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Revisiting the Inflation–Repression Relationship

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ABSTRACT

The paper analyzes the effects of financial liberalization on steady-state inflation. We develop an overlapping generations model with endogenous growth where financial intermediaries are subjected to obligatory "high" cash reserves requirement, serving as the source of financial repression. When calibrated to four Southern European semi-industrialized countries, namely Greece, Italy, Spain and Portugal, that typically had high reserve requirements, the model indicates that the sign of the infation-financial repression relationship depends crucially on the elasticity of substitution between the cash and credit goods consumed in the economy.

Journal of Economic Literature Classification: *E31, E44, E52*

Keywords: *Financial Repression; Infation; Financial Markets and the Macroeconomy.*

Introduction

The objective of this paper is to revisit the effect of financial liberalization on the rate of inflation using a closed-economy endogenous growth model with money, in an overlapping generations framework. To numerically evaluate our theoretical analysis, the model has been calibrated to match long-run facts of four southern European economies, Greece, Italy, Portugal and Spain, over the period of 1980-1998.[1] Financial repression can be broadly defined as a set of government legal restrictions, like interest rate ceilings, compulsory credit allocation and high reserve requirements, that generally prevent the financial intermediaries from functioning at their full capacity level.

The motivation to reanalyze the effects of financial repression on inflation is obtained from a recent study by Gupta (2005a). The paper develops a closed economy monetary and endogenous growth dynamic general equilibrium model with financial intermediaries subjected to obligatory "high" cash reserves requirement, serving as the source of financial repression. Modeling financial repression through "high" reserve requirements is well motivated for the four Southern European semi-industrialized countries, namely Greece, Italy, Spain and Portugal, to which the model was calibrated. Evidences indicated while on one hand, capital markets were being deregulated in the early 1980s in most of Europe, the required bank reserves increased significantly in the late 1980s (see Tables 1 and 2). Results from the model indicated a positive inflation-financial repression relationship. Though the model matched the positive relationship between inflation and reserve requirements in the data, for Italy, Portugal and Spain, the negative relationship for Greece could not be explained (see Table 3).

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Table 1
Financial Facts in European Economies (1980-2002)

	Reserves/ Deposits (percentage)	*Annual Inflation rate*	*Interest Rate Liberalization*	*Credit Ceiling Relaxation*
Spain	12.0	6.8	1984	1959-66
Greece	22.9	14.9	1980	1982-87
Italy	11.7	7.5	1980	1973-83
Portugal	17.5	12.2	1984	1978-91
Belgium	1.0	3.2	1986	Until 1978
France	2.0	4.1	1980	1958-85
Germany	5.6	2.5	1980	None
UK	1.7	5.2	1980	1964-71

Source: Table 1, Gupta (2005a)

Table 2
Bank Reserve Banks

	Spain	*Italy*	*Greece*	*Portugal*
1980-1986	15.8	15.5	22.1	20.5
1986-1991	19.3	17.2	19.6	26.4
1992-1997	9.0	10.6	26.0	15.3
1998-2002	3.0	2.3	23.5	7.1

Source: Table 2, Gupta (2005a).

Table 3
Inflation-Repression Correlation Coefficients (1980-1998)

	c_0	c_1
Spain	0.062	0.097
	(3.25)	(0.82)
Greece	0.30	–0.62**
	(6.53)	(–3.29)
Italy	0.013	0.53*
	(0.30)	(1.75)
Portugal	0.041	0.45*
	(0.78)	(1.81)

Source: Table 3, Gupta (2005a)
Regression results emerge from the following equation:
$\prod_t = c_0 + c_1 \gamma_t + \epsilon_t$.
where $\prod$: Rate of inflation,
γ: Reserve-deposit ratio,
c_i, $i = 0, 1$: regression coefficients,
$\epsilon \sim N(0, \sigma^2)$
Numbers in the parentheses indicates the t-ratios.
** significant at 1 per cent level.
* significant at 10 per cent level.

Obviously, the pertinent question is whether Greece is merely an aberration. This is so, when one realizes that the positive relationship between the reserve requirements and inflation has been well documented in the empirical literature (see for example, Haslag and Hein (1995), Haslag (1998), and Haslag and Koo (1999).). In this paper, allowing for cash and credit goods in the economy, we, however, show that the relationship between inflation and reserve requirements depends crucially on the elasticity of substitution between the two kind of goods.

In this regard, it is important to mention two recent theoretical papers. First, using a spatial economy model developed along the lines of Bencivenga and Smith (1991), Espinosa and Yip (1996) indicates that when financial repression is modelled as "imposition of binding reserve requirements" on the financial intermediaries, the interaction between the inflation tax rate and seigniorage base leads to a Laffer-Curve" type relation between inflation and repression. And more recently, Basu (2001) indicates that allowing for a benevolent government to spend the seigniorage revenue earned on the provision of a public input, one can generate a Laffer-Curve type relationship between inflation and reserve requirement. The studies, thus, suggested that there exists an optimal reserve deposit ratio, different from zero that can minimize inflation.

Our analysis is closely related to that of the Espinosa and Yip (1996) study, with the added advantage that our model is simpler and lends itself to calibration. Moreover, we are also able to obtain the major theoretical conclusions of the Espinosa and Yip (1996) study by imposing comparable restrictive assumptions on our model. The paper is organized in the following order: Besides the introduction and conclusion, Sections 2 and 3, respectively, lays out the basic model and defines the equilibrium. Section 4 lays out the process of calibration and Section 5 deals with the inflationary dynamics of liberalizing the domestic financial sector, which in our case, is portrayed in the form of a relaxation of the reserve-deposit ratio. As an aside, the subsection to Section 5 discusses some theoretical properties of the model under certain restrictive assumptions, in the process of trying to replicate the basic results of Espinosa and Yip (1996).

The Economic Environment: Consumers, Banks, Firms, and the Government

In this section, the overlapping generations model of Diamond (1965) is modified to depict a financially repressed structure. The economy is characterized by an infinite sequence of two period lived overlapping generations. Time is discrete and is indexed by $t = 1, 2, \ldots$. At each date t, there are two coexisting generations - young and old. N people are born at each time point $t \geq 1$. At $t = 1$, there exist N people in the economy, called the initial old, who live for only one period. Hereafter N is normalized to 1.

Each agent is endowed with one unit of working time when young and is retired when old. The agent supplies this one unit of labor inelastically and receives a competitively determined real wage of w_t. We assume that the agents consume only when old and, hence, the entire of the net of tax wage earnings is saved. Note this assumption helps us to focus on the portfolio choices of the agent regarding monetary and non-monetary assets. Following Lucas and Stokey (1983), we assume that there are two types of consumption good: "cash goods" and "credit goods". Cash goods, as the name suggests, requires agents to have cash in advance for purchases, while the credit goods can be purchased without cash. Let c_{mt} (c_{nt}) denote the amount of cash (credit goods) consumed by the agent when old. Given this, $c_{2t} = c_{mt} + c_{nt}$ holds. It will be assumed that both types of good are produced by the same technology and, hence, have the same price.

