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THE STOCK MARKET, MONETARY POLICY, AND ECONOMIC DEVELOPMENT

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The Stock Market, Monetary Policy, and Economic Development*

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Abstract

In this paper, we examine the impact of financial market development on capital accumulation and inflation. In particular, we explore this issue in a setting in which banks provide risk pooling services. Furthermore, money overcomes incomplete information to facilitate transactions between individuals. In contrast to previous work, we incorporate a market for equity by allowing individuals to trade capital across generations. Interestingly, we find that the quantitative impact of the stock market may be *indeterminate* – the economy may respond with significant gains in capital accumulation or relatively little. Consequently, it is not clear how much financial development will drive down inflation in the long-run. In the case of unique steady-states, expansionary monetary policy causes long-run capital accumulation to fall. However, the response is much stronger in the presence of a stock market. Furthermore, the market for capital may lead to a different *qualitative* response to monetary policy. That is, financial development may lead to a Tobin effect from inflation. Finally, by studying dynamics, we demonstrate that financial markets and monetary policy can have a significant impact on volatility in the economy. In this manner, there is additional scope for monetary policy to stabilize the economy at higher levels of financial development.

JEL Classification: E44, E52, E31, O16

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1 Introduction

A vast amount of research in macroeconomics studies the effects of financial market conditions on economic activity. While it is clear that financial market activity can affect macroeconomic behavior in the short-run, recent work demonstrates that financial markets have a substantial impact on economic performance over long periods of time. For example, King and Levine (1993) document that activity in the banking system helps economies achieve higher rates of growth.¹ In addition, Levine and Zervos (1998) observe that both stock market liquidity and volatility are critically important.²

There is also evidence that suggests inflation interferes with the growth process. While initial studies identified that inflation was generally associated with slower economic progress, further research concludes that the relationship is non-linear. Specifically, there may be threshold effects from inflation to growth. That is, beyond a particular amount of inflation, inflation causes growth to decline. Moreover, the threshold depends on the extent of economic development – while it is quite low for developed economies (around 1-3%), the number is much higher in poor countries (around 11%).³ Taken together, these results illustrate that the effects of monetary policy may depend on the stage of economic development. In addition, since the development of the financial sector affects economic growth, the impact of monetary policy likely depends on the stage of financial market development.

Notably, different types of financial markets provide different financial services. That is, the economic functions of banks may be substantially different than stock markets. Although different types of financial markets fulfill unique allocative functions, there has been surprisingly little attention devoted to studying how asset markets collectively interact from a general equilibrium perspective.⁴ Furthermore, previous work does not address how the role of monetary policy depends on the extent of financial market development.

We attempt to fill this gap by developing a monetary growth model that incorporates money, bank deposits, and equity.⁵ As in Schreft and Smith (1998), spatial

¹See also Levine (1997) and Levine, Loayza, and Beck (2000).

²Demirguc-Kunt and Levine (1996) and Rousseau and Wachtel (2000, 2001) discuss the contribution of financial market development to economic growth.

³Roubini and Sala-i-Martin (1995), Easterly et al. (1994), and Barro (1995, 1996) point out that inflation and growth are negatively correlated in the long-run. Further studies by Bullard and Keating (1995), Fisher (1993), Ghosh and Phillips (1998) and Khan and Senhadji (2001) show that the relationship is non-linear.

⁴An exception includes the recent work of Antinolfi and Kawamura (2004). They study the importance of banks relative to other types of financial markets for monetary policy. In their model, however, capital cannot be transferred over time.

⁵Bencivenga, Smith, and Starr (1995) construct an overlapping generations model to study the formation of financial markets during the process of economic development. In their framework, capital investments must be available for long periods of time until they mature. Stock markets may promote economic growth by allowing individuals to trade claims to future capital. However, in contrast to our approach, they do not examine the interactions between monetary policy and financial and economic development. See also Bencivenga and Smith (1991), Boyd and Smith (1998), Greenwood and Jovanovic (1990), and Greenwood and Smith (1997).

separation and limited communication create a role for money and commercial banks. In our economy, young individuals are subject to random relocation shocks. As money is the only asset that can cross locations, relocated agents must liquidate all their asset holdings into currency. Thus, random relocation is analogous to the liquidity preference shocks in Diamond and Dybvig (1983). As a result, our model illustrates the risk pooling role of financial intermediaries.

In contrast to banks, we consider that the stock market promotes economic development by establishing a market in which capital can be transferred across time. For example, this may reflect specialization of factor inputs. To illustrate such ideas, we consider the following motivation. Individuals in the economy have specialized production technologies. Since capital is designed to complement particular production processes, it can only be used by individuals with knowledge of the specific technology. Moreover, we assume that investment is irreversible.⁶ Consequently, in the absence of a market for transferring the specialized capital, agents' investments would be sunk. Effectively, this reduces the economy to a setting with complete depreciation of physical capital. Thus, our benchmark environment is very close to the setup of the Schreft-Smith (1998) model.

However, the stock market allows for specialized capital to be transferred across time. In this sense, we follow Greenwood and Smith (1997) by arguing that the stock market represents a set of trading institutions. The provision of these trading services permits specialized factor inputs to be transferred to individuals with knowledge of the particular production techniques. In our framework, this leads to a setting in which the ownership of capital may be transferred across generations. From such perspective, our model illustrates the intergenerational liquidity role of the stock market.⁷

Obviously, the stock market is likely to promote the accumulation of capital since it helps capital to be transferred across generations. As a result, progress in the financial sector will affect economic growth. Interestingly, the *quantitative* impact of financial development on economic development may be *indeterminate* – the economy may respond with significant gains in capital accumulation or relatively little. Consequently, it is not clear how much financial development will drive down inflation in the long-run.⁸

We proceed to study the effects of monetary policy under different degrees of financial market development. If the steady-states in the benchmark and stock market

⁶This approach is similar to Magill and Quinzii (2003).

⁷Levine (1991) constructs a model of liquidity risk to demonstrate the liquidity role of the stock market. In his model, agents who experience early needs for funds can sell claims to capital through the stock market. In contrast to Levine, we follow the approach of Diamond and Dybvig (1983) and Schreft and Smith (1998) in which banks alleviate liquidity shocks through risk pooling. Moreover, our framework allows us to examine the interactions between financial market development and monetary policy.

⁸Bencivenga, Smith, and Starr (1995) demonstrate that the effects of financial development depend on the extent of transactions costs in financial markets. Interestingly, they show that financial development can lead to lower growth. Since they do not incorporate fiat money in their framework, Bencivenga, Smith, and Starr do not consider how the effects of monetary policy depend on the stage of development in the financial sector.

economies are both unique, expansionary monetary policy causes long-run capital accumulation to fall. However, the response is much stronger in the presence of a stock market. In this sense, the relationship between inflation and economic growth depends on the provision of financial services. This provides a useful explanation for the different threshold rates observed in rich and poor countries. Since inflation has a smaller effect on growth in developing economies, the accumulated impact may not appear to be statistically significant until the inflation rate is sufficiently high. Moreover, we show that the market for capital can lead to a different *qualitative* response to changes in monetary policy. That is, in the long-run, financial development may generate a positive relationship between inflation and economic development.

Finally, by studying dynamics, we demonstrate that financial markets and monetary policy can have a significant impact on volatility in the economy. Although the number of monetary steady-states may be indeterminate, we also establish indeterminacy of dynamical equilibria. Furthermore, a market for capital can lead to endogenous volatility. Interestingly, this provides additional scope for monetary policy to stabilize the economy. Although financial development contributes to market instability, the central bank can reduce the degree of volatility by taking a sufficiently aggressive policy stance.

The paper is organized as follows. In Section 2, we describe the benchmark model. Section 3 studies the impact of financial development on capital accumulation. In particular, we demonstrate that a market for capital can lead to significantly different effects of monetary policy. Section 4 extends the model to study local dynamics. Finally, we offer concluding remarks in Section 5. Most of the technical details are presented in the Appendix.

2 The Benchmark Model

In order to discuss the impact of financial development, we begin by outlining a modified version of the Schreft-Smith (1998) model. Following their framework, we develop an overlapping generations model with spatial separation and fiat money.

In contrast to Schreft and Smith, we consider that physical capital is inherently durable. That is, it does not completely depreciate after production. However, we also assume that capital is heterogeneous and highly specialized to suit particular production technologies. Moreover, the heterogeneous capital cannot be converted into units of consumption. In this manner, investment is irreversible.

In the spirit of Greenwood and Smith (1997), we initially impose that informational constraints render it difficult for the specialized factor inputs to be traded. To be specific, the economy is at a primitive stage of financial market development in which trading services for the specialized capital do not exist. As a result, it cannot be transferred to individuals with knowledge of the particular production techniques. Effectively, this reduces the economy to a setting with complete depreciation. Thus, our benchmark model is very close to the set-up in Schreft and Smith.

2.1 The Environment in the Benchmark Economy

The economy consists of two distinct geographic locations. For example, the locations could be viewed as separate islands. Within each location, there is an infinite sequence of two-period lived overlapping generations, plus an initial group of old individuals. At the beginning of each date, a continuum of ex-ante identical young agents are born. In each generation, there are two types of agents: *depositors* and *entrepreneurs*. The population of each group of agents is equal to 1. However, regardless of their type, all individuals only derive utility from consumption (c_t) in old-age:

$$\begin{aligned} u(c_t) &= \frac{c_t^{1-\theta}}{1-\theta} \text{ for } \theta \neq 1 \\ u(c_t) &= \ln c_t \text{ otherwise} \end{aligned} \tag{1}$$

where θ is the coefficient of relative risk aversion. We focus on studying economies in which individuals are sufficiently risk averse. That is, $\theta > 1$.

Each young agent is endowed with one unit of labor. Since there is no disutility of labor effort, an individual's labor supply is independent of wages. In contrast, agents are retired when old. As a result, the total labor supply at each date is equal to the *total* population mass of young individuals.

