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Abstract

The negative relationship between growth and inflation is well-documented in the literature. However, recent evidence tends to indicate the possibility of a growth-inflation trade-off. This paper attempts to provide a theoretical explanation for this apparent empirical contradiction. To validate our point, we develop a monetary endogenous growth model of a financially repressed small open economy in an overlapping generations framework, characterized by curb markets, productive public expenditures, capital mobility, transaction costs in domestic and foreign capital markets, and a flexible exchange rate system, and analyze the impact of financial liberalization on growth and inflation. We show that including financial repression in the model is necessary but not sufficient to produce a trade-off between growth and inflation. Sufficiency requires high transaction cost in the domestic financial market.

Journal of Economic Literature Classification: E22, E26, E31, E44, E52

Keywords: Financial Repression; Growth and Inflation; Unofficial Financial Markets, Monetary Policy.

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1 Introduction

The negative relationship between growth and inflation is well-documented in the literature.[1] However, Chari, *et al.* (1995, 1996), Espinosa and Yip (1996) and Gupta (2006a) provide evidences of a possible growth-inflation trade-off. In such a scenario, this paper provides a theoretical explanation to the contradiction, in the empirical literature, regarding the growth-inflation relationship. Specifically, we formalize the concern, raised by Roubini and Sala-i-Martin (1995), of a possible spurious negative correlation between growth and inflation in the presence of financial repression.

To note, the term 'financial repression' was originally coined by economists interested in less developed countries (LDCs). In their seminal, but independent, contributions, McKinnon (1973) and Shaw (1973) were the first to spell out the notion of financial repression, defining it as the set of government legal restrictions preventing the financial intermediaries in the economy from functioning at full capacity. Generally, financial repression consists of three elements. First, the banking system is forced to hold government bonds and money through the imposition of high reserve and liquidity ratio requirements. This allows the government to finance budget deficits at a low or zero cost. Second, given that government revenue cannot be extracted that easily from private securities, the development of private bond and equity markets is discouraged. Finally, the banking system is characterized by interest rate ceilings to prevent competition with public sector fund raising from the private sector and to encourage low-cost investment. Thus, the regulations generally includes interest rate ceilings, compulsory credit allocation, and high reserve requirements.

Since the break-up of the colonial empires, many developing countries suffered from stagnant economic growth, high and persistent inflation, and external imbalances under a financially repressed regime. To cope with these difficulties, economic experts had advocated what they called "financial liberalization" - mainly a high interest rate policy to accelerate capital accumulation, hence growth with lower rates of inflation (McKinnon (1973), Shaw (1973), Kapur (1976) and Matheison (1980)). Majority of the research on financial repression has focussed on the consequences of repressive policies on inflation and growth.[2] Not surprisingly, with the birth of endogenous growth models, there has been a recent upsurge towards re-examining the effects of financial repression.[3] In general, the studies conclude that

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[1]See, for example Fischer (1991), Roubini and Sala-i-Martin (1992, 1995), Barro (1995), Haslag (1998) and Basu (2001).

[2]For a detailed literature review on financial repression, spanning more than three decades, see Gupta and Karapatakis (2005).

[3]For analyses of financial liberalization in endogenous growth models for closed economies, see Bencivenga and Smith (1991), Roubini and Sala-i-Martin (1995), Espinosa and Yip (1996), Chari, *et al.* (1995, 1996), Fung, *et al.* (1999) and Gupta (2006b). While, Kang and Sawada (2000)

financial repression is inflationary and reduces growth.

In such a backdrop, we develop a monetary endogenous growth model of a financially repressed small open economy in an overlapping generations framework, characterized by Unofficial Money Markets (UMM) or curb markets, productive public expenditures, capital mobility, costs involved in carrying out transaction in domestic and foreign capital markets, and a flexible exchange rate system, and analyze the impact of financial liberalization on growth and inflation. We show that including financial repression in a model analyzing the growth-inflation relationship is necessary but not sufficient, to produce a trade-off between growth and inflation. Sufficiency, in turn, requires high transaction costs in the domestic financial market.

At this juncture, it is important to point out that the modeling of our economic environment, characterized by the curb markets, productive public expenditures and transaction costs in financial markets, is motivated out of empirical evidences. Moreover, the need to model financial repression in an open economic environment is compelled by the recent studies of Serven (1995), Nag and Mukhopadhyay (1998), Kang and Sawada (2000), Gupta (2006c). All these authors indicate that the absence of the open economic assumption is bound to provide an incomplete and potentially misleading assessment of macroeconomic implications of domestic policy changes.

Empirical evidences of the importance of curb market loans in financing investment requirements can be found in Wijnbergen (1985), Lim (1987), Christensen (1993), Gupta and Lensink (1996), Kan (2000), Dasgupta (2004, 2005a and 2005b). Gupta and Lensink (1996) points out that informal financing is not only important in providing rural credit but also is dominant in urban areas of developing countries like India, Bangladesh and Philippines, which corroborated the findings of Van Wijnbergen's (1985) and Lim's(1987) studies on South Korea and Philippines, respectively. Christensen (1993) argued that the informal financial sector is more adept than the formal sector in reducing default risks by the use of collateral substitute and, hence, is a major source of financing investment in developing countries. Montiel, *et al.* (1993) indicates that the share of informal finance in total finance seems to range between one-third to about three-quarters. As an example they indicate that for Malawi the informal financial sector, measured by the amount of lending to the private sector, was three times as large as the the formal financial sector. Kan (2000) investigated the informal financial channels of capital accumulation by household investors. The empirical evidence drawn from micro-data of Taiwan between 1977-1992 indicated that the informal channels were heavily relied on

and Gupta (2006c) does the same for open economies.