For the cash goods, the cash-in-advance constraint is represented as follows:

$$p_{t+1}c_{mt} \le M_{1t} \tag{1}$$

where p_t and M_{1t} denotes the time t price level and nominal money balance, respectively. The constraint indicates that the agent sets aside cash in advance, when young, to consume cash goods when old. Agents may hold money as well as non-monetary asset. We will assume that the only non-monetary asset available to the agents are bank deposits, D_t, yielding a nominal return of i_{dt+1} in the next period. The deposits are allocated to productive capital in the assets market. Given the income-tax rate τ_t, the budget constraint for a young agent born at date t is given as follows:

$$M_{1t} + D_t \le (1 - \tau_t)p_t w_t \tag{2}$$

(2) indicates that the young agent of generation t, allocates the net of tax nominal wage income to monetary and non-monetary assets because no one consumes when old. We will be focussing on symmetric equilibria in which all agents of a specific generation will have the same amount of assets. The budget constraint when old is

$$p_{t+1}c_{2t} \le M_{1t} + (1 + i_{dt+1})D_t \tag{3}$$

We will assume that the cash-in-advance constraint is binding, given that money is assumed to be return-dominated by the deposits, or equivalently, $(1 + i_{dt+1}) \ge 1$. Thus (1) holds as equality. Then using (1) and (3), we have $c_{mt} = \frac{M_{1t}}{p_{t+1}}$ and $c_{nt} = \frac{(1+i_{dt+1})D_t}{p_{t+1}}$

We will specify the utility function as

$$U(c_{mt}, c_{nt}) = [(1-\sigma)c_{mt}^{(1-\lambda)} + \sigma c_{nt}^{(1-\lambda)}]^{\frac{1}{1-\lambda}} \tag{4}$$

where $0 < \sigma < 1$ and $\lambda > 0$. Note λ is the inverse of the elasticity of substitution between the cash and the credit good. Each young agent chooses c_{mt} and c_{nt} to maximize (4) subject to $c_{mt} = \frac{M_{1t}}{p_{t+1}}$, $c_{nt} = \frac{(1+i_{dt+1})D_t}{p_{t+1}}$, and (2). The first-order necessary conditions for the maximization problem requires that $\frac{U_{c_{nt}}}{U_{c_{mt}}} = (1 + i_{dt+1})$, which yields the money demand and the deposit functions as follows:

$$M_{1t} = \frac{(1-\tau_t)p_t w_t}{[1+\left(\frac{\sigma}{1-\sigma}\right)^{\frac{1}{\lambda}}(1+i_{dt+1})^{\frac{1-\lambda}{\lambda}}]} \tag{5}$$

$$D_t = \frac{[\left(\frac{\sigma}{1-\sigma}\right)^{\frac{1}{\lambda}}(1+i_{dt+1})^{\frac{1-\lambda}{\lambda}}](1-\tau_t)p_t w_t}{[1+\left(\frac{\sigma}{1-\sigma}\right)^{\frac{1}{\lambda}}(1+i_{dt+1})^{\frac{1-\lambda}{\lambda}}]} \tag{6}$$

It is easy to show that the money demand is negatively related to the nominal interest rate on deposits, while the supply of deposit is positively related to the same if $0 < \lambda < 1$. This follows from the fact that

$$\frac{d\left(\frac{1}{[1+\left(\frac{\sigma}{1-\sigma}\right)^{\frac{1}{\lambda}}(1+i_{dt+1})^{\frac{1-\lambda}{\lambda}}]}\right)}{di_{dt+1}} = -\frac{\left(\frac{\sigma}{1-\sigma}\right)^{\frac{1}{\lambda}}\frac{1-\lambda}{\lambda}(1+i_{dt+1})^{\frac{1-2\lambda}{\lambda}}}{[1+\left(\frac{\sigma}{1-\sigma}\right)^{\frac{1}{\lambda}}(1+i_{dt+1})^{\frac{1-\lambda}{\lambda}}]^2} \tag{7}$$

However, for $\lambda = 1$, the money demand and the deposit supply functions are independent of the nominal interest rate on deposits.

At the start of each period the financial intermediaries accept deposits and make their portfolio decision (that is, loans and cash reserves choices) with a goal of maximizing profits. At the end of the period they receive their interest income from the loans made and meets the interest obligations on the deposits. Note the intermediaries are constrained by legal requirements on the choice of their portfolio (that is, reserve requirements), as well as by feasibility. Given such a structure, the intermediaries obtains the optimal choice for *Lt* by solving the following problem:

$$\max_{L,D} \pi_b = i_{lt}L_t - i_{dt}D_t \tag{8}$$

$$s.t.: \gamma_t D_t + L_t \leq D_t \tag{9}$$

where π_b is the profit function for the financial intermediary, and $M_{2t} \geq \gamma_t D_t$ defines the legal reserve requirement. M_{2t} is the cash reserves held by the bank; L_t is the loans; i_{lt} is the interest rate on loans, and; γ_t is the reserve requirement ratio. The reserve requirement ratio is the ratio of required reserves (which must be held in form of currency) to deposits.

To gain some economic intuition of the role of reserve requirements, let us consider the solution of the problem for a typical intermediary. Free entry, drives profits to zero and we have

$$i_{lt}(1-\gamma_t) - i_{dt} = 0 \tag{10}$$

Simplifying, in equilibrium, the following condition must hold

$$i_{lt} = \frac{i_{dt}}{1-\gamma_t} \tag{11}$$

Reserve requirements thus tend to induce a wedge between the interest rate on savings and lending rates for the financial intermediary.

All firms are identical and produces a single final good using a production function,

$$Y = Ak^{\alpha}(n\bar{k})^{(1-\alpha)} \tag{12}$$

where A is a positive scalar, $0 < \alpha < 1$, is the elasticity of output with respect to capital, and k, n and $\bar{k}$ denotes the capital, labor and the aggregate capital stock, respectively. The production technology used here is motivated from the works of Romer (1986), Bencivenga and Smith (1991) and Espinosa and Yip (1996). The aggregate capital stock enters the production function to account for a positive externality indicating an increase in labor productivity as the society accumulates capital stock. It must be noted that in equilibrium, $k_t = \bar{k}_t$ and $n_t = 1$, since young agents supply their labor endowment inelastically at the labor market.

