) materializes as the preferred mode of financing. We undertake the first exercise to verify such claim. Second, we consider alternative seigniorage measures to examine the validity of our results. Third, we examine whether our results are sensitive to an alternative regression specification, as suggested by Bleaney, Gemmell, and Kneller (2001) and Kneller, Bleaney, and Gemmell (1999). Finally, we account for potential endogeneity between the growth rate and the explanatory regressors.

A. Existence of a Critical Level of Development

In our baseline analysis, countries were divided at the outset between developed and developing according to the World Bank classification—a practice that is quite common in the literature (e.g., Giavazzi, Jappelli, and Pagano 2000; Miller and Russek 1997). At the same time, we recognize that an ad hoc separation of countries runs the risk of placing a country in a wrong regime. To address this issue, we conduct an alternative exercise where we pool all the countries and look for a critical level of development (as measured by the logarithm of p.c. GDP), so that when p.c. GDP falls below this critical level, income tax emerges as the optimal mode of financing public expenditure. We do this by including an interaction term between government expenditures and the level of development. By excluding from the regression the implicit financing element of the government budget, we then establish the effect of public spending on growth. Such effect is now contingent on the level of economic development.

Table 4 presents the findings, with the first (second) column of results showing the effects of seigniorage (income tax)–financed spending. The results suggest that a linear hypothesized relation that captures the link between the growth effects of public expenditure and the level of development has a smaller intercept and a higher (positive) slope when public expenditure is financed through seigniorage. This result points to the existence of a critical value of p.c. GDP below which financing public expenditure through income taxes generates a less distortionary growth effect than if it were financed through seigniorage. The opposite result holds when the level of development exceeds this critical value.[15]

B. Alternative Seigniorage Measures

The measurement of seigniorage has been an issue of a long debate in the literature, and a number of alternative estimates have been proposed to measure its magnitude.[16] Below, we examine the validity of our results with respect to some of these alternate measures that are appropriate for both developed and developing countries.[17] The full description of these measures and their summary statistics appear in Appendix B.

In Table 5, we report the regression results for the developed countries by using three alternative seigniorage measures as indicated by Seigniorage2, Seigniorage3, and Seigniorage4.

15. While the difference between the slope coefficients may not appear substantial, the readers should note that we have used the *logarithm* of p.c. GDP and *not* p.c. GDP as the proxy for development. An elementary calculation based on the estimated coefficients suggests that the critical level of p.c. GDP takes value of $2,700 (in constant 1995 U.S. dollars). According to the World Bank's classification, this value lies in the upper-income range of the lower middle-income countries.

16. For a discussion on this issue, see de Haan, Zelhorst, and Roukens (1993), Drazen (1985), Honohan (1996), and Klein and Neumann (1990).

17. We have not considered the measure of seigniorage that is given by the ratio of the product of inflation and high-powered money to nominal GDP as it is often considered inappropriate for developing countries (see Walsh 1998). Also, we have abstained from considering the opportunity cost concept of seigniorage given by the ratio of the product of nominal interest rate and high-powered money to nominal GDP. The difficulty associated with this latter measure is that it requires the choice of the "correct" nominal interest rate across countries and time.

TABLE 3
Regression Results with Distortionary Taxes and Income Taxes

Dependent Variable: GDP p.c. Growth				
Country Set	**Developed**	**Developing**	**Developed**	**Developing**
Log of initial p.c. GDP	−0.015** (1.85)	−0.012** (2.05)	−0.014* (1.78)	−0.012** (2.10)
Investment	0.114*** (2.94)	0.191*** (4.50)	0.114*** (2.89)	0.199*** (4.66)
Population growth	−0.572** (1.96)	−0.751* (1.85)	−0.576* (1.94)	−0.669* (1.64)
Government expenditures	−0.029 (0.36)	−0.141** (2.21)	−0.026 (0.31)	−0.154** (2.39)
Distortionary tax revenues	−0.131 (1.40)	0.004(0.04)	—	—
Income tax revenues	—	—	−0.139 (1.46)	−0.074 (0.62)
Other distortionary tax revenues	—	—	–0.137 (1.21)	0.201 (1.15)
Nondistortionary tax revenues	–0.012 (0.12)	0.075 (0.79)	–0.014 (0.13)	0.062 (0.49)
Other revenues	−0.077 (0.77)	0.087 (0.97)	–0.076 (0.75)	0.085 (0.95)
Rest of budget financing	–0.082 (1.12)	0.111* (1.80)	–0.085 (1.12)	0.112* (1.82)
Initial secondary schooling	0.006 (0.72)	–0.011 (0.54)	0.006 (0.70)	–0.010 (0.55)
Trade	0.042*** (4.93)	0.004 (0.48)	0.043*** (4.90)	0.006 (0.60)
Terms of trade growth	0.136 (1.47)	0.151** (2.27)	0.139 (1.49)	0.158** (2.38)
R^2	0.3973	0.2140	0.4017	0.2215
No. of observations	119	198	119	198
F-test	16.65***	2.64	8.55***	4.78**
Hausman specification test	11.35	12.29	11.29	11.39
Confidence interval at 95%	(−0.226, −0.095)	(−0.275, 0.002)	(−0.260, −0.072)	(−0.400, -0.056)
Test of policy equivalence	1.95	0.00	2.12	0.39
Estimated effect of distortionary tax finance	−0.129*** (3.83)	−0.119 (1.62)	−0.125** (2.46)	−0.111 (1.34)