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by business entrepreneurs. More recently, Dasgupta (2004, 2005a and 2005b) indicated the importance of informal money lenders in financing investment for the case of India. The predominance of informal finance led the author to include the money lenders as an explicit sector in the dynamic general equilibrium model calibrated for India based on household survey data.

In our model, public capital plays an important role in the growth-generating process. Such an assertion is vindicated by recent empirical evidences provided by Aschauer (1989), Cuikerman *et al.* (1992), Roubini and Sala-i-Martin (1992), Adam (1996), Agbonytor (1998) and Basu (2001). All these studies points out that in developing economies seigniorage is an important way of financing public expenditure and, when used purposefully would be growth-augmenting. Basu (2001) computes the cross-country correlation between the annual average seigniorage rate and the public investment rate to be at 0.12 in 68 countries over the period of 1970-97. Once the top-third high-inflation countries in the sample were dropped the figure measured 0.47 and was significant at the 5 percent level. Hence, to assume that the entire revenue generated from repressive policies is used to finance the budget deficit would be a mistake and can lead to drawing incorrect policy conclusions.

Finally, the importance of transaction costs involved in trading in the domestic and foreign capital markets, is obtained from the studies of Owen and Solis-Fallas (1989), Cho (1990), Bacchetta and Caminal (1992) and Haslag and Young (1998). And, as we show below, these costs have important not only implications on the final outcome of a policy of financial deregulation on growth and inflation, but, more importantly, plays a critical role in shaping the direction of the growth-inflation relationship.

At this stage, it is important to point out at two studies related to our analysis. The papers by Bencivenga and Smith (1991) and Espinosa and Yip (1996)[4] showed that, unless, financial repression is severe enough to generate curb markets, financial liberalization enhances growth and lowers inflation. However, in the presence of curb markets, financial liberalization is inflationary and reduces the steady-state level of growth. These two studies, however, have their own limitations, besides ignoring the importance of productive public expenditures and transaction costs in financial markets. First, both of them are based on closed economy assumptions, which as has been stressed before

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[4]It must be noted that the studies of Bencivenga and Smith (1991) and Espinosa and Yip (1996) formalized the analysis of Van Wijnbergen (1982, 1983, and 1985), using microfounded endogenous growth models. Van Wijnbergen (1982, 1983, and 1985), based on short-run, reduced-form-equation models, showed that in the presence of informal curb markets, financial liberalization could lead to stagflation. For further details, see, Gupta and Karapatakis (2005).

can lead to incorrect policy conclusions. Second, their treatment of the curb market is some what *ad hoc*, and lacks motivation as to why agents in the model decides to intermediate a fraction of the capital through the informal capital market. We, however, avert from such an issue by deriving supply and demand functions for curb market loans, based on the optimization behavior of the agents in the economy. Third, the work of Bencivenga and Smith (1991) and Espinosa and Yip (1996) uses a spatial economy model. This style of modeling monetary economies, though theoretically very insightful, renders the framework incapable of calibration, and, hence, cannot be applied to country-specific analysis. But, our modeling structure can be easily extended to match long-run data of any country. The existing analysis, however, does not calibrate the model to any specific country, but relies upon matching the (average) world figures.

When compared to the literature, the current paper, thus, develops a more realistic model of a financially repressed economy, based on proper microfoundations, characterized by unofficial money markets, productive public expenditures, transaction costs, flexible exchange rates and capital mobility, to analyze the effects of financial liberalization on growth and inflation quantitatively, which, in turn, helps us in resolving the contradictory empirical evidence on the relationship between growth and inflation . The paper is organized as follows: Besides, the introduction and the conclusions, Section 2 and 3, respectively, lays out the economic environment and defines the equilibrium. And Section 4 analyzes the effect of financial liberalization on growth and inflation, and derives the conditions for a possible growth-inflation trade-off.

2   The Economic Environment

In this section, the overlapping generations model of Diamond (1965) is modified to depict a financially repressed structure of a small open economy. The economy is populated by four types of agents, namely, consumers, banks (financial intermediaries), firms and an infinitely-lived government. The following subsections lays out the economic environment in detail, by considering each of the agents separately and accounting for the external sector.

2.1 Consumers

The economy is characterized by an infinite sequence of two period lived overlapping generations of consumers. Time is discrete and is indexed by $t = 1, 2,....$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 (n_t) 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[5] and, hence, the net of tax wage earnings are allocated between bank deposits, loans in the curb market and foreign bonds.[6] The proceeds from the bank deposits, the curb market loans and foreign bonds are used to obtain second period consumption. The consumption bundle comprises of a domestically produced good and an imported foreign good. We assume a separable and additive log-utility function in the two goods. To allow for simultaneous holding of curb market loans (foreign bonds) and deposits in the consumer portfolio, given that the interest rate in the UMM (world market) is much higher compared to the controlled deposit rate, we assume the curb market loans (foreign bonds) to be subjected to transactions and information costs, as in Owen and Solis-Fallas (1989), Bacchetta and Caminal (1992) and Haslag and Young (1998). These costs are assumed to be increasing and convex function in UMM loans (foreign bonds).