At date t the final good can either be consumed or stored. Next we assume that producers are capable of converting bank loans L_t into fixed capital formation such that $p_t i_{kt} = L_t$, where i_{kt} denotes the investment in physical capital. Notice that the production transformation schedule is linear so that the same technology applies to both capital formation and the production of both types of consumption good (cash and credit) and, hence, both investment and consumption good sell for the same price p. Moreover, we follow Diamond and Yellin (1990) and Chen, Chiang and Ping (2000) in assuming that the goods producer is a residual claimer, i.e., the producer uses up the unsold consumption good in a way which is consistent with lifetime value maximization of the firms. Such an assumption regarding ownership avoids the “unnecessary” Arrow-Debreu redistribution from firms to consumers and simultaneously retains the general equilibrium structure.

The representative firm at any point of time t maximizes the discounted stream of profit flows subject to the capital evolution and loan constraint. Formally, the problem of the firm can be outlined as follows

$$\max_{k_{t+1},nt} \sum_{i=0}^{\infty} \rho^i [p_t A k_t^{\alpha} (n_t \bar{k}_t)^{(1-\alpha)} - p_t w_t n_t - (1+i_{Lt}) L_t] \tag{13}$$

$$k_{t+1} \leq (1-\delta_k) k_t + i_{kt} \tag{14}$$

$$p_t i_{kt} = L_t \tag{15}$$

where ρ is the firm owners (constant) discount factor, and δ_k is the (constant) rate of capital depreciation. The firm solves the above problem to determine the demand for labor and investment.

The firm's problem can be written in the following recursive formulation:

$$V(k_t) = \max_{n,k'} [p_t A k_t^{\alpha} (n_t \bar{k}_t)^{(1-\alpha)} - p_t w_t n_t - p_t (1+i_{Lt})(k_{t+1} - (1-\delta_k) k_t)] + \rho V(k_{t+1}) \tag{16}$$

The upshot of the above dynamic programming problem are the following first order conditions

$$k_{t+1} : (1+i_{Lt}) p_t = \rho V'(k_{t+1}) \tag{17}$$

$$(n_t) : (1-\alpha) A \left(\frac{k_t}{n_t} \right)^{\alpha} \bar{k}_t^{(1-\alpha)} = w_t \tag{18}$$

And the following envelope condition

$$V'(k_t) = p_t [\alpha A \left(\frac{\bar{k}_t n_t}{k_t} \right)^{(1-\alpha)} + (1+i_{Lt})(1-\delta_k)] \tag{19}$$

Given that $\frac{p_{t+1}}{p_t} = \pi_{t+1}$, optimization, leads to the following efficiency condition, besides (18), for the production firm

$$(1+i_{Lt}) = \rho(\pi_{t+1}) [A\alpha \left(\frac{n_{t+1} \bar{k}_{t+1}}{k_{t+1}} \right)^{(1-\alpha)} + (1+i_{Lt+1})(1-\delta_k)] \tag{20}$$

given that $k_t = \bar{k}_t$ and n_t =1, holds in equilibrium, equations (18) and (20) can be rewritten as:

$$(1-\alpha) A k_t = w_t \tag{21}$$

$$(1+i_{Lt}) = \rho(\pi_{t+1}) [A\alpha + (1+i_{Lt+1})(1-\delta_k)] \tag{22}$$

Equation (22) provides the condition for the optimal investment decision of the firm. The firm compares the cost of increasing investment in the current period with the future stream of benefit generated from the extra capital invested in the current period. And equation (21) simply states that the firm hires labor up to the point where the marginal product of labor equates the real wage.

Next, we describe the activities of an infinitely-lived government. The government purchases g_t units of the consumption good and is assumed to costlessly transform these one-for-one into what are called government good. The government good is assumed to be useless to the agents. The government finances these purchases by income taxation, and seigniorage. Formally, the government's budget constraint at date t can be defined as follows:

$$p_t g_t = \tau_t p_t w_t + M_t - M_{t-1} \tag{23}$$

where $M_t = M_{1t} + M_{2t}$. To be consistent with perpetual growth, we assume nominal government spending to be a constant proportion of nominal wage, that is, $p_t g_t = \beta p_t w_t$. We will only concentrate on cases where there is a positive deficit to be financed, i.e., when $\beta > \tau$.

A notable exception from the government budget constraint is government bonds. Bonds have been left out for a technical reason. In a world of no uncertainty incorporating government bonds in either the consumer or bank problem would imply plausible multiplicity of optimal allocations of deposits or loans and government bonds. Since the arbitrage conditions would imply a relative price of one between deposits or loans and government debt.

Equilibrium

A valid perfect-foresight, competitive equilibrium for this economy is a sequence of prices $\{p_t, i_{dt}, i_{lt}\}_{t=0}^{\infty}$, allocations $\{c_{nt}, c_{mt}, n_t, i_{kt}\}_{t=0}^{\infty}$, stocks of financial assets $\{M_{1t}, M_{2t}, D_t, L_t\}_{t=0}^{\infty}$, and policy variables $\{\gamma_t, \tau_t, g_t\}_{t=0}^{\infty}$ such that:

- Taking τ_t, w_t, i_{dt} and p_t as given, the consumer optimally chooses c_{mt} and c_{nt} such that (4) is maximized subject to the budget constraint;
- Banks maximize profits, taking, i_{dt}, i_{lt} and γ_t as given and such that (10) holds;
- The real allocations solve the firrm's date-t profit maximization problem, (13), given p_t, w_t and i_{lt};
- The money market equilibrium conditions: $M_t = p_{t+1}c_{mt} + \gamma_t D_t$ is satisfied for all $t \geq 0$;
- The loanable funds market equilibrium condition: $p_t\, i_{kt} = (1 - \gamma_t) D_t$ where the total supply of loans $L_t = (1\text{-}\gamma_t) D_t$ is satisfied for all $t \geq 0$;
- The goods market equilibrium condition require: $c_{2t} + i_{kt} + g_t = k_t^{\alpha}(n_t \overline{k_t})^{(1-\alpha)}$ is satisfied for all $t \geq 0$;
- The labor market equilibrium condition: $(n_t)^d = 1$ holds for all $t \geq 0$;
- The government budget is balanced on a period-by-period basis.

Calibration

The next step in the analysis is to choose values for the parameters of the model. The values come from either *a priori* information or so that various endogenous variables, along the models balanced growth path, match the long run values observed in the data for Greece, Italy, Portugal and Spain. The parameters that needs to be calibrated can be grouped under the following three categories:

Preference: σ and λ.
Production: A, α, ρ *and* δ_k
Policy: γ, τ and β

The country{specific calibrations are reported in Table 4. Note unless otherwise stated, the source for all data is the IMF - International Financial Statistics (IFS).