***, **, *: Significant at 1%, 5%, and 10% level, respectively. t-statistics in parentheses.

For a ready comparison, we reproduce in the first column the results from Table 2 where Seigniorage1 had been used in the regression. As it can be seen in Table 5, for all measures of seigniorage, our previously obtained results remain intact for the set of developed countries. Similarly, as shown in Table 6, the results are preserved for the set of developing countries.

C. Omitting a Neutral Element from the Budget

A methodology proposed by Bleaney, Gemmell, and Kneller (2001) and Kneller, Bleaney, and Gemmell (1999) in evaluating the effects of fiscal variables has drawn wide attention among the researchers. According to this approach, it is necessary from an econometric perspective to control for possible omitted variable bias that will result should any component of government expenditure that is important for growth be excluded from the model. Following their example, we include all elements of the budget except one growth neutral element (i.e., nondistortionary tax revenue). The results that are presented in Table 7 indicate that between the two financing methods, only distortionary tax (seigniorage) has a negative and a significant *direct* effect on growth in the case of developed (developing) countries. In this setting, we obtain the growth effect of public expenditure (conditional upon its mode of finance) by adding the coefficient of public expenditure with the coefficient of the financing variable (e.g., seigniorage and distortionary tax revenue). The values of the sums along with the tests of the joint significance of the sums of the coefficients and a 95% confidence interval indicate that the results are in support of our original findings.

D. Testing for Endogeneity

An important econometric issue that arises in estimating our empirical model is that several of our controls—in particular investment, trade, and the fiscal variables—are potentially endogenous. To address such problem, Arellano and Bond (1991) propose a Generalized

TABLE 4
Regression Results with Pooled Data and Interaction Term of Public Expenditures with Development

Dependent Variable: GDP p.c. Growth		
Country Set	**Seigniorage Finance**	**Income Tax Finance**
Log of initial p.c. GDP	−0.003* (1.84)	–0.003* (1.92)
Investment	0.187*** (6.74)	0.192*** (6.81)
Population growth	−0.204 (1.64)	–0.215* (1.74)
Government expenditures	−0.167*** (3.10)	−0.112* (1.91)
Government expenditures × log of p.c. GDP	0.021*** (3.39)	0.014** (2.10)
Government revenues	−0.011 (0.45)	—
Seigniorage	—	–0.005*** (2.99)
Rest of budget financing	–0.005 (1.21)	–0.002 (0.64)
Initial secondary schooling	0.002 (0.34)	0.004 (0.52)
Trade	0.004 (1.07)	0.004 (1.12)
Terms of trade growth	0.00005 (0.57)	0.00003 (0.34)
R^2	0.2290	0.2598
No. of observations	227	227
Hausman specification test	12.08	14.53

***, **, *: Significant at 1%, 5%, and 10% level, respectively. t-statistics in parentheses.

Method of Moments (GMM) panel estimator that employs an increasing sequence of lagged values of the levels of all endogenous and predetermined variables as instruments. The consistency of the Arellano-Bond estimator depends crucially on the assumption that the errors are not serially correlated. However, since the removal of country-specific effects through first differencing induces first-order serial correlation in the transformed errors, the appropriate null hypothesis is that second-order serial correlation is absent from the transformed residuals. In addition, Arellano and Bond (1991) suggest a Sargan test for overidentifying restrictions, which tests for the overall validity of the instruments.