In contrast to depositors, entrepreneurs are also endowed with technical skills that allow them to manage firms when old. However, the skills are specific to particular types of production technologies – an entrepreneur of type j will be able to run a production technology j when old. Such technologies utilize both labor (L_t) and *specialized* capital (K_t^j) to produce output equal to $Y_t = F^j(K_t^j, L_t^j)$. In addition, each production function exhibits constant returns to scale. In this manner, it is convenient to denote the utilization of each factor of production in terms of the labor provided by young entrepreneurs: $k_t^j = K_t^j/L_t^e$ and $l_t^j = L_t^j/L_t^e$. As a result, we may write $f^j(k_t^j, l_t^j) \equiv \frac{F^j(K_t^j, L_t^j)}{L_t^e}$. Furthermore, each production function is quasiconcave, twice continuously differentiable and satisfies standard Inada conditions.

There are three types of assets in this economy: money (fiat currency), government bonds, and capital. As we explain later, only depositors hold currency. Consequently, we define the monetary base, M_t , in terms of the population of *depositors*. In contrast to money, government bonds will be held by both types of agents. Let B_t^d and B_t^e denote the demand for government debt by depositors and entrepreneurs respectively. Total demand is given by: $B_t^D = B_t^d + B_t^e$. Since both groups of agents hold bonds, we denote the value of government debt in terms of the *total* population of agents (including entrepreneurs). Therefore, the nominal *per capita* supply of government debt is equal to B_t .

A government security held in period t yields I_t units of currency in period $t + 1$. Assuming that the price level is common across locations, we refer to P_t as the number of units of currency per unit of goods at time t . Thus, in real terms, the supply of money per depositor is $m_t^s = M_t/P_t$. The real supply of government debt per capita is $b_t = B_t/P_t$. Finally, the gross real return to government debt in period $t + 1$ is

$R_t = I_t \frac{P_t}{P_{t+1}}$ (where $\frac{P_t}{P_{t+1}}$ is the rate of return on money). At the initial date 0, the generation of type j entrepreneurs at each location is endowed with the aggregate stock K_0^j . In addition, old depositors are endowed with the initial aggregate money stock, $M_0 > 0$.

Capital is generated in the following manner. Output produced by entrepreneurs is divided between their consumption and payments to workers. One unit of investment by a young entrepreneur j in period t becomes one unit of capital next period. In addition to the specialized nature of capital, it is also irreversible – once the consumption good matures into capital, it cannot be converted back without incurring an infinite adjustment cost. Consequently, in the absence of a market for capital, agents’ investments would be sunk. Although this has the same effect as complete depreciation, the *physical* rate of depreciation is actually less than 100%. That is, only a fraction $\delta \in [0, 1]$ of the capital stock actually breaks down after production. However, the absence of a market ties the lifetime horizon of capital to that of entrepreneurs.⁹

While entrepreneurs cannot sell their capital, depositors also face a trading friction due to private information. In particular, they are subject to random relocation shocks. That is, with some probability, π a depositor has to relocate to the other location. The probability of relocation, is exogenous, publicly known and is the same across locations. Each island is characterized by complete information about agents’ asset holdings, but communication across islands is not possible. As a result, depositors do not have the ability to issue private liabilities.

As in standard random relocation models, fiat money is the only asset that can be carried across locations.¹⁰ Furthermore, currency is universally recognized and cannot be counterfeited – therefore, it is accepted in both locations. In this manner, money facilitates transactions made difficult by spatial separation and limited communication. As a result, money has an advantage over holdings of government debt in terms of liquidity. Consequently, although it is dominated in rate of return ($\frac{P_t}{P_{t+1}} < R_t$), it is accepted as a medium of exchange on each island.

Since money is the only asset that can cross locations, depositors who learn they will be relocated will liquidate all their asset holdings into currency. Random relocation thus plays the same role that liquidity preference shocks perform in Diamond and Dybvig (1983). As banks provide insurance against the shocks, each young depositor will put all of her income in the bank rather than holding assets directly. In contrast to depositors, entrepreneurs are not subject to relocation – therefore, they do not allocate funds into banking accounts.

In addition to depositors and entrepreneurs, there is a government that adjusts the amount of new liabilities in order to finance interest payments on previously issued debt. It also obtains revenues through seigniorage. The expenditures and revenues make up the government budget constraint:

⁹In this manner, the economy resembles the world of financial autarky in Greenwood and Smith (1997). See also Section I of Levine (1991).

¹⁰Government bonds cannot be used for transactions purposes as they come in large denominations.

$$R_{t-1}b_{t-1} = \frac{M_t - M_{t-1}}{P_t} + b_t \quad (2)$$

We assume that the government chooses a permanent ratio of bonds to money. Thus, at date 0, it fixes the ratio of debt to currency (denoted by β) at:

$$\beta \equiv \frac{b_t}{m_t} \quad (3)$$

The government conducts monetary policy by changing the nominal stock of money so that the ratio is always equal to β . Henceforth, we will refer to the type of monetary policy as a fixed bonds-money ratio rule. It may be convenient to think of variations in β as permanent open market operations. We will sometimes interpret an increase in β as a tight monetary policy. For convenience, the government is a net borrower. That is, $\beta > 0$.

2.2 Trade

2.2.1 A typical entrepreneurs' problem

In period t , a young entrepreneur works and earns the wage rate w_t . All young age income is saved as investment in new capital, i_t^j , and government bonds, b_t^e . A typical young entrepreneur's budget constraint is given by:

$$w_t = i_t^j + b_t^e \quad (4)$$

In the absence of a market for capital, investment in period t determines the level of capital in the following period:

$$k_{t+1}^j = i_t^j \quad (5)$$

Consequently, an entrepreneur has k_{t+1}^j units of capital in period $t+1$ that is combined along with labor, l_{t+1}^j , to produce the economy's homogeneous consumption good. Thus, the amount of old age consumption must satisfy:

$$c_{t+1}^j = f(k_{t+1}^j, l_{t+1}^j) - w_{t+1}l_{t+1}^j + b_t^e R_t \quad (6)$$

Although each entrepreneur possesses knowledge of a particular type of production technique j , the utility maximization problem for each is symmetric. Consequently, we suppress the superscript j throughout the remaining analysis. Instead, we denote the consumption level of a representative entrepreneur in period $t+1$ as c_{t+1}^e . Therefore, a representative young entrepreneur at time t solves the following:

$$\underset{i_t, l_{t+1}}{Max} \frac{c_{t+1}^{e, 1-\theta}}{1-\theta} \quad (7)$$

subject to the resource constraints (4), (5), and (6). Substituting the constraints into the objective function, the problem may be expressed as:

$$\underset{i_t, l_{t+1}}{Max} \frac{(f(i_t, l_{t+1}) - w_{t+1}l_{t+1} + (w_t - i_t) R_t)^{1-\theta}}{1 - \theta} \quad (8)$$

Since factor markets are perfectly competitive, labor and capital earn their marginal products. By constant returns to scale, real wages are:

$$w_{t+1} = \frac{[f(k_{t+1}, l_{t+1}) - k_{t+1}f_{k_{t+1}}(k_{t+1}, l_{t+1})]}{l_{t+1}} \quad (9)$$

The lifetime-utility maximizing choice of investment renders entrepreneurs to be indifferent between additional holdings of capital and government debt. This leads to the no-arbitrage condition:

$$f_{k_{t+1}}(k_{t+1}, l_{t+1}) = R_t \quad (10)$$

2.2.2 A representative bank's problem

In the economy, the banking sector is perfectly competitive.¹¹ As a result, banks choose portfolios to maximize the expected utility of each depositor. Since financial intermediaries reduce depositors' consumption variability, each of them chooses to deposit all of their income. The bank promises a gross real return r_t^m if the young individual will be relocated and a gross real return r_t^n if not. Since the market for deposits is perfectly competitive, financial intermediaries take the real return on assets as given.

The bank's portfolio choice involves determining the amount of real money balances, m_t , and the amount of government debt to acquire per depositor, b_t^d .¹² The bank's balance sheet is expressed by:

$$m_t + b_t^d \leq w_t ; t \geq 0 \quad (11)$$

Announced deposit returns must satisfy the following constraints. First, since currency is the only asset that can be transported across locations, relocated agents will choose to liquidate their asset holdings into currency. Depending on the bank's money holdings and the inflation rate, the return to movers satisfies:

$$\pi r_t^m w_t \leq m_t \frac{P_t}{P_{t+1}} \quad (12)$$

In addition, we choose to study equilibria in which money is dominated in rate of return (i.e., $\frac{P_t}{P_{t+1}} < R_t$). Therefore, banks will not carry money balances between

¹¹In random relocation models, the generation of young depositors form coalitions to provide insurance against liquidity risk. Such coalitions provide similar financial services to commercial banks.

¹²Since entrepreneurs do not experience liquidity shocks, they do not benefit from the provision of consumption insurance by financial intermediaries. Furthermore, banks do not have the ability to implement the specialized capital inputs into any of the production technologies. In this manner, we presume that capital is exclusively owned and financed by entrepreneurs – banks do not invest in productive inputs.

periods t and $t + 1$. The bank's total payments to non-movers are therefore paid out of its returns on government bonds in $t + 1$:

$$(1 - \pi_t)r_t^n w_t \leq R_t b_t^d \quad (13)$$

Thus, each bank chooses values of r_t^m , r_t^n , m_t , and b_t^d in order to solve the problem:

$$\underset{r_t^m, r_t^n, m_t, b_t^d}{Max} \pi \frac{(r_t^m w_t)^{1-\theta}}{1-\theta} + (1-\pi) \frac{(r_t^n w_t)^{1-\theta}}{1-\theta} \quad (14)$$

subject to (11), (12), and (13). The solution yields the bank's money demand function:

$$m(I_t) = \frac{w_t}{\left[\frac{(1-\pi_t)}{\pi} I_t^{\frac{1-\theta}{\theta}} + 1 \right]} \quad (15)$$

It will also be useful to refer to the bank's reserves to deposits ratio, $\gamma(I_t) \equiv m(I_t)/w_t$. In order to make clear comparisons to previous work, we follow Schreft and Smith (1998) by studying the case in which $\theta > 1$. As a result, the bank's money demand function is increasing in the nominal interest rate. Notably, the higher nominal rate of return to government debt yields both a substitution effect and an income effect. The substitution effect occurs because the higher return to government debt raises the cost of holding money and lowers its demand. On the other hand, the higher interest rate implies that banks can obtain the same amount of interest income by acquiring a lower amount of bonds. In this manner, the income effect leads to an increase in the demand for money.