A first set of parameter values is given by numbers usually found in the literature. These are:

- λ : the inverse of the elasticity of substitution between the cash and credit good is first set at 1, then at 0.17, following Cooley and Hansen (1991), and Chari, Jones and Manuelli (1995), respectively.
- $(1-\alpha)$: since the production function is Cobb-Douglas, this corresponds to the labor income share. The value of the parameter is derived from Zimmermann (1997), and ranges between 37.30 per cent (Spain) and 40.20 percent (Greece);
- δ_k: the depreciation rate of physical capital for Spain, Italy and Greece is derived from Zimmermann (1997) and the value for Portugal is obtained from Correia, Neves and Rebelo (1995). The values range between 0.032 (Greece) and 0.052 (Italy).

A second set of parameters is determined individually for each country. Here, we use averages over the whole sample period to find values that do not depend on the current business cycle. These parameters, which are also listed in Table 4, are:

- θ: the annual gross growth rate in per capita Gross Domestic Product (GDP) ranges between 1.0186, i.e., 1.86 percent (Greece) to 1.0295, i.e., 2.95 percent (Portugal);
- π : the annual gross rate of inflation lies between 1.0752, i.e., 7.52 percent (Spain) and 1.1516 , i.e., 15.16 per cent (Greece);
- γ: the annual reserve-deposit ratio lies between 0.137 (Italy) and 0.235 (Greece);
- τ: the tax rate, calculated as the ratio of tax{receipts to GDP, lies between 0.2274 (Greece) and 0.3625 (Italy);

The following parameters are determined from the balanced growth paths to match long-run averages of the endogenous variables of the model, and tabulated in Table 4.

- i_d: The nominal rate of interest rate on bank deposits is obtained from equation (11), and the value ranges between 11.07 per cent (Spain) to 17.56 per cent (Greece) to match i_l (the nominal interest rate on loans). The country specific values lies between 12.89 per cent (Spain) and 22.96 per cent (Greece).

Table 4
Calibration Parameters

									α		A		ρ		β	
	α	δ_k	θ	π	γ	τ	i_l	i_d	$\lambda = 1$	$\lambda = 0.17$	$\lambda = 1$	$\lambda = 0.17$	$\lambda = 1$	$\lambda = 0.17$	$\lambda = 1$	$\lambda = 0.17$
Spain	0.373	0.05	1.0254	1.0752	0.141	0.2553	12.89	11.07	0.8652	0.5594	0.2173	0.2156	0.9102	0.9107	0.2731	0.2727
Italy	0.383	0.052	1.0193	1.0858	0.137	0.3625	15.02	12.96	0.9042	0.5698	0.2323	0.2322	0.8982	0.8982	0.3760	0.3760
Greece	0.402	0.032	1.0186	1.1516	0.235	0.2274	22.96	17.56	0.8621	0.5448	0.1661	0.1657	0.8494	0.8495	0.2662	0.2661
Portugal	0.354	0.05	1.0295	1.1304	0.198	0.2773	19.09	15.31	0.9255	0.5783	0.2294	0.2289	0.8668	0.8669	0.3035	0.3033

Note: Parameters defined as above.

- σ: measures the weight the consumer assigns on the credit good in its preference function and is obtained from equations (5), (6) and (11). The parameter has two values corresponding to the two alternative values of the elasticity of substitution between the cash and credit goods. When $\lambda = 1$, the value ranges between 0.8621 (Greece) to 0.9255 (Portugal), and when $\lambda = 0.17$, σ lies between 0.5448 (Greece) and 0.5783 (Portugal).
- A: the technology parameter, is calibrated from equations (6), (15) and (21), to match the annual growth rates. Given that there are two values of λ, we have two corresponding values of A. For $\lambda = 1$, the value lies between 0.1661 (Greece) and 0.2323 (Italy) and for $\lambda = 0.17$, A lies between 0.1657 (Greece) and 0.2322 (Italy);
- ρ: the discount rate for the producers is obtained from equation (22), and given two alternative values of A, also has two values for each country. For $\lambda = 1$, ρ lies between 0.8494 (Greece) and 0.9102 (Spain) and when $\lambda= 0.17$, the corresponding values of ρ ranges from 0.8495 (Greece) to 0.9107 (Spain);
- β: the parameter measures the ratio of government spending to the wage bill and given the two alternative values for the elasticity of substitution between cash and credit goods, resulting in two values for α, the parameter has two values for each country as well. The parameter is calculated from equation (5), (6) and (23). Note for $\lambda = 1$, the value of β lies between 0.2662 (Greece) and 0.3760 (Italy) and for $\lambda = 0.17$ the same ranges between 0.2661 (Greece) and 0.3760 (Italy).

Financial Liberalization and Inflationary Dynamics

We are now ready to analyze the effects of financial liberalization in our benchmark model. Note, financial repression has been modeled as banks being obligated to maintain a "high" reserve requirement, i.e., a high value of γ, in our case. In this sense, financial liberalization would imply a reduction in the size of the obligatory reserve requirement, γ, and hence allowing the financial intermediaries to loan out a larger fraction of their deposits as loans to fulfill the investment requirement of the firms.

Using equations (6), (11), (15), (21), (22), (23) and the loanable funds market equilibrium, we can deduce the following implicit function specifying the relationship between the gross inflation rate and the parameters of the model:

$$\beta - \frac{\left(1+\gamma\left(\gamma+\frac{A\pi\alpha(1-\gamma)\rho}{1-\pi(1-\delta)\rho}\right)^{\frac{1-\lambda}{\lambda}}\left(\frac{\sigma}{1-\sigma}\right)^{\frac{1}{\lambda}}\right)\left(1-\frac{1}{\pi\left(1-\delta+\frac{A(1-\alpha)(1-\gamma)\left(\gamma+\frac{A\pi\alpha(1-\gamma)\rho}{1-\pi(1-\delta)\rho}\right)^{\frac{1-\lambda}{\lambda}}\left(\frac{\sigma}{1-\sigma}\right)^{\frac{1}{\lambda}}(1-\tau)}{1+\left(\lambda+\frac{A(1-\gamma)\pi\alpha\rho}{1-\pi(1-\delta)\rho}\right)^{\frac{1-\lambda}{\lambda}}\left(\frac{\sigma}{1-\sigma}\right)^{\frac{1}{\lambda}}}\right)}\right)(1-\tau)}{1+\left(\gamma+\frac{A\pi\alpha(1-\gamma)\rho}{1-\pi(1-\delta)\rho}\right)^{\frac{1-\lambda}{\lambda}}\left(\frac{\sigma}{1-\sigma}\right)^{\frac{1}{\lambda}}} - \tau = 0 \tag{24}$$

When λ = 0.17, due to the non-linearity of the system of equations, the relationship obtained between the rate infation and the policy variables, γ, and γ cannot be solved explicitly. Hence, we plot the function, equation (24), given the parameter values. The point where the function $F(\pi, \Omega)$ (the left-hand-side of equation (24)) intersects the X-axis, determines the steady-state rate of inflation, where Ω denotes the set of all (consumption, production and policy) parameters of the model.