While Arellano and Bond (1991) are primarily interested in dynamic panels, their estimator can be applied just as well when estimating static models. Since our earlier model specifications are static, we begin by reestimating our model for both developed- and developing-country samples using the Arellano-Bond procedure. As instruments we use the second lag of the levels of investment, trade, and the fiscal variables and the first lag of initial income, which we treat as predetermined; all other variables are assumed to be exogenous and instrument for themselves.[18]

The results for the static model are reported in the first two columns of Table 8. Although the results remain robust in the case of developing countries, the same does not appear to be true for the set of developed countries. This static specification, however, may not be appropriate for the sample of developed countries. While the Sargan test of overidentifying restrictions does not reject the null that our instruments are uncorrelated with the residuals for both the developed- and developing-country samples, we only marginally fail to reject the null hypothesis of no second-order serial correlation for the developed-country sample at the 10% level.

This marginal nonrejection of the null of serial correlation is worrisome, suggesting a possible misspecification of our model. In addition, Bleaney, Gemmell, and Kneller (2001) finds substantial lagged effects of growth for a similar set of OECD countries, suggesting that the long-run effects of fiscal policy take more than one interval (five years) to be effective. Following their approach, we introduce lagged growth as an explanatory variable for both sets of countries.[19] Introduction of a lagged dependent variable indicates that the assumption of no serial correlation in the errors cannot be rejected for both samples (Columns 3 and 4 of Table 8). Moreover, the Sargan test statistic also strongly supports the validity of our instruments. The results from the dynamic specifications suggest that our original results are robust and are not

18. In sensitivity analyses, we also considered the possibility that the initial income variable is endogenous (Barro and Sala-i-Martin 1995). We did the same for the schooling variable in light of recent evidence of reverse causation from schooling to growth (Bils and Klenow 2000). Using the second lagged levels as their instruments, our results did not change.

19. To capture the effect of lagged growth and to be consistent with the approach of Bleaney, Gemmell, and Kneller (2001), we exclude initial income level from our estimated regression. As instruments of lagged growth, we use its second lagged level.

TABLE 5
Regression Results for Developed Countries with Alternative Seigniorage Measures

Dependent Variable: GDP p.c. Growth				
Seigniorage Measure	**Seigniorage1**	**Seigniorage2**	**Seigniorage3**	**Seigniorage4**
Log of initial p.c. GDP	−0.017** (2.26)	–0.017** (2.26)	–0.017** (2.29)	–0.017** (2.31)
Investment	0.117*** (3.03)	0.121*** (3.12)	0.118*** (3.01)	0.117*** (3.01)
Population growth	–0.584** (2.09)	–0.571** (2.05)	–0.578 (2.07)	–0.578 (2.07)
Government expenditures	–0.089 (1.08)	–0.022 (0.23)	–0.106 (1.24)	–0.107 (1.18)
Government revenues	–0.028 (0.33)	–0.094 (0.94)	–0.013 (0.16)	–0.013 (0.14)
Rest of budget financing	–0.032 (0.42)	–0.101 (1.11)	–0.013 (0.17)	−0.013 (0.15)
Initial secondary schooling	0.007 (0.80)	0.006 (0.76)	0.007 (0.79)	0.006 (0.77)
Trade	0.038*** (4.96)	0.038*** (4.96)	0.039*** (5.04)	0.039*** (5.05)
Terms of trade growth	0.125 (1.34)	0.122 (1.32)	0.126 (1.35)	0.126 (1.34)
R^2	0.3722	0.3790	0.3718	0.3711
No. of observations	119	119	119	119
F-test	15.77***	16.04***	16.53***	17.20***
Hausman specification test	10.12	10.53	10.16	10.47
Confidence interval at 95%	(−0.167, −0.069)	(–0.165, –0.068)	(–0.169, –0.071)	(–0.168, –0.072)
Test of policy equivalence	0.11	0.88	0.02	0.02
Estimated effect of tax finance	−0.119*** (4.09)	–0.116*** (4.03)	−0.120*** (4.21)	–0.117*** (4.28)

***, **, *: Significant at 1%, 5%, and 10% level, respectively. t-statistics in parentheses.

TABLE 6
Regression Results for Developing Countries with Alternative Seigniorage Measures