2.3 General Equilibrium

We now combine the results of the preceding section and characterize the equilibrium for the benchmark economy. In equilibrium, labor effort receives its marginal product (9). Furthermore, the labor market clears:

$$L_t = L_t^e + L_t^d = 2 \quad (16)$$

From the bank's balance sheet, (11) and entrepreneurs' budget constraint, (4), we can obtain the total demand for government bonds, with $b_t^D = b_t^e + b_t^d$. Using the bonds to reserves ratio, (3), the total supply of bonds can be expressed as $b_t^S = \beta m(I_t)$. In equilibrium, bond demand is equal to bond supply:

$$\beta m(I_t) = (w(k_t) - k_{t+1}) + (w(k_t) - m(I_t)) \quad (17)$$

where $w(k_t) - k_{t+1}$ represents the demand for government debt by entrepreneurs and $w(k_t) - m(I_t)$ is the demand for debt by banks. Alternatively, we can re-write this expression as a fraction of income:

$$\Omega(k_{t+1}) \equiv \frac{k_{t+1}}{w_t} = 2 - (1 + \beta) \gamma(I_t) \quad (18)$$

Combining the no-arbitrage condition, (10) with the government's budget constraint (2) and the fixed debt to reserves policy (3), we obtain the evolution of real money balances:

$$m_{t+1} = \frac{(1 + \beta I_t)}{(1 + \beta)} \frac{f_{k_{t+1}}(k_{t+1}, 2)}{I_t} m_t \quad (19)$$

Alternatively, we may express this information in terms of the evolution of the real reserves to deposits ratio:

$$\gamma(I_{t+1}) = \frac{(1 + \beta I_t)}{(1 + \beta)} \frac{f_{k_{t+1}}(k_{t+1}, 2)}{I_t} \gamma(I_t) \frac{w(k_t)}{w(k_{t+1})} \quad (20)$$

Conditions (18) and (20) characterize the behavior of the economy at each point in time.

2.3.1 Steady-State Analysis

Imposing steady-state on (18) and (20) so that $k_t = k_{t+1} = k$ and $I_t = I_{t+1} = I$, the following two loci characterize the behavior of the economy in the long run:

$$\Omega(k) = \frac{k}{w} = 2 - (1 + \beta) \gamma(I) \quad (21)$$

and

$$f_k(k, 2) = \frac{(1 + \beta) I}{(\beta I + 1)} \quad (22)$$

As described above, we refer to the first equation as the bond market clearing condition. The second is the no-arbitrage condition. Since the technical properties are nearly identical to Schreft and Smith (1998), much of the details are provided in the Appendix.¹³ Instead, we choose to concentrate on providing economic interpretation for our results. In this manner, it is easier to obtain insight into the role of a market for capital.

The bond market clearing condition, equation (21), describes combinations of capital and interest rates in which the amount of bond holdings is equal to the supply of government debt. Notably, under higher rates, banks will hold less debt because of the income effect. Consequently, for a given stock of capital, this leads to excess supply of bonds. In order for the market to clear, entrepreneurs must adjust their portfolios from capital to government debt. These interactions are illustrated in Figure 1:

¹³Although the benchmark model is very close to Schreft and Smith, the effective labor supply each period is higher in our model. Consequently, the marginal product of capital will be higher if capital and labor are complementary factors.

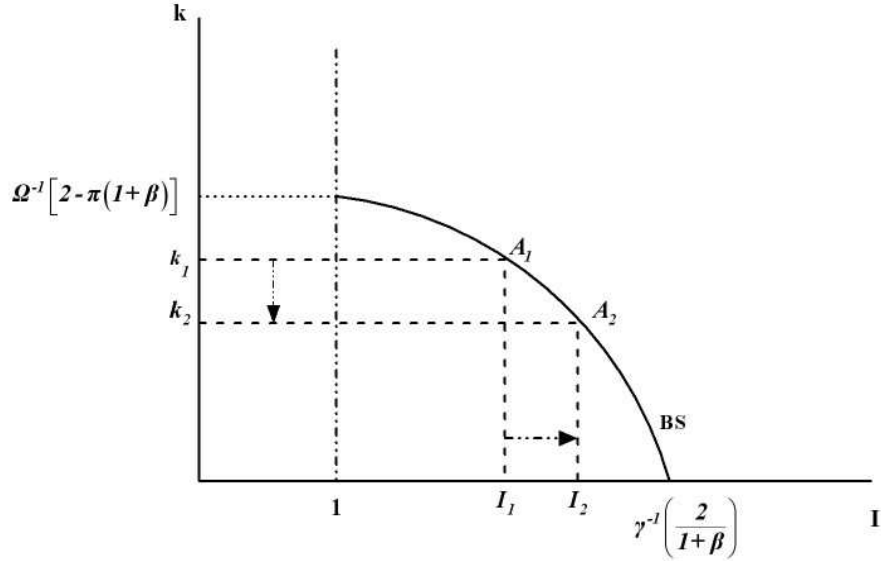


Figure 1: The Bond Market Clearing Condition

Alternatively, we can express the condition in terms of the amount of government debt, b , and the nominal interest rate, I . We begin by looking at the demand for government debt as a fraction of the total amount of savings by a young individual (either a depositor or an entrepreneur):

$$\frac{b^D}{w(k)} = (1 - \Omega(k)) + (1 - \gamma(I)) \quad (23)$$

For a given capital stock, the relative demand is decreasing in the nominal interest rate. This is illustrated in Figure 2 below. If the amount of capital is higher, the curve shifts back.

In contrast, the relative supply is given by:

$$\frac{b^S}{w(k)} = \beta\gamma(I)$$

If the nominal interest rate is higher, the demand for currency rises. Consequently, the government must increase the supply of bonds in order to maintain the fixed debt to reserves ratio, β . As shown in Figure 2, the supply curve is upward-sloping. Since the bond supply curve relates to the amount of money held by banks, it is independent of the amount of capital held by entrepreneurs. Moreover, since $\gamma''(I) > 0$, both curves are convex.

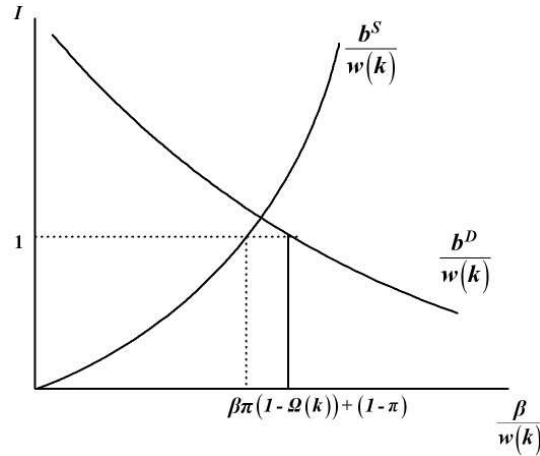


Figure 2: Bond Market Equilibrium

Recall that the bond market clearing condition, equation (21), demonstrates combinations of nominal interest rates and levels of capital in which the bond market is in equilibrium. As an example, suppose that the nominal interest rate rises. In order for this to be consistent with market clearing, the relative demand curve must shift out. However, the higher demand for government debt would only take place if entrepreneurs hold less capital. The effects are illustrated in Figure 3 below.

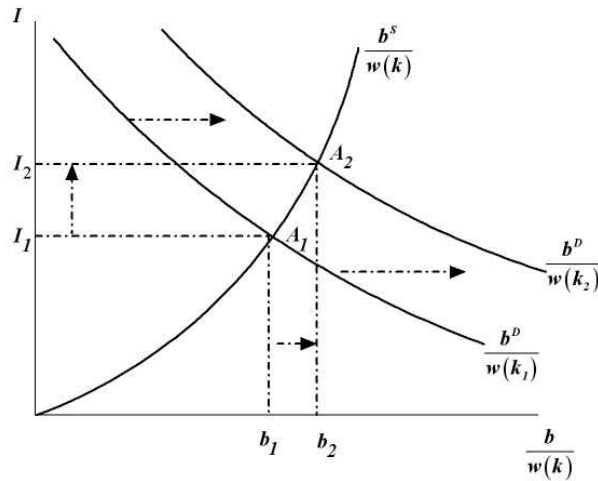


Figure 3: Bond Market Adjustment

In contrast to the bond market clearing condition, equation (22) represents conditions on I and k in which entrepreneurs are indifferent between holding capital or government debt. It is easily shown that the no-arbitrage curve is downward-sloping. The logic is as follows. If nominal interest rates increase, the real rate of return to government debt would be higher. Therefore, in order for entrepreneurs to be willing to hold both types of assets, the return to capital must rise. This requires that the

stock of capital is lower. Furthermore, it is straightforward to show that the *real* return to government bonds must go to infinity as $I \rightarrow \infty$. Consequently, the capital stock must go to zero. Similarly, $I \rightarrow 0$ as $k \rightarrow \infty$. Finally, the no-arbitrage curve includes the point $(1, f_k^{-1}(1))$.