However, when $\lambda = 1$, we can solve explicitly for the rate of inflation, in terms of the parameters of the model, and is given by equation (25).

$$\pi=-\left(\frac{(1+(-1+\gamma)\,\sigma)\,(-1+\tau)}{(-1+\beta+(-1+\gamma)\sigma(-1+\tau))\,(-1+\delta+A(-1+\gamma)\sigma(-1+\tau))}\right) \tag{25}$$

One can observe that equation (25) is a quadratic equation in γ, that is for a given rate of inflation, there can be two alternative values of the reserve requirements. To help us study the theoretical properties of the model better, and in the process replicate the Espinosa and Yip (1996) study, we assume further that $\delta_k = 1$. Then using equations (5), (6), (11), (15), (21), (22) and (23), and applying the steady-state conditions and also assuming that the consolidated government follows time-invariant policies, we have the following two expressions for the gross growth rate (θ) and the gross inflation rate (π).

$$\theta = (1\text{-}\gamma)\,(1-\tau)\,(1-\alpha)A \tag{26}$$

$$\pi = \frac{-1+\sigma-\gamma\sigma}{A(-1+\alpha)\,(-1+\gamma)\,\sigma(-1+\beta+(-1+\gamma)\sigma(-1+\tau))} \tag{27}$$

Clearly from (26), the growth rate is negatively related to the reserve requirement. To analyze the behavior of the inflation rate in relation to the reserve requirement, we lay out the following properties of the gross inflation rate.

Properties:

(i) $\pi\ (\gamma=0) = -\left(\dfrac{-1+\sigma}{A(-1+\alpha)\sigma(-1+\beta-\sigma(-1+\tau))}\right)>0$

(ii) $\pi\ (\gamma\to 1) = \infty$

(iii) Setting $\dfrac{d\pi}{d\gamma}=0,$ we have:

(a) $\gamma_1 \to \dfrac{-1+\sigma+\sqrt{\dfrac{\beta-\tau}{1-\tau}}}{\sigma}$; (*b*) $\gamma_2 \to \dfrac{-1-\sigma+\sqrt{\dfrac{\beta-\tau}{1-\tau}}}{\sigma}$; (Infeasible, requires: $\sigma > 1$, for $\gamma > 0$.)

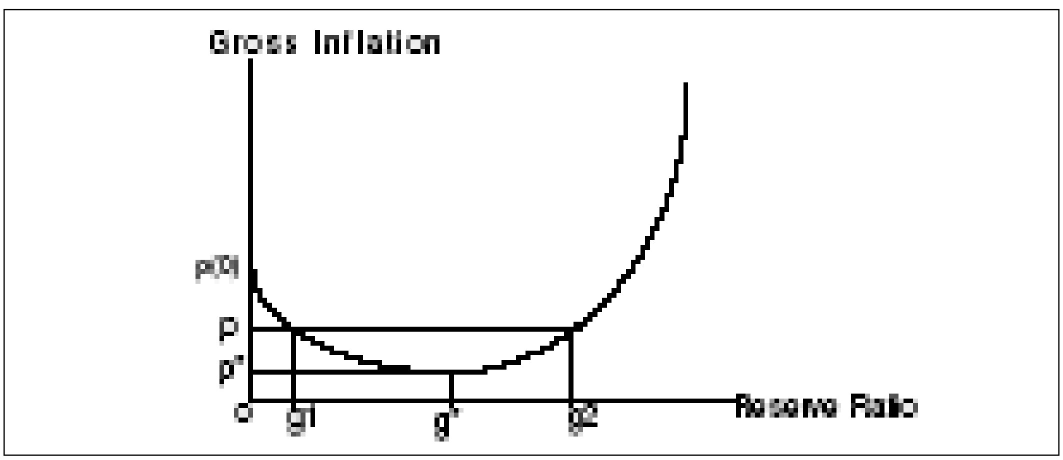
(v) $\pi(\gamma_1)=\dfrac{\sigma\sqrt{-(\sigma^2(\beta-\tau)(-1+\tau))}}{A(-1+\alpha)\,\sigma(-1+\tau)+\sqrt{-(\sigma^2(\beta-\tau)(-1+\tau))}-(\beta\sigma)+\sqrt{-(\sigma^2(\beta-\tau)(-1+\tau))}+\sigma\tau}>0$

(vi) $$\frac{d\gamma_1}{d\sigma}=\frac{\sqrt{[(\beta-\tau)(1-\tau)]}}{\sigma^2}\left(1-\sqrt{\left[\frac{\beta-\tau}{1-\tau}\right]}\right)>0.$$

Using properties (i) through (v), we can easily deduce a Laffer-curve type of relationship between steady-state inflation and reserve requirements (for a given level of gross inflation p, there exists two reserve ratios $g1$ and $g2$), as depicted by Figure 1. The relationship indicates, that inflation and reserve requirements are positively correlated only after a threshold level g^*, defined by γ_1 (resulting in a minimum gross inflation of p^*), however, for reserve ratios below it, the correlation is negative. So the model tends to suggest that unless financial repression is severe enough, financial liberalization, in the form of lower reserve requirements is inflationary. Note the vertical intercept given by property (i) is indicated by $p(0)$ in Figure 19. Moreover, from (vi), we observe that the negative inflation-repression relationship can be prolonged as the weight assigned by the consumer on the credit good increases. Finally, as in Espinosa and Yip (1996), the model shows that growth and inflation are not necessarily negatively correlated. This result as Espinosa and Yip (1996) points out, might help explaining the mixed empirical evidence on the correlation of inflation and economic growth. Having replicated the theoretical results of the Espinosa and Yip (1996) study, we turn to the process of calibration which is then used to numerically evaluate the inflation-repression relationship, predicted by our original model (not subjected to the restrictive assumptions), under alternative assumptions of the preference structure.

Having analyzed the theoretical properties of the model, we turn our attention to analyzing the effects of financial liberalization on inflation using our generalized calibrated model. Figures 2 through 5, depicts the policy experiment, where we increase the reserve -deposit ratio, γ, in a phase-wise manner in the closed interval of 0 to 0.99, with $\lambda = 1$. And Figures 6 through 11 plots $F(\pi, \Omega)$, and studies the effect of reducing the reserve

Figure 1
Inflation-Repression Laffer-Curve



requirements by 5 per cent, from its average values reported in Table 4. Figures 2 through 5 indicate the fact that, higher reserve requirements are inflationary only after a threshold point. This is evident especially for Spain, Italy and Portugal, Figures 2, 3 and 5 respectively.