Dependent Variable: GDP p.c. Growth				
Seigniorage Measure	**Seigniorage1**	**Seigniorage2**	**Seigniorage3**	**Seigniorage4**
Log of initial p.c. GDP	−0.014** (2.51)	−0.015*** (2.60)	−0.014*** (2.48)	−0.014** (2.48)
Investment	0.195*** (4.63)	0.194*** (4.65)	0.198*** (4.63)	0.105*** (2.63)
Population growth	−0.684* (1.66)	−0.746* (1.81)	−0.664* (1.61)	−0.934** (2.23)
Government expenditures	−0.165** (2.39)	−0.187*** (2.73)	−0.144* (1.66)	−0.294*** (4.10)
Government revenues	0.091 (1.06)	0.121 (1.42)	0.063 (0.62)	0.200** (2.26)
Rest of budget financing	0.103 (1.59)	0.144** (2.37)	0.051 (0.57)	0.224*** (3.51)
Initial secondary schooling	−0.012 (0.65)	−0.010 (0.52)	−0.013 (0.69)	−0.014 (0.79)
Trade	0.004 (0.48)	0.004 (0.46)	0.004 (0.45)	0.007 (0.76)
Terms of trade growth	0.146** (2.19)	0.144** (2.19)	0.148** (2.19)	0.123 (1.83)
R^2	0.2095	0.2207	0.2011	0.2163
No. of observations	199	199	199	194
F-test	2.94*	2.31	3.58*	4.94**
Hausman specification test	14.06	14.07	13.53	12.90
Confidence interval at 95%	(−0.144, −0.003)	(−0.136, 0.005)	(−0.152, −0.010)	(−0.164, −0.024)
Test of policy equivalence	1.12	2.00	0.39	5.09**
Estimated effect of tax finance	−0.100** (2.39)	−0.039 (0.94)	−0.098** (2.34)	−0.086** (2.07)

***, **, *: Significant at 1%, 5%, and 10% level, respectively. t-statistics in parentheses.

due to simultaneity bias or omitted variables (although now appear to be greater in magnitude). Finally, note that while lagged growth appears significant for the high-income sample as predicted by Bleaney, Gemmell, and Kneller (2001), the results for the developing countries are not affected by the introduction of this dynamic element.

TABLE 7
Regression Results with Total Government Revenues Excluding the Nondistortionary Element of Tax Revenues

Dependent Variable: GDP p.c. Growth		
Country Set	**Developed**	**Developing**
Log of initial p.c. GDP	−0.019** (2.27)	−0.013** (2.34)
Investment	0.105*** (2.80)	0.208*** (4.91)
Population growth	−0.364 (1.26)	−0.869** (2.16)
Government expenditures	0.030 (0.47)	−0.008 (0.10)
Distortionary tax revenues	−0.228*** (2.73)	−0.110 (0.97)
Nondistortionary tax revenues	—	—
Other revenues	−0.123 (1.38)	−0.048 (0.52)
Seigniorage	−0.313 (1.64)	−0.233** (2.05)
Rest of budget financing	−0.162** (2.30)	−0.045 (0.51)
Initial secondary schooling	0.002 (0.23)	−0.018 (0.019)
Trade	0.047*** (5.21)	0.0002 (0.02)
Terms of trade growth	0.151* (1.68)	0.155** (2.37)
R^2	0.4381	0.2397
No. of observations	119	198
Hausman specification test	11.17	14.54
F-test for seigniorage finance	2.17	10.75***
Estimated effect of seigniorage finance (95% confidence interval)	−0.283 (−0.599, 0.033)	−0.242 (−0.363, −0.120)
F-test for distortionary tax finance	22.90***	2.01
Test of policy equivalence	0.20	1.09
Estimated effect of distortionary tax finance (95% confidence interval)	−0.198 (−0.266, −0.130)	−0.118 (−0.256, 0.019)

***, **, *: Significant at 1%, 5%, and 10% level, respectively. t-statistics in parentheses.

VI. CONCLUDING REMARKS

It is widely believed among economists and development experts that economic policies should be made conditional upon the stages of economic development due to vast differences in the functioning and the structure of developed and developing economies. Despite this, most of the analyses about the growth effects of public spending conducted at the theoretical and at the empirical levels have ignored the task of linking the findings and policy prescriptions to the stages of economic development. In this study, we pay special attention to this omission. Here, our interest is *not* to identify the prevalent mode of financing across the countries. Rather, our contribution lies in identifying the best way to finance public expenditures in the two sets of countries. Both the theoretical and the empirical analyses suggest that for the high-income economies, an expansion in government expenditures financed with taxes retards growth more than if it were financed through seigniorage. However, an opposite result is obtained in the case of low-income countries.