Together, the interaction between the bond market clearing and no-arbitrage conditions determine the steady state levels of capital and nominal interest rate. We begin with a Proposition regarding existence of steady-state equilibria in the benchmark economy. It is nearly the same as Schreft and Smith (1998), but augmented to allow for both depositors and entrepreneurs in our model:

Proposition 1. *Suppose that $\gamma^{-1} \left(\frac{2}{(1+\beta)} \right) > 1$ and $\Omega^{-1} (2 - (1 + \beta) \pi) > f_k^{-1}(1)$. Under these conditions, a steady-state in which $I^* > 1$ and $k^* > 0$ exists and is unique. Alternatively, if $\gamma^{-1} \left(\frac{2}{(1+\beta)} \right) > 1$ and $\Omega^{-1} (2 - (1 + \beta) \pi) < f_k^{-1}(1)$, the number of steady-states is indeterminate. That is, it is possible that two steady-states exist. It is also possible that a steady-state does not exist.*

The conditions for existence may be better understood upon examining Figures 4 and 5. In particular, if $\Omega^{-1} (2 - (1 + \beta) \pi) < f_k^{-1}(1)$, the bond market curve and the no-arbitrage curve may intersect twice. However, for relatively high values of the debt-reserves ratio, the curves may not intersect. In this case, a steady-state would not exist.

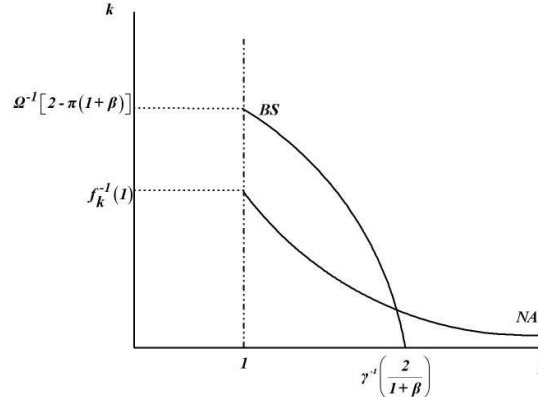


Figure 4: Unique Steady State

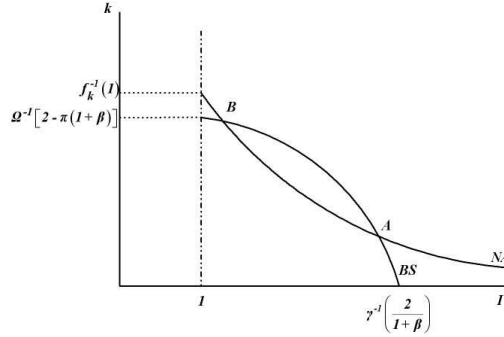


Figure 5: Multiple Steady-States

As may be observed in Figure 5, under multiple steady-states, there is a steady-state with a low capital stock and a high nominal interest rate. Alternatively, the other steady-state has a high level of capital and a low nominal interest rate. The economy with a low level of capital accumulation resembles less developed countries with low savings. Since the nominal interest rate is relatively high, government debt crowds out capital formation. Due to the high level of government debt, the government must finance high interest payments. In order to finance the high interest payments, the government imposes a high inflation tax. In contrast, the other steady-state has a low inflation rate.

2.4 The Effects of Monetary Policy

We proceed to study the impact of monetary policy in the benchmark model. Since the effects are nearly identical to Schreft and Smith (1998), we keep our discussion brief and focus only on the behavior in the unique steady-state. The intuition carries over to settings with multiple steady-states.

To understand the impact of monetary policy, we study a case in which the central bank contracts the money supply. This occurs if the government engages in open market sales of bonds. Consequently, the bonds to money ratio increases to $\beta' > \beta$.

As a first step, we begin with a ‘partial equilibrium’ perspective. That is, we discuss the effects of monetary tightening from two different channels. We refer to the first channel as the *no-arbitrage effect*. This is represented by the shift in the no-arbitrage curve. The second channel is the *bond supply effect*. This occurs through changes in bond market clearing conditions.

We start by investigating the no-arbitrage effect – this represents how the rates of return between capital and government debt must adjust to the lower degree of liquidity. That is, we initially consider the impact of the increase in β through the no-arbitrage condition, taking the requirements for bond market clearing as given. Due to the higher debt to reserves ratio, the government’s debt obligations will be relatively higher. This requires the government to raise inflation tax revenues which cause the real return to bonds to fall. As a result, entrepreneurs are not indifferent between capital investment and government debt. Thus, under the fixed nominal

interest rate, the capital stock would be higher. We show how this causes the no-arbitrage locus to tilt upwards around $(1, f_k^{-1}(1))$ in Figure 6A. In particular, the effects are illustrated as the movement from point A_1 to A' .

However, Figure 6B also illustrates that the bond market would not be in equilibrium at A' since entrepreneurs adjust their portfolios from government debt to capital. The resulting excess supply of government debt is illustrated in the Figure.

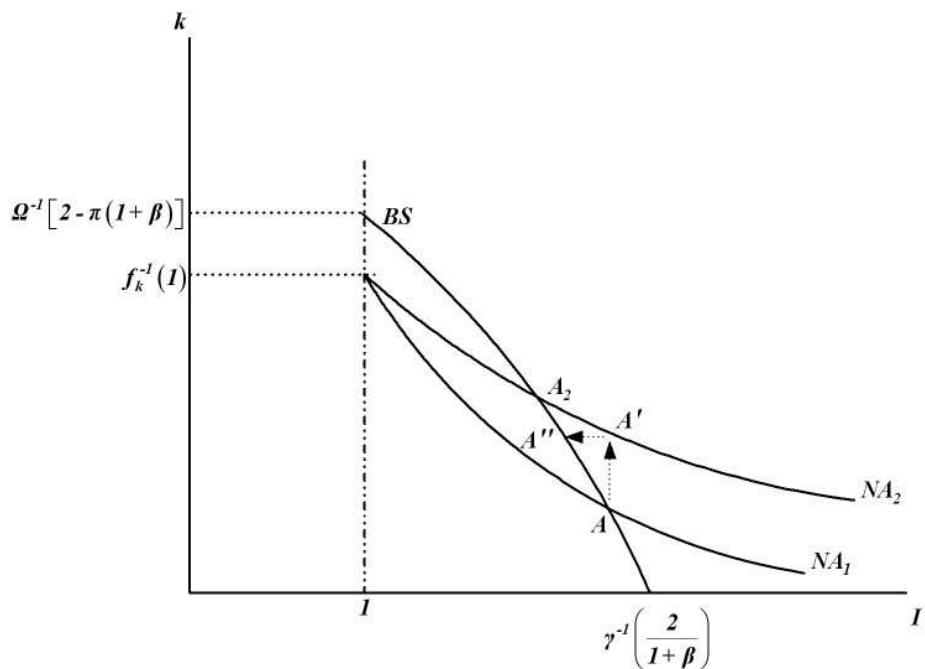


Figure 6A: The No-Arbitrage Effect

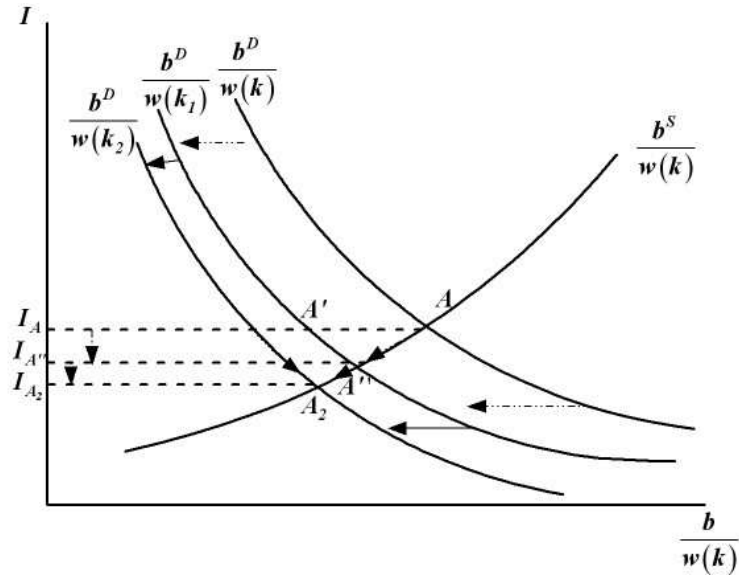


Figure 6B: Effect of Higher Debt to Reserves Ratio on the Bond Market

Since the bond demand curve shifts back, the nominal interest rate will need to adjust in order for the market to clear. As shown in Figure 6B, the income effect causes the interest rate to fall. This is shown in both Figures as a movement from A' to A'' . Due to the lower nominal interest rate, the real return to government debt will also be lower. Consequently, the capital stock will increase from A'' to A_2 . Thus, the *no-arbitrage effect* from contractionary monetary policy is associated with lower nominal interest rates and greater capital accumulation.

Next, we will demonstrate the effects of the increase in the supply of bonds. As mentioned above, we refer to this as the *bond supply effect*. At the interest rate I_A , the bond market is in excess supply. The resulting impact on the bond market is illustrated in Figure 7A.

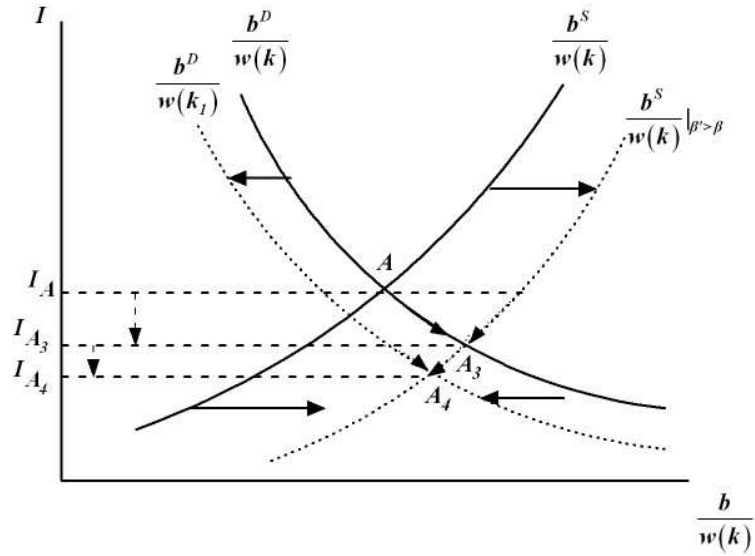


Figure 7A: The Effects of Higher Bond Supply

In order for the market to return to equilibrium, the nominal interest rate must fall from I_A to I_{A_3} . The effect is also shown in Figure 7B. For a given stock of capital (and supply of money), the higher supply of government debt shifts the bond supply curve (BS) in.