Formally, the agents problem born in period t is as follows:

$$U(c_{t+1}, c_{t+1}^*) \quad = \quad \sigma \log c_{t+1} + (1 - \sigma) \log c_{t+1}^* \tag{1}$$

$$p_t d_t + p_t l_t^c + (e_t p_t^*) b_t^* \quad \leq \quad (1 - \tau_t) p_t w_t \tag{2}$$

$$p_{t+1} c_{t+1} + (e_{t+1} p_{t+1}^*) c_{t+1}^* \quad \leq \quad \left\{ \begin{array}{c} (1 + \bar{i}_{dt+1}) p_t d_t + (1 + i_{t+1}^c) p_t l_t^c - p_t \frac{1}{2} c_1 \left(\frac{l_t^{c\,2}}{w_t} \right) \\ + (1 + i_{t+1}^*)(e_t p_t^*) b_t^* - (e_t p_t^*) \frac{1}{2} c_2 \left(\frac{b_t^{*\,2}}{w_t} \right) \end{array} \right\} \tag{3}$$

where $U(\cdot)$ is the utility function[7], with the standard assumption of positive and diminishing marginal utilities in

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[5]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).

[6]Adding another asset like domestic money, via a cash-in-advance constraint, allowing for (domestic and imported) cash- and credit-goods does not change our conclusions, but merely complicates the computations. Hence, cash requirements to meet consumption has been ignored from the consumer-portfolio.

[7]The additively separable log-utility function is a special case of the function: $U = [\sigma c_{t+1}^{1-\lambda} + (1-\sigma) c_{t+1}^{*\,1-\lambda}]^{\frac{1}{1-\lambda}}$, with λ=1. Note $\frac{1}{\lambda}$

both goods; σ $(1 - \sigma)$ is the weight the consumer assigns to the domestic (foreign) good in the utility function; c_{t+1} and c_{t+1}^* are the old age consumption of domestic and foreign good, respectively; d_t, l_t^c, and b_t^* are the real deposits, curb market loans and foreign bonds held in period t, respectively; τ_t is the tax rate at period t; p_t (p_t^*), is the price of the domestic (foreign) consumption good at period t; e_{t+1} is the nominal exchange rate; $\bar{i}_{dt+1}$, i_{t+1}^c and i_{t+1}^* is the controlled nominal interest rate on bank deposits and the nominal interest rate prevailing in the UMM and the world market, respectively, with $i_{t+1}^c > \bar{i}_{dt+1}$ and $i_{t+1}^* > \bar{i}_{dt+1}$; and, $\frac{1}{2} c_1 \left(\frac{l_t^{c2}}{w_t} \right)$, and $\frac{1}{2} c_2 \left(\frac{b_t^{*2}}{w_t} \right)$ captures the real information and transaction costs involved when making loans in the curb market and buying foreign bonds, respectively, with c_i's > 0 for $i = 1, 2$, being the cost parameters. Alternatively, these costs can be viewed as resource losses in averting government regulations imposed on transactions in the curb and foreign bond markets. However, as Gupta and Karapatakis (2005) points out, that government is likely to have a higher capability in controlling the foreign bonds market than the unofficial money market, and hence, these costs in the curb markets are likely to be more structural in nature. Cho (1990) points out, that these costs may arise due to the issue of a matching problem between individual borrowers and lenders, unlike in the case of a bank which can pool in resources to be lent out. These forms are in line with the transaction cost formulations of Feenstra (1986), Wang and Yip (1992) and Walsh (2000), and is, simultaneously, consistent with endogenous growth[8], ensured by the production structure discussed below. The above form satisfies the assumptions of increasing and convexity of the cost in the amount of curb market loans.[9] Moreover, such a formulation helps in obtaining Tobin-type demand or supply functions for the assets. Note that the real resources spent in the process of transaction in the curb and foreign bond markets are decreasing in the real wage. Intuitively, this tend to suggest that as the agent becomes richer, for each and every unit of curb market loans made or of foreign bonds purchased, the amount of resources he needs to part with, falls, possibly, due to better contacts developed with agents in these markets or government officials, as the economy evolves over time.[10]

Note utility maximization is equivalent to maximizing the old-age consumption utility function with respect to

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is the elasticity of substitution between the domestic and the imported good. The choice of the utility function has no bearing on the results of the model we are interested in.

[8]Note in equilibrium the ratio of the transaction costs with respect to real wage is constant, as all real variables grow at the same rate.

[9]Similar specifications of transaction and information costs are assumed in Bacchetta and Caminal (1992) and Haslag and Young (1998) in reference to foreign and non-bank financial intermediary deposits respectively.