Several aspects of the modeling strategy employed in our analysis merit comments. First, our analysis does not explicitly consider the role of public infrastructure or productive government spending. We have consciously adopted such strategy to keep our theoretical analysis tractable and to make our results easily comparable to the established literature (e.g., Espinosa-Vega and Yip 1999, 2000; Palivos and Yip 1995). It is, however, possible to appeal to simple intuition to understand the effects of productive public expenditures in our model. In its presence, the adverse growth effects of seigniorage and taxation would be

TABLE 8
Regression Results That Account for Endogeneity

Dependent Variable: GDP p.c. Growth; Seigniorage: Seigniorage1				
	Static Model		Dynamic Model	
Country Set	**Developed**[a]	**Developing**[b]	**Developed**[a]	**Developing**[b]
Log of initial p.c. GDP	0.002 (0.16)	−0.062*** (2.65)	—	—
Investment	0.213*** (3.01)	−0.037 (0.34)	0.072 (0.98)	−0.070 (0.41)
Population growth	−1.162** (2.16)	−1.178 (1.37)	−0.275 (0.48)	−0.760 (0.76)
Government expenditures	−0.067 (0.43)	−0.318*** (2.87)	−0.226 (1.19)	−0.297** (1.98)
Government revenues	0.012 (0.57)	0.345** (1.96)	0.016 (0.07)	0.323** (1.86)
Rest of budget financing	−0.133 (1.30)	0.055 (0.56)	−0.074 (0.44)	0.072 (0.62)
Initial secondary schooling	0.022* (1.91)	−0.001 (0.03)	0.008 (0.96)	−0.096* (1.71)
Trade	0.037 (1.21)	0.034 (1.02)	−0.013 (0.39)	0.092*** (2.58)
Terms of trade growth	0.425** (2.34)	0.026 (0.23)	0.410*** (2.85)	0.023 (0.21)
Lagged growth	—	—	−0.538*** (5.46)	−0.059 (0.47)
No. of observations	81	119	81	119
Sargan test[c], [e] [*p* value]	15.75 [0.610]	19.08 [0.387]	15.32 [0.639]	22.59 [0.207]
Second order serial correlation test[d] [*p* value]	1.468 [0.142]	−0.199 [0.842]	0.441 [0.660]	−0.503 [0.615]
Confidence interval at 95%	(−0.208, 0.098)	(−0.093, 0.147)	(−0.342, -0.077)	(−0.277, 0.330)
Estimated effect of tax finance	−0.051 (0.70)	0.121 (0.78)	−0.234*** (3.45)	0.029 (0.15)

***, **, *: Significant at 1%, 5%, and 10% level, respectively. Robust t-statistics in parentheses.

[a]Germany drops from the country set due to the lack of sufficient data points.

[b]Ethiopia, Romania, and South Africa drop from the country set due to the lack of sufficient data points.

[c]The null hypothesis is that the instruments used are not correlated with the residuals.

[d]The null hypothesis is that the errors in the first-difference regression exhibit no second-order serial correlation.

[e]The reported statistic is from the two-step estimate.

partially offset by the positive effects of government spending. Such results are not in conflict with our main conclusions. As long as the return from investment (ρ_t) in developed countries remains high due to low default risk, the relative return (R_t^m/ρ_t) will continue to remain less sensitive to the movement in R_t^m and the seigniorage financing will continue to emerge as the optimal financing policy in developed countries.

Second, our analysis of the consolidated government budget suggests that the revenue side of the budget can be decomposed into three distinct parts—tax revenue and grants, seigniorage, and the rest of the budget financing of which new issues of interest-bearing debt (held by public outside the government sector) constitute a significant part. Such tight compartmentalization has been challenged by a handful of researchers. For example, if the monetary authority must act to ensure that the government's intertemporal budget is balanced, then an increase in government debt will eventually require an increase in seigniorage (e.g., Leeper 1991). Under such circumstance, an analysis based on the entire budget deficit and not on its components would make better sense. An analysis conducted by Miller and Russek (1997) along this line has yielded results that render support to our viewpoint.