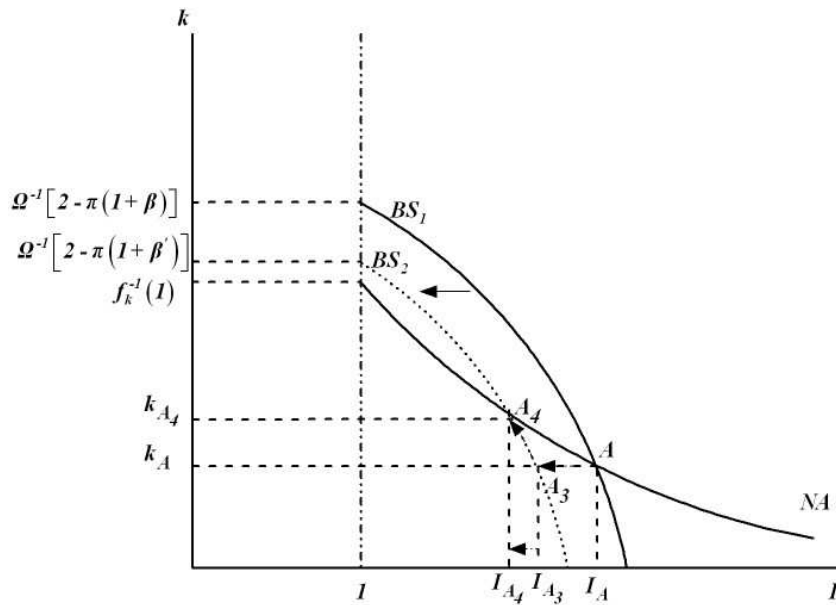


Figure 7B: The Bond Supply Effect

This movement is represented in Figures 7A and 7B from A to A_3 . However, the lower nominal interest rate implies that the return to capital exceeds the real return to government debt. Consequently, entrepreneurs would choose to invest more and

the level of capital accumulation would be higher. The increase in capital shifts the bond demand curve back – as a result, the interest rate and capital stock will further adjust such that the capital stock is even higher and the nominal interest rate falls from I_{A_3} to I_{A_4} . In this manner, we find that the *bond supply effect* is associated with lower nominal interest rates and a higher stock of capital.

In summary, both channels work in the same direction – both the no-arbitrage effect and the bond supply effect lead to greater capital accumulation and lower nominal interest rates. The combined impact is illustrated in Figure 8 below:

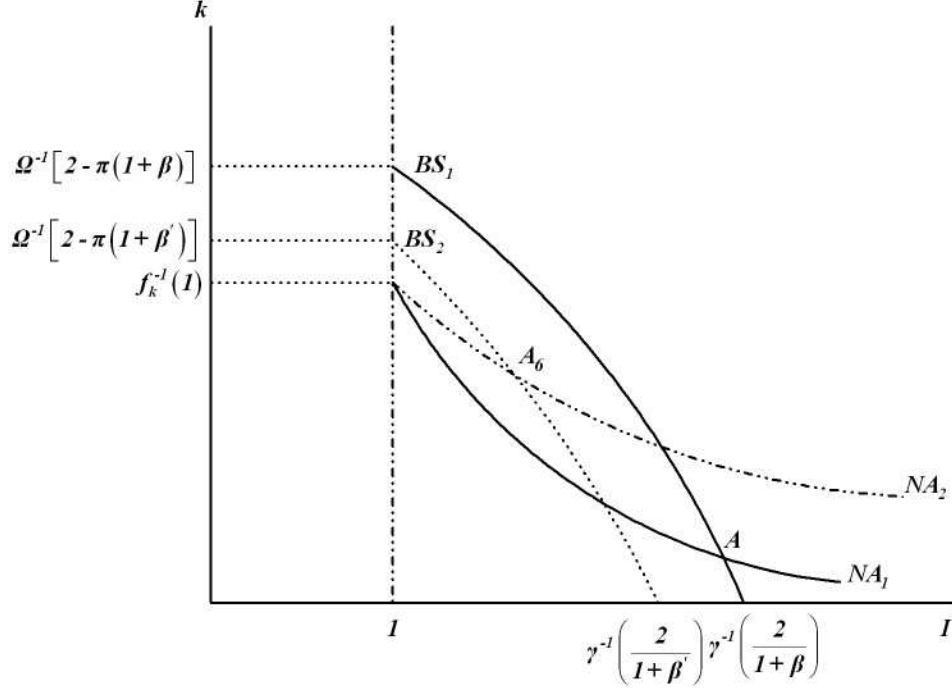


Figure 8: Effects of Contractionary Monetary Policy under a Unique Steady-State

We have discussed the effects of higher β as if the stock of money balances is fixed and the supply of bonds is higher. Alternatively, a higher value of β could also result from a fixed supply of bonds and a lower supply of money – therefore, we follow the literature in interpreting higher values of β as a contractionary monetary policy. As in Schreft and Smith (1998), monetary tightening leads to greater capital accumulation and a lower nominal interest rate. In turn the inflation rate adjusts so that the government’s budget constraint is satisfied:

$$\frac{P_{t+1}}{P_t} = \frac{I}{f_k(k, 2)} \quad (24)$$

The effect on inflation depends on the intensity of capital for production. As an example, assume that the production function is Cobb-Douglas: $f(k) = A2^{1-\alpha}k^\alpha$. If $\alpha < (1/2)$, monetary tightening is associated with lower inflation.

3 The Economy with a Stock Market

In this section, we demonstrate the impact of the stock market on economic development. Interestingly, the *quantitative* impact of financial development may be *indeterminate* – the economy may respond with significant gains in capital accumulation or relatively little. Consequently, it is not clear how much financial development will drive down inflation in the long-run.¹⁴ We also study the effects of monetary policy in the presence of a stock market. Notably, we establish that the response of the economy depends on the extent of financial market development.

In contrast to the benchmark model, the stock market allows for specialized capital to be transferred across time. In this sense, we follow Greenwood and Smith (1997) by arguing that the stock market represents a set of trading institutions. The provision of these trading services permits specialized factor inputs to be transferred to individuals with knowledge of the particular production techniques. In our framework, this leads to a setting in which the ownership of capital may be transferred across generations. From such perspective, our model illustrates the intergenerational liquidity role of the stock market. That is, it allows for the perpetuity of firms over time through large numbers of owners.

The provision of a market for capital only directly affects the utility maximization problem of entrepreneurs. Consequently, we only examine their choices. We begin by considering the budget constraint of a representative young entrepreneur in period t . In the absence of a market for capital, young entrepreneurs split their wage income between purchases of government debt and investment. However, in the presence of a stock market, they may also purchase available capital from the old entrepreneurs:¹⁵

$$w_t = b_t^e + i_t + (1 - \delta) k_t \quad (25)$$

In contrast to the economy without a stock market, old-age income includes the value of undepreciated capital, $(1 - \delta) k_{t+1}$:

$$c_{t+1}^e = f(k_{t+1}, l_{t+1}) - w_{t+1} l_{t+1} + R_t b_t^e + (1 - \delta) k_{t+1} \quad (26)$$

Therefore, the capital stock in period $t + 1$ is expressed by:

$$k_{t+1} = i_t + (1 - \delta) k_t \quad (27)$$

A typical entrepreneur maximizes her lifetime utility (28) subject to (25), (26), and (27) :

¹⁴Roubini and Sala-i-Martin (1995) construct a model examining the linkages between financial development and tax evasion. In their framework, they impose that financial development lowers the marginal utility from holding money. Since development lowers the inflation tax base, the government may choose to repress the financial sector. In contrast to their analysis, we explicitly incorporate the economic functions of different types of financial institutions. For example, in our framework, banks promote risk sharing in the economy. In addition, fiat money overcomes information frictions to facilitate transactions between individuals.

¹⁵The resale price of available capital is equal to one. This follows Magill and Quinzii (2003).

$$\underset{i_t, (1-\delta)k_t, l_{t+1}}{Max} \frac{c_{t+1}^{e, 1-\theta}}{1-\theta} \quad (28)$$

The young individual will invest in both capital and government bonds if they yield the same rate of return:

$$R_t = f_{k_{t+1}}(k_{t+1}, l_{t+1}) + 1 - \delta \quad (29)$$

From (29), it is clear that the stock market raises the return to capital. In the benchmark economy, the marginal value of capital only derives from the increase in output. In contrast, in the presence of a stock market, entrepreneurs receive additional consumption by selling their capital to young agents. The value of the transfer is equal to $(1 - \delta)$. Therefore, $(1 - \delta)$ may be interpreted as the after-tax resale value of capital in the economy. For example, δ may represent taxes involved in the transfer of ownership. These may be explicit taxes such as capital gains taxes. Alternatively, they may also reflect transactions costs involved in the transfer of capital. In this manner, δ also represents the extent of stock market development.

3.1 General Equilibrium

In equilibrium, the bond market clearing condition is the same as the benchmark economy:

$$\Omega(k_{t+1}) = \frac{k_{t+1}}{w_t} = 2 - (1 + \beta)\gamma(I_t) \quad (30)$$

In addition, the no-arbitrage condition, (22), along with the government's budget constraint (2), and the fixed debt to reserves policy, (3), yields the evolution of the reserves to deposits ratio:

$$\gamma(I_{t+1}) = \frac{(1 + \beta I_t)}{(1 + \beta)} \frac{(f_k(k_{t+1}, 2) + 1 - \delta)}{I_t} \gamma(I_t) \frac{w(k_t)}{w(k_{t+1})} \quad (31)$$

Conditions (30) and (31) characterize the economy's equilibrium conditions at each point in time.