However, as is observed from Figure 4, until at very high reserve requirements, the relationship between inflation and reserve requirement for Greece is negative. We can obtain the turning points of the relationship for each country, by deducing the minimum points from equation (25). We find that there are two values of reserve requirements for which the derivative of the gross inflation rate with respect to the reserve ratio reaches zero, but we can ignore one of the values for each country, since it is negative and, hence, not economically feasible. The feasible values of the reserve requirements minimizing the gross inflation rate are 41.94 per cent, 43.69 per cent, 79.92 per cent and 56.58 per cent for Spain, Italy, Greece and Portugal, respectively. Note data suggests that the reserve requirements for Greece had varied between 15.45 per cent to 37.95 per cent during the period of 1980-1998, so clearly the model can explain the negative inflation-repression relationship for Greece, with $\lambda = 1$. On the other hand, with the current parameterization, the positive relationship in Spain, Italy and Portugal cannot be captured.

When $\lambda = 0.17$, we find, from Figures 6, 7, 8 and 10, that there multiple equilibria for all the countries, with two for Greece and three each for Spain, Italy and Portugal, indicated by the points where $F(\pi, \Omega)$ intersects the X-axis. When we reduce the reserve requirements by 5 per cent, we find that we have only two equilibria for each country. We can safely say that the initial equilibrium for each country is E_2, since it corresponds to the stead-state rate of inflation given the parameter values. However, when reserve requirements are reduced by 5 per cent, the economy can be either at E_{1n} or E_{2n}, but the important fact is that in either of the two equilibria, we have lower rate of steady-state inflation. This implies that unlike with $\lambda = 1$, when $\lambda = 0.17$, lower reserve requirements unambiguously