[10]Note as the economy grows, so does the capital stock and the real wage. See Subsection 2.3 for further details.

c_{t+1}^* and l_t^c and b_t^*. The maximization problem of the consumer yields the following optimal choices:

$$l_t^c = \left(\frac{i_{t+1}^c - \bar{i}_{dt+1}}{c_1} \right) w_t \tag{4}$$

$$b_t^* = \left(\frac{i_{t+1}^* - \bar{i}_{dt+1}}{c_2} \right) w_t \tag{5}$$

$$d_t = \left([1 - \tau_t] + \left(\frac{c_1 + c_2}{c_1 c_2} \right) \bar{i}_{dt+1} - \left[\frac{i_{t+1}^c}{c_1} + \frac{i_{t+1}^*}{c_2} \right] \right) w_t \tag{6}$$

$$c_{t+1} = \sigma \left(\frac{1}{\pi_{t+1}} \right) \left[(1 + \bar{i}_{dt+1})(1 - \tau_t) + \frac{c_2(i_{t+1}^c - \bar{i}_{dt+1}) + c_1(i_{t+1}^* - \bar{i}_{dt+1})}{2 c_1 c_2} \right] w_t \tag{7}$$

$$c_{t+1}^* = (1 - \sigma) \left(\frac{1}{\pi_{t+1}} \right) \left[(1 + \bar{i}_{dt+1})(1 - \tau_t) + \frac{c_2(i_{t+1}^c - \bar{i}_{dt+1}) + c_1(i_{t+1}^* - \bar{i}_{dt+1})}{2 c_1 c_2} \right] w_t \tag{8}$$

Note that the supply function of deposits and curb-market loans and the demand functions for foreign bonds conform to traditional supply-demand theory of assets. We are assuming that the Purchasing Power Parity (PPP) condition, $p = ep^*$ holds. Since p^* is parametrically given to the small-open economy, we set it to unity without any loss of generality. Hence, implying that the domestic price level and the nominal exchange rates are synonymous for the model economy with the PPP condition satisfied, i.e., $p_t = e_t$. Note $\frac{p_{t+1}}{p_t} = \pi_{t+1}$ is the gross rate of inflation. Finally, the no-arbitrage condition between curb market loans and foreign bonds requires: $1 + i_{t+1}^c + \frac{1}{2}(i_{t+1}^c - \bar{i}_{dt+1})$ $= 1 + i_{t+1}^* + \frac{1}{2}(i_{t+1}^* - \bar{i}_{dt+1})$, or, simply $i_{t+1}^c = i_{t+1}^*$ to hold for all t.

2.2 Financial Intermediaries

The financial intermediaries, in this economy, behave competitively but are subjected controlled interest rates and multiple reserve requirements. The banks provide a simple pooling function, along the lines described in Bhattacharya and Haslag (2001), by accumulating deposits of small savers and loaning it out to firms after meeting the cash reserve and government bond reserve requirements. For simplicity bank deposits are assumed to be one period contracts, guaranteeing a controlled nominal return of $\overline{i_{dt}}$ with a corresponding controlled nominal loan rate of $\bar{i}_{lt}$. Generally, in a repressed regime both the deposit and loan rates are set well below the market clearing level.[11]

Note the rate of return on the government bonds is generally very low and hence the reserve requirement on them serves to generate a forced demand. For the sake of simplicity we will assume them to yield a zero rate of return.[12]

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[11]See Gupta and Karapatakis (2005) for details

[12]This assumption allows us to avoid incorporating government bonds in the household portfolio and helps us to negate plausible multiplicity of optimal allocations of deposits and government bonds that would have cropped up, given that households would not hold government bonds unless

Given such a structure, the real profit of the intermediary can be defined as follows:

$$\Pi_{Bt} = \bar{i}_{lt} l_t - \bar{i}_{dt} d_t \tag{9}$$

with

$$m_t + b_t + l_t \leq d_t \tag{10}$$

$$m_t \geq \gamma_{1t} d_t \tag{11}$$

$$b_t \geq \gamma_{2t} d_t \tag{12}$$

where Π_{Bt} is the profit of the bank in real terms at period t; l_t is the loans in real terms at period t. Equation (10) ensures the feasibility condition, and b_t and m_t, respectively, are banks holding of government bonds and fiat money in real terms. The banks are also subject to the multiple reserve requirements on cash and government bonds, given by (11) and (12).

The solution to the bank's profit maximization problem results from free entry, driving profits to zero and is given by

$$\bar{i}_{lt}(1 - \gamma_{1t} - \gamma_{2t}) - \bar{i}_{dt} = 0 \tag{13}$$

Simplifying, in equilibrium, the following condition must hold

$$\bar{i}_{lt} = \frac{\bar{i}_{dt}}{1 - \gamma_{1t} - \gamma_{2t}} \tag{14}$$

As is observed, from (14) the solution to the bank's problem yields a loan rate higher than the interest rate on the deposits, since reserve requirements tend to induce a wedge between borrowing and lending rates. Given the multiple reserve requirements and the controlled interest rate on deposits, the nominal interest rate on the loans is also controlled and determined from (14).

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they promised a return at least as large as the bank deposits. However, assuming that the government bonds yields a positive nominal rate of return but lower than the interest rate on deposits would have no bearing on our results and would merely change the profit function of the banks.