3.1.1 Steady-State Analysis

Imposing steady-state on (30) and (31), the following two conditions characterize the long-run behavior of the economy:

$$\Omega(k) = \frac{k}{w} = 2 - (1 + \beta)\gamma(I) \quad (32)$$

and

$$f_k(k, 2) + 1 - \delta = \frac{(1 + \beta)I}{(1 + \beta I)} \quad (33)$$

As mentioned above, the bond market clearing condition, (32), is the same as the benchmark economy. Although the no-arbitrage curve is downward-sloping in both economies, the no-arbitrage curve in the stock market economy lies above the benchmark curve. For a given nominal interest rate, financial development raises the real return to capital. In order for entrepreneurs to be willing to hold both types of assets, the marginal product of capital has to decline. As a result, at a fixed nominal interest rate, the capital stock is higher in the economy with a stock market.

Furthermore, in the appendix, we show that the no-arbitrage curve is steeper in an economy with a market for capital. The intuition is as follows. At a given nominal interest rate, the real return to government bonds is the same in both economies (the benchmark and stock market). Thus, as mentioned above, the capital stock will be higher in the economy with a stock market. Next, suppose that the nominal interest rate falls from I_0 to I_1 . The reduction in the nominal rate also implies that the real return to government debt will be lower. As a result, the return to capital (relative to government debt) in both economies increases. Consequently, entrepreneurs will seek to acquire more capital. By diminishing returns, along with the Inada conditions, the capital stock must increase more in the stock market economy. To see this, refer to Figures 9A and 9B. As illustrated, the no-arbitrage curve in the economy with a stock market has a steeper slope.

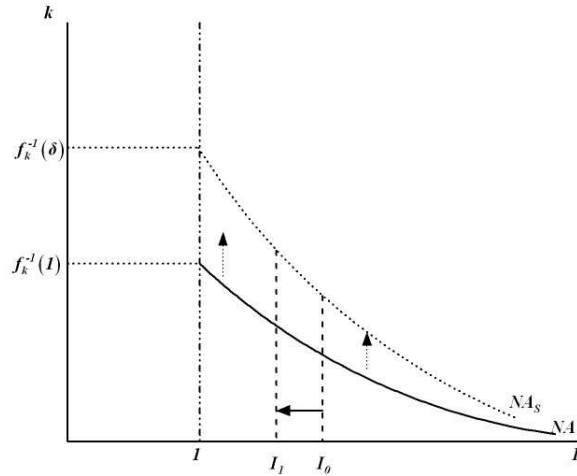


Figure 9A: The No-Arbitrage Curve in the Presence of a Market for Capital

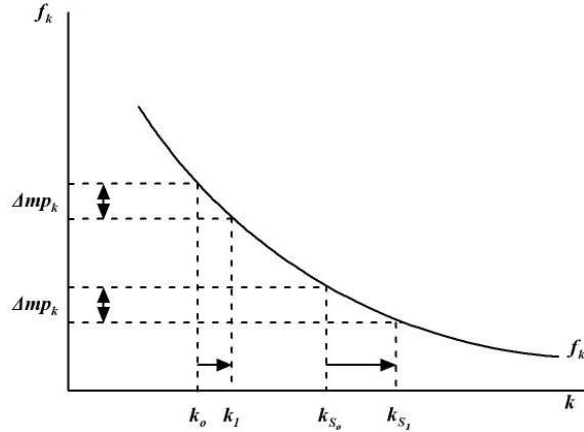


Figure 9B: The Marginal Product of Capital at Different Levels of Economic Development

The impact of the stock market through the no-arbitrage curve represents a limited ‘partial equilibrium’ perspective. At a fixed nominal interest rate, the return to physical capital is higher. Obviously, the higher return to capital should promote capital accumulation. However, at this point, our analysis has ignored the interactions across the various financial markets in the economy. Notably, the increased demand for capital will lower interest rates in the bond market. Consequently, the collective effect of the stock market may lead to significant gains in economic development.

The Long Run Effects of Financial Development on the Economy We proceed to discuss the effects of financial development on capital accumulation and nominal interest rates. We begin with the following observation:

Proposition 2. *Suppose that $\gamma^{-1} \left(\frac{2}{(1+\beta)} \right) > 1$ and $\Omega^{-1} (2 - (1 + \beta) \pi) > f_k^{-1} (1)$. Under these conditions, a steady-state in the benchmark economy exists and is unique. Furthermore, if $\delta \geq \bar{\delta}$, a steady-state in the economy with a market for capital is also unique. If $\delta < \bar{\delta}$, a unique steady-state will not exist.*

Notably, Proposition 2 implies that a unique steady-state is less likely to exist if capital may be transferred across generations. That is, the region of the parameter space where a unique steady-state exists is larger in the benchmark economy. Figure

10 illustrates the possibility:

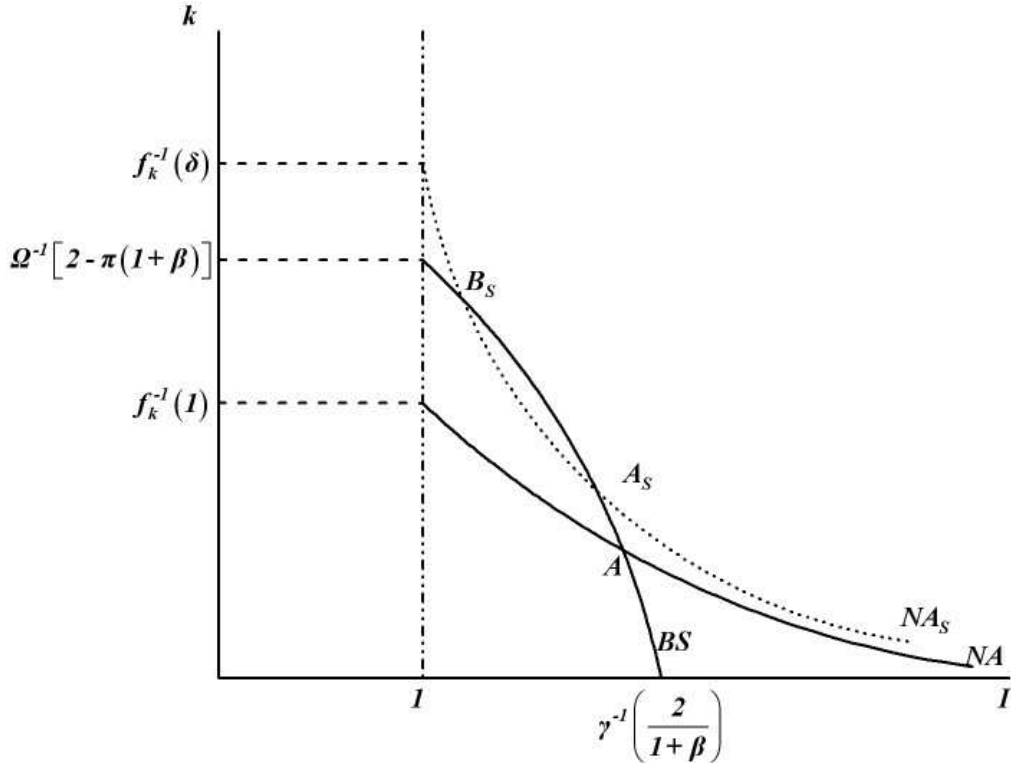


Figure 10: Financial Development May Lead to Multiple Steady-States

As observed from the Figure, the stock market (in the long-run) unambiguously leads to a higher level of economic development and lower nominal interest rates. However, if the depreciation rate is small enough, multiple steady-states may emerge.¹⁶ Consequently, the long-run impact of financial development is *indeterminate* – the economy may respond with significant gains in economic development *or* relatively little increase.¹⁷ Moreover, as we discuss below, the impact of *monetary policy* may also be *indeterminate* if capital can be transferred between generations.

In order to provide detailed interpretation, we focus most of our discussion on the case of a unique steady-state. The intuition under multiple steady-states follows

¹⁶Since δ may also be interpreted as the degree of taxation of stock market transactions, Proposition 2 suggests that the impact of the stock market will be lower if the tax rate is sufficiently high. However, if the government significantly promotes stock market activity, the economy may experience a substantial increase in capital accumulation.

¹⁷Minier (2003) empirically examines the links between stock market activity and economic growth. In particular, she finds that the effect of the stock market depends on the stage of development. In countries with a high degree of market capitalization, financial development is growth-enhancing. However, in countries with small stock markets, increased capitalization is associated with lower growth. In our model, we demonstrate that the gains from financial development may be indeterminate if the depreciation rate is not too high. In the event of multiple steady-states, the net impact of financial development depends on the size of the public sector – if the government has a large budget deficit, introducing a stock market will have a relatively small effect on the level of economic development.

from there. As discussed above, the no-arbitrage condition curve for the stock market economy lies above the benchmark curve. This is illustrated as a movement from A to A'_S in Figures 11A and 11B.