Figure 2
Inflation Repression Relationship for Spain

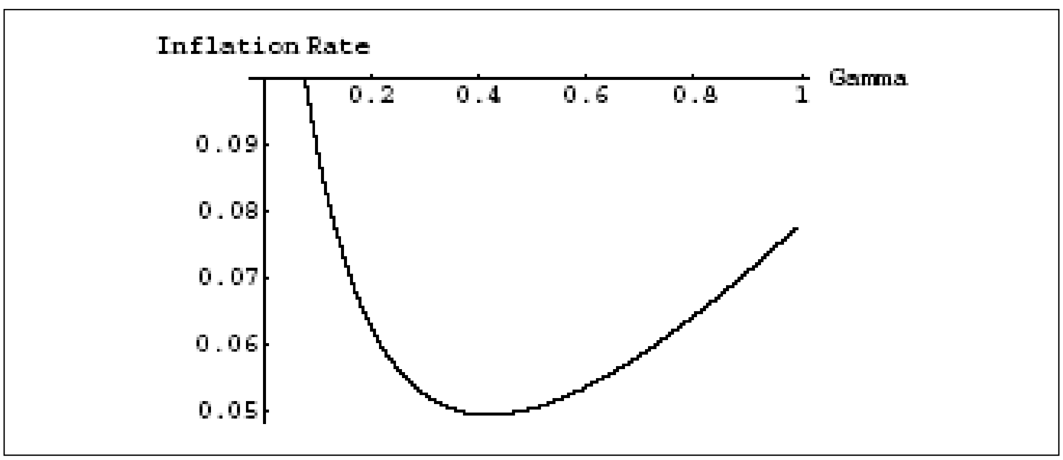


Figure 3
Inflation Repression Relationship for Italy

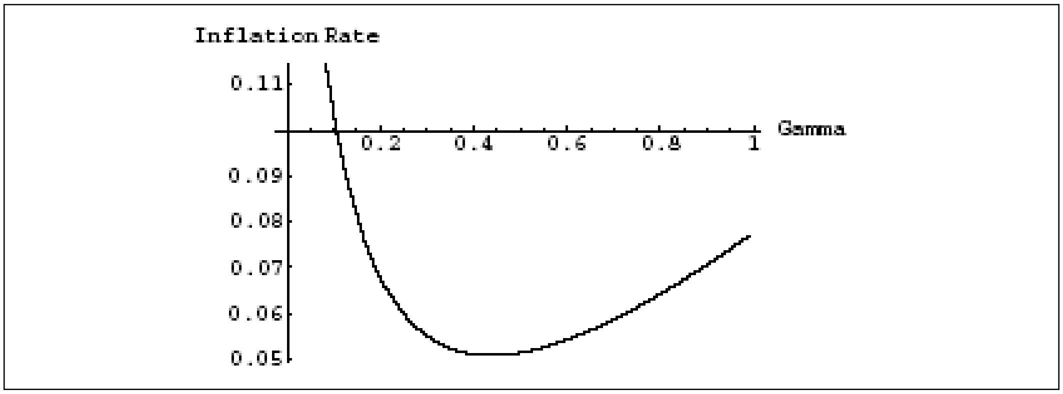


Figure 4
Inflation Repression Relationship for Greece

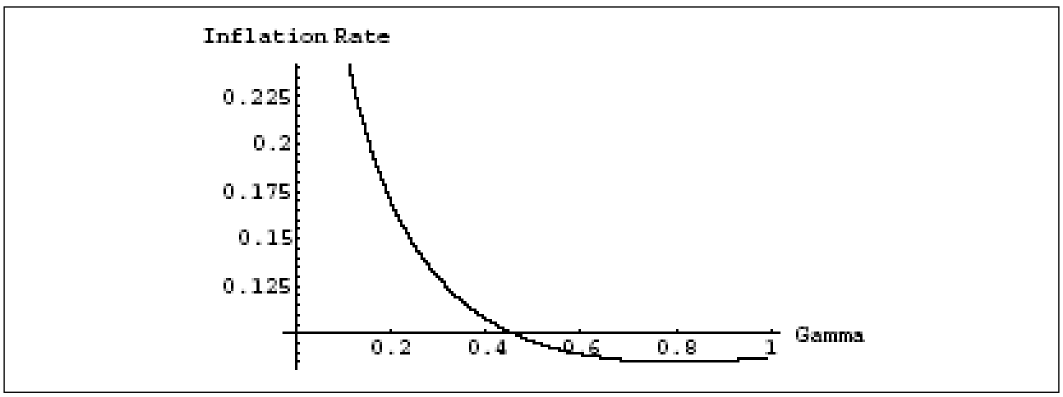


Figure 5
Inflation Repression Relationship for Portugal

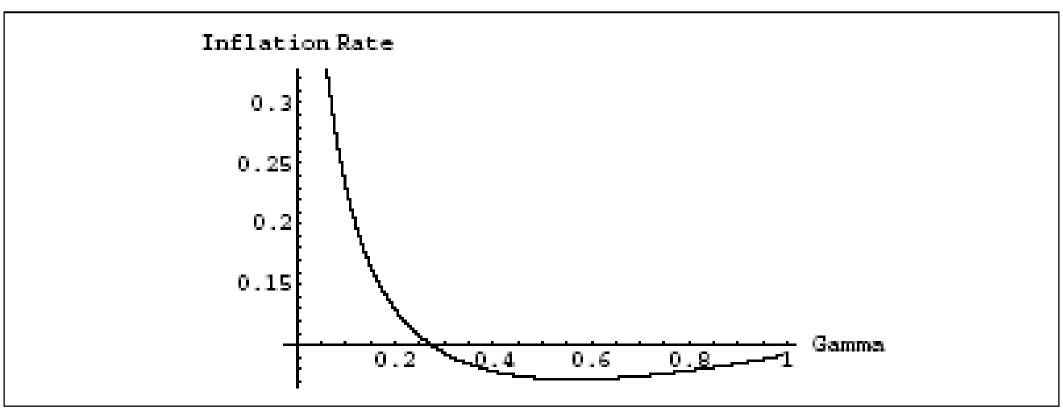


Figure 6
Inflation Repression Relationship for Spain

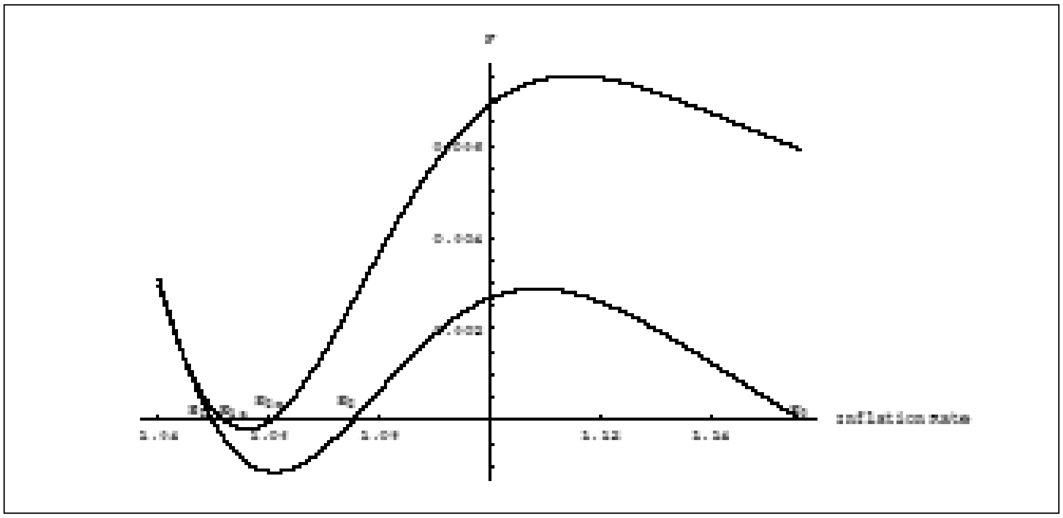
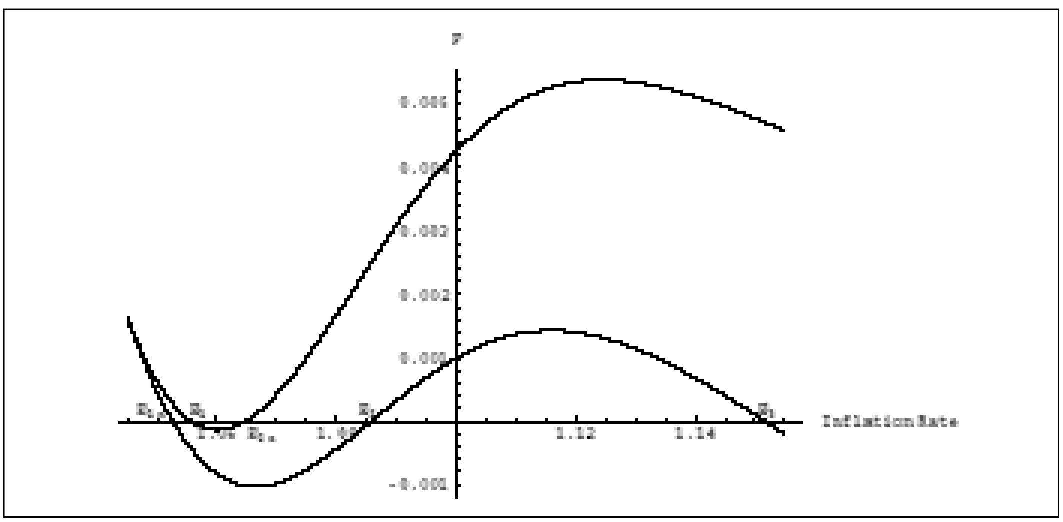


Figure 7
Inflation Repression Relationship for Italy



reduces rate of inflation. Note since for Greece and Portugal, the change in the gross rate of inflation between E_1 and E_{1n} is marginal, following a lower reserve requirement, we use Figures 9 and 11 for Greece and Portugal, respectively, to study the effects in the local neighborhood of E_{1n}. Interestingly, with lower reserve requirements, if the economies were at E_1, they would move to E_{1n}, corresponding to a higher rate of inflation.