Finally, we conclude the paper with some thoughts toward future research. The primary innovation of our theoretical analysis has been to offer a new perspective where the capital market imperfection and the portfolio choice of the financial intermediaries assume a central position in explaining the difference in the optimal mode of financing public expenditure across the developed and developing countries. We, however, acknowledge that a set of similar results can be derived from a different perspective where the costs of tax collection and enforcement play the central role. The developing countries typically encounter widespread tax evasion and large costs of tax collection. Accordingly, seigniorage appears

as a relatively inexpensive source of government revenue in developing countries. This view has surfaced frequently in the existing literature (e.g., Cukierman, Edwards, and Tabellini 1992; De Gregorio 1993; Roubini and Sala-i-Martin 1995). Clearly, under such circumstance, it is tempting for a developing country to rely too much on seigniorage as a source of revenue. Thus, tax-financed increases in government spending could promote economic growth (or be less harmful) in a developing country as such action would tend to correct the overreliance on seigniorage. For a similar reason, one may encounter a relatively less distortionary effect of seigniorage financing in a developed country, where taxation is a convenient way of raising revenue due to the presence of an efficient tax-collection system. An investigation of such hypothesis is left as part of our future research agenda.

APPENDIX A: PROOF OF PROPOSITION 1

First, note from Equation (9) that

$$\partial\Phi/\partial R^m = (\gamma/(1+\gamma)(\Phi/R^m) > 0, \tag{A1}$$

$$\partial\Phi/\partial\rho = -(\gamma/(1+\gamma)(\Phi/\rho) < 0. \tag{A2}$$

Totally differentiating the growth rate of the economy Equation (12) and the government's budget constraint Equation (15), we arrange the system of equations in the following matrix form:

$$\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} d\theta \\ dR^m \end{bmatrix} = \begin{bmatrix} a_{13} & a_{14} \\ a_{23} & a_{24} \end{bmatrix} \begin{bmatrix} d\beta \\ d\tau \end{bmatrix},$$

where

$$a_{11} = 1,$$

$$a_{12} = -[(1-\tau)(1-\alpha)Ax/(1+\Phi)^2](\partial\Phi/\partial R^m) < 0,$$

$$a_{13} = 0,$$

$$a_{14} = -(1-\alpha)Ax\Phi/(1+\Phi) < 0,$$

$$a_{21} = 1/Ax\Phi(1+\kappa),$$

$$a_{22} = -\{[1/Ax\Phi(1+\kappa)] + [(\theta - R^m)/Ax\Phi^2(1+\kappa)](\partial\Phi/\partial R^m)\} < 0,$$

$$a_{23} = 1,$$

$$a_{24} = -(1-\alpha) < 0.$$

Define $\Delta \equiv a_{11}a_{22} - a_{21}a_{12}$ to be the determinant of the left matrix on the left hand side of the above system. When simplified, it is found to be

$$\Delta = -[1/Ax\Phi(1+\kappa)] - (\gamma/(1+\gamma))(1/R^m)(1/(1+\kappa))\{[\theta\Phi - R^m(1+\Phi)]/Ax\Phi(1+\Phi)\} < 0.$$

Using Cramer's rule, we obtain the effect on growth of an expansion in government spending financed via seigniorage when we impose the restriction $d\tau = 0$. This implies

$$\partial\theta/\partial\beta|_s = [(1-\tau)(1-\alpha)Ax/(1+\Phi)^2\Delta](\partial\Phi/\partial R^m) < 0. \tag{A3}$$

To obtain the effect of an expansion in government spending financed via income taxation, we set the restriction $d\beta = (1-\alpha)d\tau$. As a result

$$\partial\theta/\partial\beta|_T = [1 + (R^m/\gamma\theta)](1/(1+\kappa))[(1-\tau)(1-\alpha)Ax/(1+\Phi)^2\Delta](\partial\Phi/\partial R^m) < 0. \tag{A4}$$

APPENDIX B: COUNTRY SETS, DATA SOURCES, AND VARIABLES DESCRIPTION

Country Sets

Developed OECD Countries (21): Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

Developing Countries (40): Argentina, Bolivia, Brazil, Burkina Faso, Burundi, Cameroon, Chile, Colombia, Costa Rica, Dominican Republic, Egypt, Ethiopia, Gambia, Hungary, India, Indonesia, Iran, Korea Republic,