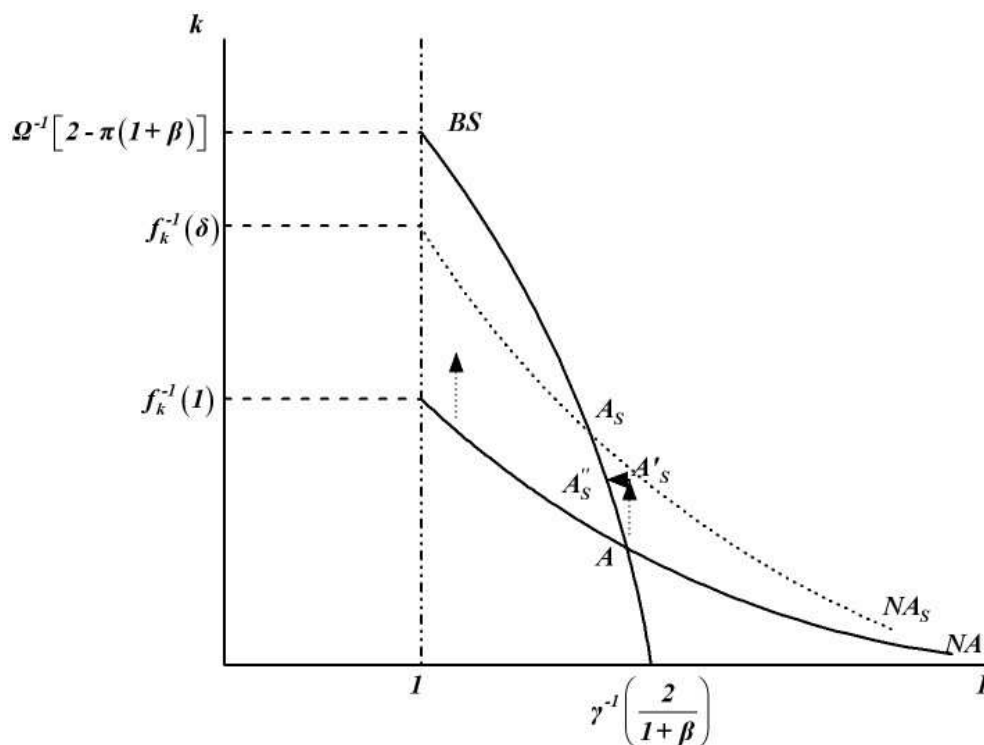


Figure 11A: The Effect of the Stock Market when the Steady-State is Unique

Notably, the movement from A to A'_S occurs because of the higher rate of return to capital in the presence of a stock market. Since capital may be transferred across generations, the return to capital will be higher. This implies that the capital stock must be higher in order for entrepreneurs to be indifferent between capital and government debt.

Furthermore, as shown in Figure 11B, at a fixed nominal interest rate, the higher level of capital will be associated with an excess supply of government debt.

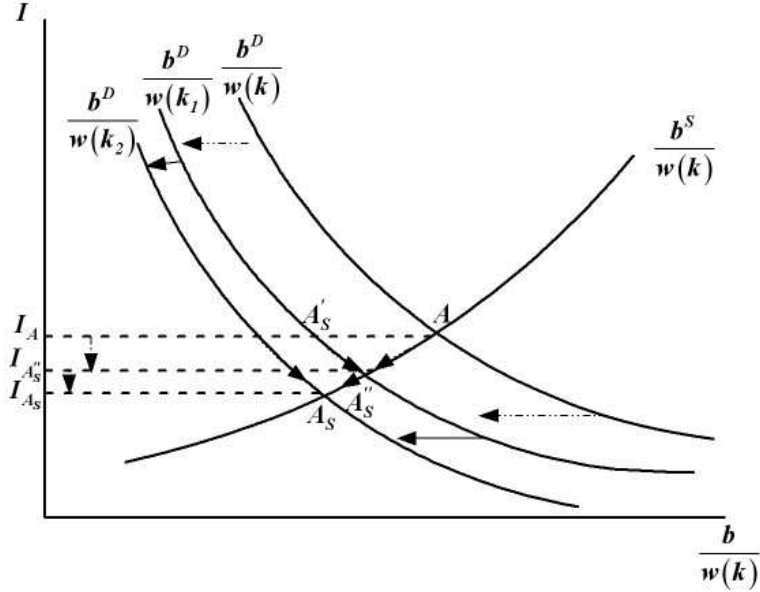


Figure 11B: The Effect of the Stock Market on the Bond Market

In order for the market for bonds to be in equilibrium, the nominal interest rate must fall so that banks will choose to acquire more debt. The decrease in the interest rate is depicted in the Figure by the movement from I_{A_S} to I_{A_S}'' . The lower interest rate contributes to a general equilibrium effect – since the nominal interest rate is lower, the real return to government debt is lower. As a result, the relative bond demand curve shifts back so that the interest rate falls further and capital accumulation is higher. In this manner, we show that financial development can be associated with lower nominal interest rates and higher capital accumulation.

The relationship between the nominal interest rate and inflation follows from the government's budget constraint:

$$\frac{P_{t+1}}{P_t} = \frac{1 + \beta I}{1 + \beta} \quad (34)$$

In the long run, inflation and nominal interest rates are positively correlated. Intuitively, when the government pays a lower interest rate on debt, the required inflation tax rate will fall. As a result, since nominal interest rates are lower in the presence of a stock market, there is also less inflation.

3.2 The Implications of Financial Development for Monetary Policy

In this section, we examine the interactions between financial development and monetary policy. We follow our previous approach in which the central bank pursues permanent open market operations by committing to a fixed debt-reserves ratio. In this manner, the inflation rate is endogenous and adjusts to satisfy the government's budget constraint. Next, we discuss the implications of an alternative method of

policy intervention. In particular, we look at the links between inflation targeting, financial development, and the amount of capital accumulation. While the preceding analysis demonstrates that financial development should lower nominal interest rates under open market operations, inflation targeting is likely to have a different impact.

3.2.1 Open Market Operations

Interestingly, we have shown that the *quantitative* impact of financial development on economic development may be indeterminate. Although the market for capital is unambiguously associated with higher capital accumulation, the effect crucially depends on the depreciation rate in the economy. In particular, if the depreciation rate is sufficiently small, two different steady-states may occur. Notably, this finding generates some significant implications for monetary policy. If the impact of financial development is determinate (unique steady-states occur in both types of economies), monetary policy will have a stronger impact on capital accumulation if a market for capital exists. However, if the impact of financial development is indeterminate, monetary policy may have a different *qualitative* impact.

We begin with the following Proposition:

Proposition 3. *Suppose that $\gamma^{-1} \left(\frac{2}{(1+\beta)} \right) > 1$ and $\Omega^{-1} (2 - (1 + \beta) \pi) > f_k^{-1} (1)$.*

Furthermore, let $1 > \delta \geq \bar{\delta}$. Under these conditions, the steady-states in both the benchmark and stock market economies are unique. However, monetary policy has a stronger impact on capital accumulation if a market for capital exists.

We showed in the previous section that financial development affects the economy in two ways. First, there is a direct effect on capital accumulation due to the higher rate of return. In particular, the real return to capital increases for a given nominal interest rate. Second, there is an additional general equilibrium effect through conditions in the bond market. Since entrepreneurs acquire more capital, they will hold less government debt. The lower amount of demand leads to lower nominal interest rates and additional gains in capital accumulation. In our discussion below, we focus on comparing the effects of monetary policy when a unique steady-state occurs.

The No-Arbitrage Effect

As a benchmark, it is useful to re-consider how monetary tightening (an increase in the debt-reserves ratio, β) affects the no-arbitrage curve in the absence of a stock market. For a fixed nominal interest rate, the government raises the inflation tax in order to finance interest payments on the higher level of government debt. This lowers the real rate of return to bonds. Consequently, entrepreneurs will acquire additional capital until the rates of return between the two types of assets are equal. This is reproduced in Figure 12A below as the movement from A to A' . However, due to diminishing returns, the no-arbitrage curve will tilt up more in the economy with a market for capital. In the Figure, the impact is represented as a movement from A_S to A'_S :

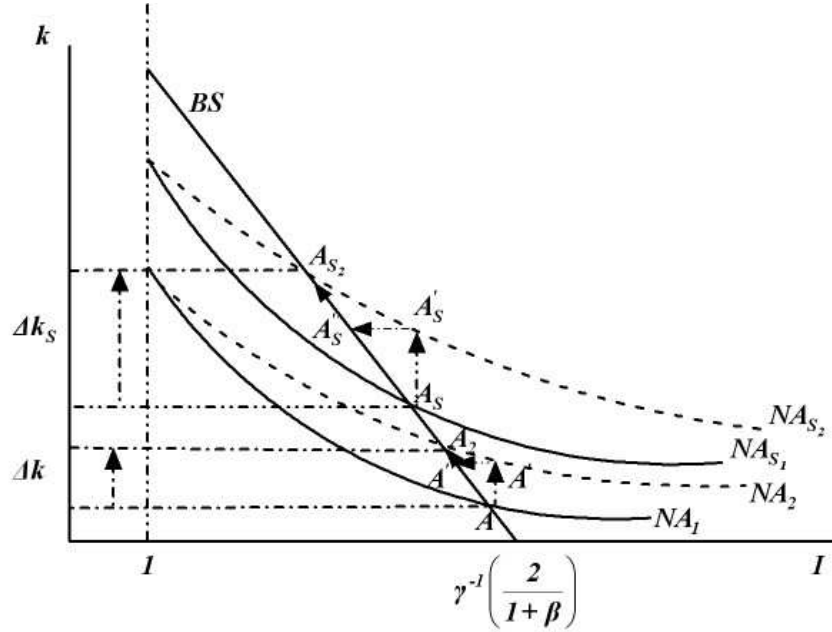


Figure 12A: The No-Arbitrage Effect and Financial Development

In particular, the vertical distance between the two points is greater than the distance between A and A' .

Due to the increase in capital accumulation (in either economy), the bond demand curve will shift back. However, the demand curve shifts more in the economy with the stock market. *Consequently, the nominal interest rate will fall more if a market for capital exists.* This is illustrated by the movement from A'_S to A''_S . In particular, the movement from A'_S to A''_S is stronger than the movement from A' to A'' . Moreover, the additional effect of the lower nominal interest rate causes the capital stock to further increase (from A''_S to A_{S2}) – thus, the gains in capital accumulation are greater if a market for capital exists. Taken together, *the no-arbitrage effect implies that the capital stock is more responsive to monetary policy if capital can be transferred across generations.*

The Bond Supply Effect

We proceed to investigate the effects of monetary policy resulting from a higher supply of government bonds. Notably, the bond supply curve has the same position regardless of the extent of financial sector development. However, the curve will shift out when there is an increase in the relative supply of debt to currency reserves. For a fixed stock of capital, the increase in bond supply leads to excess supply of government debt. Consequently, the nominal interest rate must fall. This may be observed in Figure 12B.