2.3 Firms

All firms are identical and produces a single final good using a constant returns to scale, Cobb-Douglas-type, of production function, given as follows:

$$y_t \quad = \quad A k_t{}^{\alpha} (g_t n_t)^{(1-\alpha)} \tag{15}$$

where y_t is the output; n_t is the hours of labor supplied inelastically to production in period t; k_t is the per-firm capital stock in period t; g_t publicly-provided intermediate input in period t; A is a positive scalar; $0 < \alpha < 1$, is the elasticity of output with respect to capital. Note, the production function in (15) is subject to constant returns to scale in k and n while, there is increasing returns to scale in all the three inputs taken together. We follow Barro (1990) in assuming that g is a non-rival and non-excludable input in the production process. Each firm takes the level of g as given while solving its own optimization problem. The production function, thus, exhibits private diminishing returns.

At time t the final good can either be consumed (domestically or exported) or stored. Firms operate in a competitive environment and maximize profit taking the wage rate, the rental rate on capital and the price of the consumption good as given, besides, $\overline{k_t}$. Given that both interest rates on deposits and loans are controlled and subject to a ceiling, there exists an excess demand for loans in the official loan market. However, the UMM serves as the "residual" market and absorbs the excess demand for loans from the banking system and in turn clears the entire market for credit. Hence, the interest cost in the unofficial market defines the true marginal cost (rental rate) of production for the firms, with the loan rate in the official market having no disciplinary effect on the behavior of the firms given the existence of credit rationing. Thus the producers convert available bank loans, l_t, and curb market loans, l_t^c, into fixed capital formation such that $p_t i_{kt} = p_t[l_t + l_t^c]$, where i_t 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 consumption goods for domestic agents and export, and, hence, both investment and consumption (domestic and export) goods sell for the same price p_t.

We follow Diamond and Yellin (1990) and Chen *et al.* (2000) in assuming that the goods producer is a residual claimer, i.e., the producer ingests the unsold consumption good, and not exported, in a way consistent with lifetime maximization of value the of firms. This ownership assumption avoids unnecessary Arrow-Debreu redistribution from firms to households and simultaneously maintains the general equilibrium nature.

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

$$\max_{k_{t+1}, n_t} \sum_{i=0}^{\infty} \rho^i [p_t y_t - p_t w_t n_t - p_t(1+i_t^c)l_t^c - p_t(1+\bar{i}_{lt})l_t] \tag{16}$$

$$k_{t+1} \leq (1-\delta_k)k_t + i_{kt} \tag{17}$$

$$p_t i_{kt} \leq p_t[l_t^c + l_t] \tag{18}$$

$$l_t \leq (1-\gamma_{1t}-\gamma_{2t})d_t \tag{19}$$

where ρ is the firm owners 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 in period t, or the gross amount of capital to be carried over to period $t+1$. Note given regulated interest rates in the official loan market and, hence, credit rationing, the firms obtains a fixed amount of loans supplied inelastically by the banks. The term $p_t(1+\bar{i}_{lt})l_t$ captures the fixed cost of the firm. The residual capital needs of the firm is satisfied by the loans obtained from the curb market and hence the interest rate in the UMM enters as the relevant variable in the loan demand function.

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

$$V(k_t) = \max_{n,k'} p_t y_t - p_t w_t n_t - (1+i_t^c)p_t(k_{t+1}+(1-\delta_k)k_t - l_t) \tag{20}$$
$$-p_t(1+\bar{i}_{lt})l_t + \rho V(k_{t+1})$$

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

$$k_{t+1} \quad : \quad (1+i_t^c)p_t = \rho V'(k_{t+1}) \tag{21}$$

$$(n_t) \quad : \quad y_{nt} = w_t \tag{22}$$

And the following envelope condition.

$$V'(k_t) = p_t[y_{k_{t+1}} + (1+i_t^c)(1-\delta_k)] \tag{23}$$

where y_{nt} and $y_{k_{t+1}}$ are the marginal product of capita with respect to labor and investment, respectively. Optimization, leads to the following efficiency condition, besides (22), for the production firm.

$$(1+i_t^c) = \rho(\pi_{t+1})[y_{k_{t+1}} + (1+i_{t+1}^c)(1-\delta_k)] \tag{24}$$

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Equation (24) 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. Equation (22) simply states that the firm hires labor up to the point where the marginal product of labor equates the real wage.

To note with the production structure in (15), and using $n_t = 1$ and treating λg_t as given to the firms, we have, $y_{nt} = \left[A(1 - \alpha) \left(\frac{g_t}{k_t} \right)^{(1-\alpha)} k_t \right]$ and $y_{k_{t+1}} = A\alpha \left(\frac{g_t}{k_t} \right)^{\alpha}$.

2.4 Government and the External Sector

In this subsection 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 play a productive role, and enters into the production function as described by equation (15). The government finances these purchases by income taxation, issuing government bonds and printing of fiat money. Formally, the government's budget constraint at date t can be defined as follows:

$$p_t g_t = \tau_t p_t w_t + [M_t - M_{t-1}] + [B_t - B_{t-1}] \tag{25}$$

where M_t and B_t, respectively, are banks holding of fiat money and government bonds in nominal terms. To be consistent with perpetual growth, the real government expenditure, g_t is assumed to be a fixed fraction, η, of the capital stock, k_t.