Figure 8
Inflation Repression Relationship for Greece

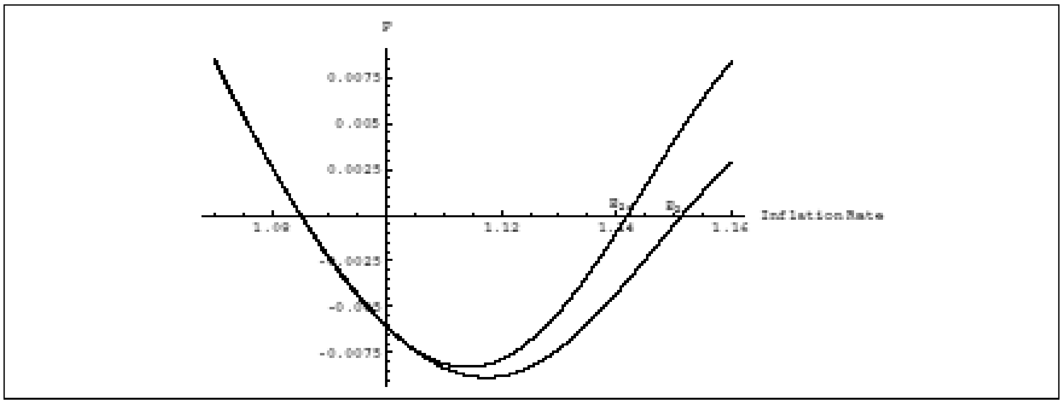


Figure 9
Inflation Repression Relationship for Greece

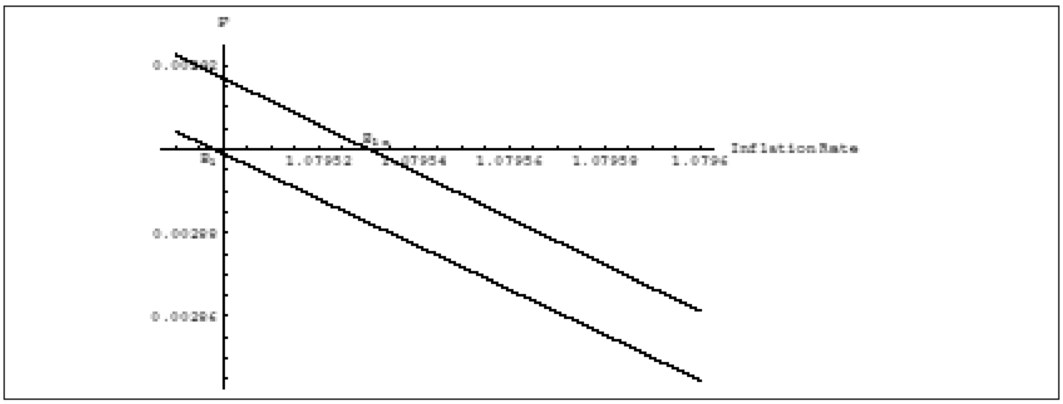


Figure 10
Inflation Repression Relationship for Portugal

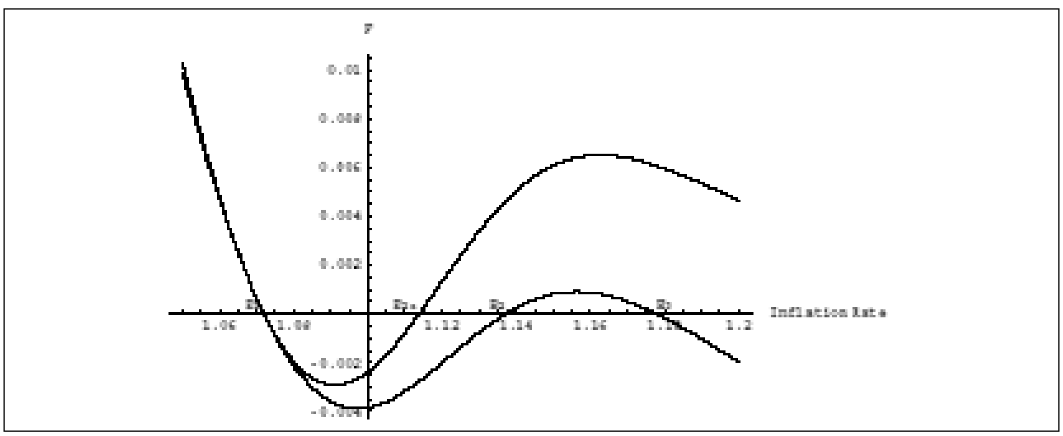
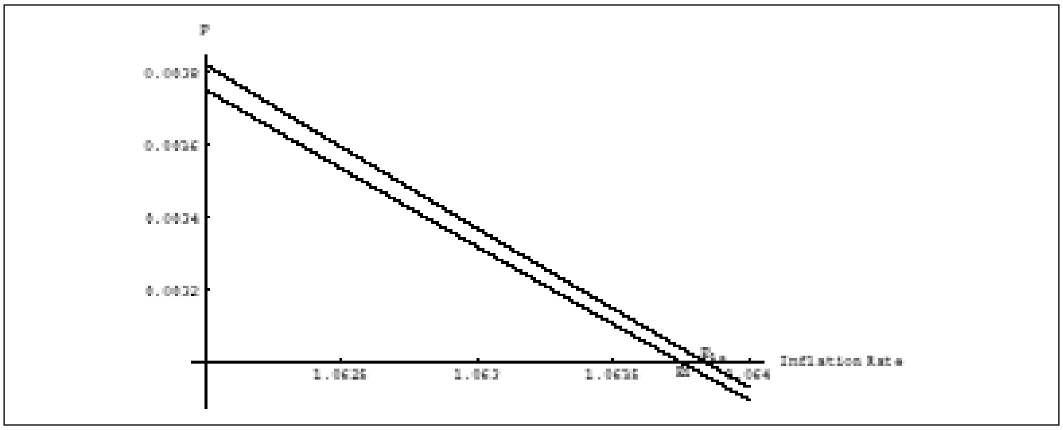


Figure 11
Inflation Repression Relationship for Portugal



Conclusion

The paper revisits the effect of financial liberalization on the rate of inflation using a closed-economy endogenous growth model with money, in an overlapping generations framework. To numerically evaluate our theoretical analysis, the model has been calibrated to match long-run facts of four southern European economies — Greece, Italy, Portugal and Spain, over the period of 1980-1998.

The motivation to reanalyze the effects of financial repression on inflation is obtained from a recent study by Gupta (2005a). The paper develops a closed economy monetary and endogenous growth dynamic general equilibrium model with financial intermediaries subjected to obligatory "high" cash reserves requirement, serving as the source of financial repression. Results from the model indicated a positive inflation-financial repression relationship. Though the model matched the positive relationship between inflation and reserve requirements in the data, for Italy, Portugal and Spain, the negative relationship for Greece could not be explained. Obviously, the pertinent question is whether Greece is merely an aberration. In this paper, allowing for cash and credit goods in the economy, we, however, show that the relationship between inflation and reserve requirements depends crucially on the elasticity of substitution between the two kind of goods.

The paper concludes that the negative relationship between inflation and reserve requirements can arise with low elasticity of substitution between the cash and credit goods. However, for higher elasticity of substitution, the widely documented positive relationship follows. The paper also indicates the possibility of a Laffer-curve type of relationship between inflation and reserve requirements, along the lines of Espinosa and Yip (1996), under certain assumptions regarding the preference and production parameters of the model. From a policy perspective, the paper suggests that lower levels of repression, in form of lower reserve requirements, cannot guarantee lower rate of inflation, unless the elasticity of substitution between cash and credit goods are high, necessarily above one. As a further area of research, along these lines, the paper obviously calls for ways to devise econometric estimation of the elasticity of substitution between cash and credit goods. One way to proceed would be to use non-linear techniques to estimate the money demand function obtained from this model. However, it must be realized that the results obtained would be specific to the sample period and the model specification.

Notes

1. The choice of the sample period is to maintain uniformity with respect to definitions of data. Note while, Italy, Portugal and Spain joined the European Monetary Union in 1998, Greece got included in 2002.
2. See Gupta (2005b) for an extension of the closed economy model of Gupta (2005a) into an open economy model by accounting for import of intermediate goods.
3. This assumption has no bearing on the results of our model. It makes computations easier and also seems to be a good approximation of the reality. For details see Hall (1988).
4. See Chari, Jones and Manuelli (1996), for an excellent summary of the emipirical evidence on inflation and growth.

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