TABLE A1

Numerical Simulation Parameters

	Author's Parameters				Our Parameters					
Authors	γ	τ	A	α	λ	x	ζ	κ	R^m	δ
King and Rebelo (1990)	9	0.3	1	0.33	[0, 1]	2	0.5	0.4	0.9, 1.1	[2.4, ∞] [2.1, ∞]
Chari, Christiano, and Kehoe (1991)	8	0.26	1	0.34	[0, 1]	2	0.4	0.3	0.9, 1.1	[2.1, ∞] [1.8, ∞]
Jones, Manuelli, and Rossi (1993)	1.5	0.22	1.8	0.36	[0, 1]	2	0.2	0.6	0.9 1.1	[2.6, ∞] [1.3, ∞]

TABLE B1

Data Sources and Variables Description

Variables	Description
IMF, *Government Finance Statistics*[a]	
Government revenues	Total government revenues and grants
Government expenditures	Total government expenditures
Distortionary tax revenues*	Sum of taxation on income, profits, and capital gains, taxation on social security contributions, taxation on payroll or workforce, and taxation on property
Nondistortionary tax revenues*	Taxation on domestic goods and services
Other revenues*	Sum of taxation on international trade and transactions, nontax revenues, other tax revenues, and grants
Income tax revenues*	Taxation on income, profits, and capital gains
Other distortionary tax revenues*	Distortionary tax revenues less taxation on income, profits, and capital gains
IMF, *International Financial Statistics*	
Monetary base (or high-powered money)	Reserve money (line 14 in *International Financial Statistics*)
Seigniorage1(base regression)	Ratio of the change in high-powered money to nominal GDP (Fischer 1982)
Seigniorage2	Ratio of the product of the high-powered money growth rate times the level of high-powered money to nominal GDP (Chamley 1991, Honohan 1996)
Seigniorage3	Ratio of high-powered money to nominal GDP in current period minus ratio of high-powered money to nominal GDP in last period plus the product of the ratio of high-powered money to nominal GDP in last period times the growth rate of nominal GDP in current period to one plus the growth rate of GDP in current period (Walsh 1998)
Seigniorage4	Ratio of the product of the inflation rate times high-powered money to the product of one plus the inflation rate times nominal GDP (de Haan, Zelhorst, and Roukens 1993; Walsh 1998)
World Bank, *World Development Indicators* CD-ROM	
GDP p.c. growth rate	Annual percentage growth rate of GDP p.c. based on constant local currency
Initial p.c. GDP	Figures are in constant 1995 U.S. dollars
Investment	Gross capital formation (% of GDP)
Population growth rate	Annual population growth rate
Budget surplus	Overall budget balance for central government (% of GDP)
Rest of budget financing	Overall budget balance less seigniorage measure
Initial secondary schooling	Initial secondary school enrolment (% gross)
Trade	Sum of exports and imports of goods and services (% of GDP)
Terms of trade growth rate	The log difference between terms of trade figures (goods and services, 1995 = 100)
Inflation rate	Consumer prices (annual %)

[a]The classification of the variables with the asterisk follows Bleaney, Gemmell, and Kneller (2001) and Kneller, Bleaney, and Gemmell (1999) and Bleaney. The data are consolidated and cover all levels of government.

Notes: The budget surplus has been also calculated with the IMF's *Government Finance Statistics*. The data from both sources is similar and the choice of the World Bank series is due to the availability of more data points. The correlation between the two series is 0.99 for both developed and developing countries.

Lesotho, Malaysia, Mauritius, Mexico, Morocco, Nepal, Nicaragua, Pakistan, Paraguay, Peru, Romania, Senegal, Singapore, South Africa, Sri Lanka, Syrian Arab Republic, Thailand, Tunisia, Uruguay, Venezuela, Zambia, and Zimbabwe.

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TABLE B2

Descriptive Statistics of Variables Used in the Sensitivity Analysis

Variable \ Country Set	Mean		Standard Deviation	
	Developed	Developing	Developed	Developing
Distortionary tax revenues	0.1912	0.0695	0.0624	0.0422
Income taxation revenues	0.0949	0.0476	0.0387	0.0329
Other distortionary tax revenues	0.0963	0.0219	0.0237	0.0093
Nondistortionary tax revenues	0.0944	0.0563	0.0379	0.0279
Other revenues and grants	0.0429	0.0968	0.0167	0.0593
Seigniorage2	0.0050	0.0163	0.0049	0.0168
Seigniorage3	0.0024	0.0113	0.0046	0.0097
Seigniorage4	0.0071	0.0209	0.0082	0.0176

Notes: As in Table B1.

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