Finally, the balance of payments identity of this economy, assuming that (PPP), i.e., $p = ep^*$ holds for all t, is given by

$$b_t^* - (1 + r_t^*)b_{t-1}^* = x_t - c_t^* \tag{26}$$

where r^* is the real rate of return on foreign bond holdings, i.e., $(1 + r^*) = \left(\frac{1+i^*}{\pi^*} \right)$ for all t, and; x_t is the export. Note π^* is the world rate of inflation. But, given that p^* has been normalized to unity, the world rate of inflation is zero, therefore $r^* = i^*$ for all t. The identity, given by equation (26), implies the current account deficit, which is the interest payments obtained on foreign bonds $(r_t^*)b_{t-1}^*$) less the trade surplus $(x_t - c_t^*)$ has to be equal to the change in holdings of foreign bonds $(b_t^* - b_{t-1}^*)$. Without any loss of generality and maintaining consistency with perpetual

growth, the exports of the economy, x_t, will be assumed to be a fixed fraction, φ, of the domestic output. Alternatively, (26) becomes:

$$b_t^* - (1 + r_t^*)b_{t-1}^* = \varphi y_t - c_t^* \qquad (27)$$

3 Equilibrium

A valid perfect-foresight, competitive equilibrium for this economy is a sequence of prices $\{p_t, e_t, \bar{i}_{dt}, \bar{i}_{lt}, i_t^c\}_{t=0}^{\infty}$, allocations $\{c_t, c_t^*, n_t, i_{kt}\}_{t=0}^{\infty}$, stocks of financial assets $\{m_t, d_t, l_t^c, b_t, b_t^*\}_{t=0}^{\infty}$, exogenous sequences of $\{p_t^*, i_t^* = r_t^*\}_{t=0}^{\infty}$, and policy variables $\{g_t, \tau_t, \bar{i}_{dt}, \bar{i}_{lt}, \gamma_{1t}, \gamma_{2t}, B_t\}_{t=0}^{\infty}$ such that:

- Taking $\bar{i}_{dt}, \bar{i}_{lt}, i_t^c, i_t^*, \tau_t, w_t, e_t$ and p_t, the consumer optimally chooses $c_{t+1}, c_{t+1}^*, d_t \ l_t^c$ and b_t^*, such that (1) is maximized subject to (2) and (3);

- The stock of financial assets, m_t and d_t, solve the bank's date–t profit maximization problem, (9), subject to (10), (11) and (12), given prices and policy variables.

- The real allocations solve the firm's date–t profit maximization problem, (16), subject to (17), (18) and (19), given prices and policy variables.

- The goods, money, loanable funds, labor and the bond market equilibrium condition is satisfied for all $t \geq 0$.

- The government budget, equation (25), is balanced on a period-by-period basis.

- The equilibrium condition in the external sector requires, equation (27) to hold, along with the PPP and the interest rate parity conditions being satisfied for all $t \geq 0$.

- $d_t, l_t^c, b_t^*, m_t, b_t, \bar{i}_{dt}, \bar{i}_{lt}, i_t^c, i_t^*, p_t = e_t$ and p_t^* must be positive for all $t \geq 0$.

4 Interest Rate Deregulation, Growth and Inflation

We will assume the government to follow time invariant policy rules, which means that the institutionally determined nominal interest rate on deposits and loans, $\bar{i}_{dt}$ and $\bar{i}_{lt}$, respectively, the tax rate, τ_t, the cash reserve–ratio, γ_{1t}, and

the bond reserve–ratio, γ_{2t}, are constant over time. Finally, note, financial liberalization, in our context, would imply an increase in the interest rate on deposits, i.e., an increase in $(\bar{i}_d)$.

Realizing that, in steady-state, all the real variables grow at the same rate , interest rates remain constant, and all market clears, the following two expressions, obtained from equations (4), (6), (10), (11), (12), (17), (18), (19), (22), (24), and (25) can be used to solve for the steady-state gross growth (θ) and inflation (π) rate[13], given the production (A, α, and ρ) and policy (τ_t, $\bar{i}_d$, γ_1, γ_2 and η) parameters:

$$\theta = 1 - \delta + A(1-\alpha)\eta^{1-\alpha}\left[(1-(\gamma_1+\gamma_2))(1-\tau)+\left(\frac{(1-\gamma_1-\gamma_2)(c_1+c_2)}{c_1 c_2}-\frac{1}{c_1}\right)(\bar{i}_d-i^*)\right] \quad (28)$$

$$\eta = \left[A(1-\alpha)\left(\tau+(\gamma_1+\gamma_2)\left(1-\frac{1}{\pi\theta}\right)\left(1-\tau+\left(\frac{c_1+c_2}{c_1 c_2}\right)(\bar{i}_d-i^*)\right)\right)\right]^{\frac{1}{\alpha}} \quad (29)$$

So we can solve for the gross growth rate from (28) directly, while, replacing the expression of the gross growth rate from (28) into (29), would yield us a closed-form solution for the gross rate of inflation, given as follows:

$$\pi = \left[1-\left(\frac{(\gamma_1+\gamma_2)[(1-\tau)+\frac{c_1+c_2}{c_1 c_2}(\bar{i}_d-i^*)]}{[\frac{\eta^\alpha}{A(1-\alpha)}-\tau]}\right)\right]\frac{1}{\theta} \quad (30)$$

$$\pi = \left[1-\left(\frac{(\gamma_1+\gamma_2)[(1-\tau)+\frac{c_1+c_2}{c_1 c_2}(\bar{i}_d-i^*)]}{[\frac{\eta^\alpha}{A(1-\alpha)}-\tau]}\right)\right]\times$$

$$\left(\frac{1}{\left\{1-\delta+A(1-\alpha)\eta^{1-\alpha}\left[(1-(\gamma_1+\gamma_2))(1-\tau)+\frac{(1-\gamma_1-\gamma_2)(c_1+c_2)}{c_1 c_2}-\frac{1}{c_1}\quad\bar{i}_d-i^*\right]\right\}}\right) \quad (31)$$

At this stage it is important to point out that the effect of an interest rate deregulation, i.e., an increase in $\bar{i}_d$, will produce a positive, negative or no effect based on whether $(1-\gamma_1-\gamma_2)\frac{(c_1+c_2)}{c_1 c_2}$ is greater than, less than or equal to $\frac{1}{c_1}$. Intuitively this implies, that the growth effect of an interest rate deregulation will be positive (negative) depending upon whether the coefficient of transaction costs for operating in the curb market (c_1) is high (low), given the size of the reserve requirements ($\gamma_1+\gamma_2$) and the transaction cost parameter for operating in the foreign market (c_2). The analysis of the inflation rate is, however, cumbersome, given an expression like (31). Hence, we calibrate the model to match world averages, and study the effects of an interest rate deregulation on growth and inflation, quantitatively. This exercise, then helps us in obtaining conditions for a possible growth-inflation trade-off.

The following parameter values were chosen initially and the source is mentioned in the parentheses given aside[14]: The tax rate, $\tau = 0.25$ (Chari *et al.* (1995)), the reserve requirement, $\gamma_1+\gamma_2 = \gamma = 0.15$ (Haslag and Young (1998)),

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[13]Given that purchasing power parity holds, the movement in the steady-state inflation rate exactly mirrors the movements of the steady-state level of exchange rate depreciation of domestic currency.

[14]The parameter values, obtained from different studies have been rounded off to their closest multiple of five.

the interest rate on the deposits $\overline{i_d} = 0.10$ (Gupta (2005)) the elasticity of capital with respect to output, $\alpha = 0.7$ (Basu (2001)), the depreciation rate of capital, $\delta_k = 0.05$ (Zimmermann (1994)), and the transaction cost parameters c_1 and c_2 = 1.0 (Gupta (2005)). The value of A, the production function scalar, is calibrated from the equilibrium conditions to match a growth rate of 2.5 percent ($\theta = 1.025$, (Basu (2001))), and is equal to 1.1655. We choose the curb market rate of interest, i^c, to be equal to 15 percent (Gupta (2005)). Given the no arbitrage condition in the curb and foreign bonds market, $i_c = i^* (= r^*)$, we set the world rate of interest, r^*, to 15 percent as well. Finally, given and an inflation rate of 5 percent ($\pi = 1.05$, (Gupta (2005))), the ratio of the government expenditure to the capital stock, η, is calibrated from equation (25), and the value obtained is equal to 0.0320.

The graphs labeled P_1 and G_1 in Figures 1 and 2, respectively, shows the behavior of the steady-state gross rate of inflation and growth, respectively, in response to an increase in the nominal interest rate on deposits, $\overline{i_d}$, between 10.0 and 14.5 percent. As can be observed from the graphs P_1 and G_1, interest rate deregulation increases the steady-state gross rate of growth, while, the steady-state rate of gross inflation decreases. The analytical reason behind the movement in the steady-state gross rate of growth is obvious given the above set of parameterization for $c_1 = 1.0$, $c_2 = 1.0$ and $\gamma = 0.15$. Note $\frac{1}{c_1} (= 1) < (1 - \gamma)\frac{(c_1+c_2)}{c_1 c_2} = (1.70)$. The economic intuition, on the other hand, follows from the fact that the derivative of the curb market loans as a percentage of the capital stock with respect to $\overline{i_d}$ $((-\frac{1}{c_1})A(1 - \alpha)\eta^{(1-\alpha)})$ is less than the corresponding derivative of the bank loans as a percentage of the capital stock $((1 - \gamma)\frac{(c_1+c_2)}{c_1 c_2}A(1 - \alpha)\eta^{(1-\alpha)}$ in absolute terms. So the fall in the curb market loans as a percentage of capital due to a rise in the official interest rate is outweighed by the increase in the bank loans as a percentage of capital, and hence, aggregate loans as a percentage of capital, which, in turn, leads to an increase in investment as a fraction of the capital stock or the gross growth rate.

Note the movement in the steady-state rate of inflation is straightforward. As can be seen from equation (30), an interest rate deregulation reduces the numerator, and increases the denominator, via the increase in the gross rate of growth θ. Hence, as can be seen from Figure 1, the gross rate of inflation falls unambiguously. To obtain an economic intuition, we first rewrite (29) as follows, using (6) and the fact that $i^c = i^*$ holds:

$$\eta = \left[A (1 - \alpha) \eta^{(1-\alpha)} \tau + (\gamma_1 + \gamma_2) \left(1 - \frac{1}{\pi \theta} \right) \frac{d}{k} \right] \tag{32}$$

where $\frac{d}{k}$ is the ratio of the bank deposit to the capital stock. Note, given the parameterization, an interest rate deregu-

lation increase the growth rate, as well as, $\frac{d}{k}$, hence, the only way the government budget constraint, outlined in (32), can hold is via a fall in the rate of inflation. Thus to summarize, based on the current calibration of the parameters, an interest rate deregulation enhances growth and reduces inflation. This, in turn, implies a negative growth-inflation relationship, in the event of financial liberalization, as is so often observed in the literature.[15]

[INSERT FIGURES 1 and 2 HERE.]

Next, we reduce the transaction cost parameter in the curb market, by lowering the value of c_1 to 0.1 from 1.0, and carry out the same experiment as above. The model is re-calibrated to obtain the new parameter values for A and η to match the equilibrium conditions. The revised values are $A = 1.0881$, and $\eta = 0.02822$. In this case, as can be seen from the graphs P_2 and G_2 in Figures 1 and 2, respectively, an increase in the deposit rate now reduces both gross inflation and the growth rate.[16] The result obtained can, as above, be again explained, by looking at the movements of the bank loan ratio to capital and the curb market loan ratio to capital, with respect the changes in the nominal rate of interest on the deposits, specifically the absolute sizes of $((-\frac{1}{c_1})A(1-\alpha)\eta^{(1-\alpha)})$ and $((1-\gamma)\frac{(c_1+c_2)}{c_1 c_2}A(1-\alpha)\eta^{(1-\alpha)}$, respectively. Given that $\frac{1}{c_1}$ $(= 10) > (1-\gamma)\frac{(c_1+c_2)}{c_1 c_2}$ $(= 9.35)$, the increase in $\overline{i_d}$ reduces the ratio of the curb market loans to capital stock more than the increase in the bank loans as a percentage of the capital stock, the gross growth rate declines in this case.

As far as the corresponding fall in the inflation rate is concerned, the economic intuition is no longer as straight-forward as in the previous case. A fall in the growth rate, given the rate of inflation reduces the term $\left(1 - \frac{1}{\pi\theta}\right)$, while the ratio of the deposits to the capital stock increases unambiguously. Now given that the inflation rate has ultimately gone down in Figure 1, under the current parameterization, implies that the rise in $\frac{d}{k}$ must have been more than the decline in θ, and, hence, required a fall in π to ensure that the government budget constraint in (32) holds. The proof, that this is exactly what has happened, is simple, and can be understood numerically, by comparing the derivative of θ and $\frac{d}{k}$ with respect to $\overline{i_d}$. The values are -0.0728 and 1.2313, respectively. Given the values of the derivatives and the calibrated parameters, it is now obvious, that a fall in the growth rate following interest rate deregulation needs to be accompanied by a fall in the inflation rate as well. This, in turn, generates a possible trade-off between growth and

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[15]See Endnote 1 for further details.

[16]Keeping c_2 at 1.0, alternative values of c_1, between 0.9 to 0.2 were used, reducing the same by 0.1. But it was only at $c_2 = 0.1$, that a trade off between growth and inflation emerged.

inflation.[17]

5   Conclusions

The negative relationship between growth and inflation is widely accepted in the literature. However, Chari *et al*. (1995, 1996), Espinosa and Yip (1996) and Gupta (2006a) provide evidence of a possible growth-inflation trade-off. In such a scenario, this paper provides a theoretical explanation to the contradictory empirical evidences on the growth-inflation relationship.

To validate our point, we develop a monetary endogenous growth model of a financially repressed small open economy in an overlapping generations framework, characterized by Unofficial Money Markets (UMM) or curb markets, productive public expenditures, capital mobility, costs involved in carrying out transaction in domestic and foreign capital markets, and a flexible exchange rate system, and analyze the impact of financial liberalization on growth and inflation. When calibrated to match world figures we show that the relationship between growth and inflation following interest rate deregulation depends critically on the size of the transaction cost parameter of the curb market. Specifically, we point out that including financial repression in a model analyzing the growth-inflation relationship is only necessary, and not sufficient, to produce a trade-off between growth and inflation. Sufficiency, in turn, requires high transaction costs in the unofficial financial market.

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[17]The experiment of financial deregulation was carried out by recalibrating the model for a value of $c_2 = 0.1$, with c_1 at 1.0 and 0.1, respectively. We found that growth and inflation continued to move in opposite directions, i.e, growth increased and inflation decreased following an interest rate deregulation. However, the response of growth and inflation to the change in the interest rate on deposits became stronger in the latter case, when compared to the former.

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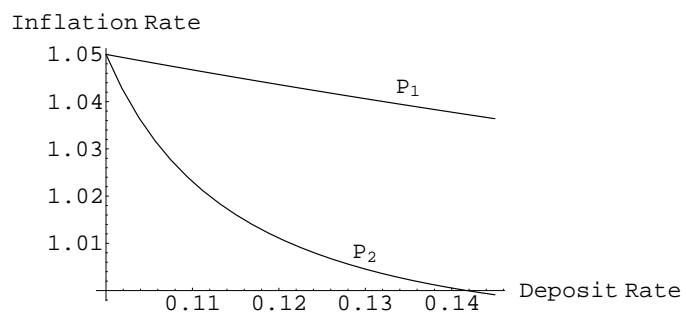
Figure 1: Interest Rate Deregulation and Inflation

Figure 2: Interest Rate Deregulation and Growth