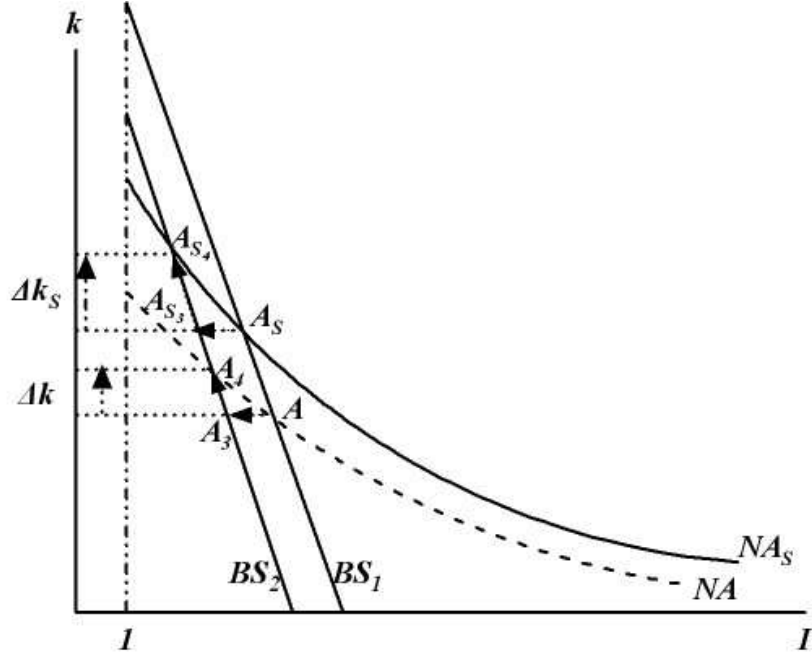


Figure 12B: The Bond Supply Effect and Financial Development

Notably, the shift is parallel – that is, the nominal interest rate will fall by the same amount as in the benchmark model. This is illustrated in the Figure as the movement from A to A_3 and A_S to A_{S_3} . Again, this reflects that the nominal interest rate must fall by the same amount in either economy.

Nevertheless, the capital stock in the economy with a stock market is higher than in the benchmark steady-state. And, the reduction in the real return to government debt causes the no-arbitrage condition in each economy to be violated. Consequently, to achieve the same real reduction in earnings from capital, the capital stock must increase significantly more if a market for capital exists. This is represented in the Figure by the movement from A_{S_3} to A_{S_4} compared to the vertical distance from A_3 to A_4 . *As in the case of the no-arbitrage effect, the increase in capital accumulation is stronger in the presence of a stock market.*

In summary, the bond supply and no-arbitrage channels of monetary policy are stronger in a more developed financial system. This clearly implies that the effects of monetary policy depend on the level of financial development. In addition, we present the following:

Proposition 4. *Suppose that $\gamma^{-1} \left(\frac{2}{(1+\beta)} \right) > 1$ and $\Omega^{-1} (2 - (1 + \beta) \pi) > f_k^{-1} (1)$.*

Furthermore, let $\delta < \bar{\delta}$. If a steady-state in the stock market economy exists, then multiple steady-states occur. In the steady-state with a relatively low capital stock, contractionary monetary policy will be associated with a larger increase in capital accumulation than the benchmark economy. Moreover, in the steady-state with a relatively high capital stock, contractionary monetary policy will be associated with less capital accumulation.

Proposition 4 establishes an important observation. If financial development is associated with modest gains in the level of economic development, the qualitative impact of monetary policy will be the same as the benchmark economy – if the degree of liquidity is restricted, the capital stock will fall.

In contrast, the effects will be considerably different if financial development is associated with a significant improvement in economic development. For example, suppose that multiple steady-states occur in the presence of a market for capital. In the high capital steady-state, nominal interest rates will be relatively low. Consequently, if the central bank pursues tighter monetary policy by increasing the relative supply of government debt, nominal interest rates will increase. As a result, the real return to bonds will be higher and entrepreneurs will acquire less capital. In this manner, *financial development* may also generate a *different* qualitative response to changes in monetary policy.

3.2.2 Inflation Targeting

In this exercise, we assume that the monetary authority targets an inflation rate, $Z = \frac{P_{t+1}}{P_t} > 1$. Under this policy, the government adjusts the debt to reserves ratio, β , so that the government's budget constraint is satisfied at the inflation tax rate, Z . In the steady-state, we have:

$$\beta = \frac{Z - 1}{I - Z} \quad (35)$$

Suppose that $I > Z > 1$. In this case, β is a decreasing function in I . If the nominal interest rate increases, the government's payment obligations will be higher. However, the inflation tax rate is fixed at rate Z . This prevents the government from generating the additional seigniorage revenue that is required to satisfy its budget constraint. Consequently, the government must lower its obligations by issuing less debt.

We are particularly interested in examining the impact of inflation targeting under different levels of financial development. The bond supply condition is the same in either the benchmark or stock market economies:

$$\Omega(k) = \frac{k}{w(k)} = 2 - \left(\frac{I - 1}{I - Z} \right) \gamma(I) \quad (36)$$

If a market for capital exists, the no-arbitrage condition is:

$$f_k(k, 2) + 1 - \delta = \frac{I}{Z} \quad (37)$$

Obviously, if $\delta = 1$, (37) corresponds to the no-arbitrage condition for the benchmark economy.

To begin, we discuss the impact of financial development in the case of unique steady-states. In order to gain insight into the impact of the stock market, please refer to Figure 13. Since the market for capital raises its return, the no-arbitrage curve in the stock market economy lies above the benchmark curve:

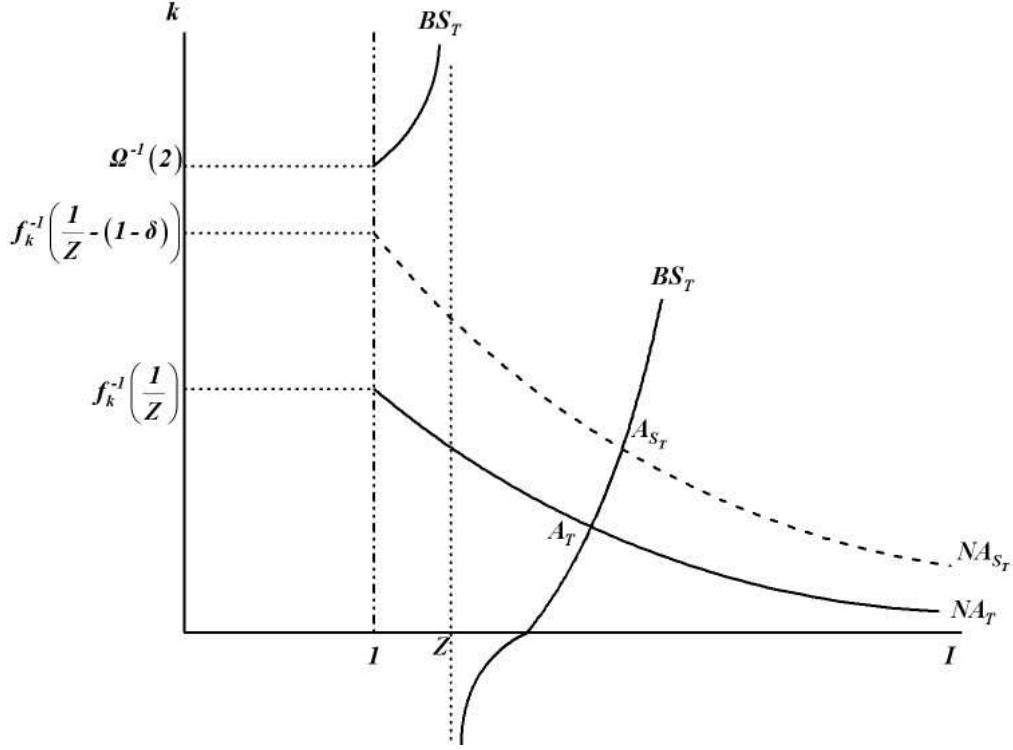


Figure 13: The Impact of the Stock Market under Inflation Targeting

In the Figure, both types of steady-states are unique and $I > Z$. For a fixed inflation tax rate, the nominal interest rate will be higher if a market for capital exists. This occurs because the rate of return to capital is higher if capital can be transferred across generations. Since the inflation tax rate is the same in both types of economies, the real return to government debt will be higher if a stock market exists.

Consequently, in an economy with a market for capital, the debt to reserves ratio must be lower. This implies that economies with better developed financial systems will be associated with less government debt.¹⁸ Therefore, if the impact of financial development is determinate, we arrive to the following conclusion: *The effects of financial development on long-term interest rates depend on the method of policy intervention. If the central bank targets a degree of liquidity (through permanent open market operations), financial development will lead to lower nominal interest rates. In contrast, if the central bank targets the inflation rate, we observe higher nominal interest rates.*

However, if the inflation target is sufficiently high, the impact of financial development will be indeterminate:

Lemma 1. *Suppose that $f(k) = A2^{1-\alpha}k^\alpha$. In either the benchmark or the stock market economies, multiple steady-states may exist if the inflation target is sufficiently*

¹⁸In contrast, Roubini and Sala-i-Martin (1995) show that financial development will lead to a net increase in payment obligations of the government.

high. However, the required lower bound for the target is higher in the benchmark economy. In the benchmark economy, multiple steady-states occur if $z > \frac{1-\alpha}{\alpha}$. In contrast, in the economy with a stock market, if $z > \frac{(1-\alpha)}{\alpha+(1-\alpha)(1-\delta)}$, multiple steady-states occur.

Financial Market Development and the Effects of Monetary Policy under Inflation Targeting

We next discuss the interactions between monetary policy and financial development if central banks use inflation targeting as the method of policy intervention. We assume that the inflation targets adopted by central banks are relatively low. Based upon the results in Lemma 1, this implies that both types of steady-states (corresponding to the benchmark and stock market economies) will be unique. Therefore, in examining the impact of monetary policy, it will be useful to refer to Figure 13.

If the central bank adopts a less restrictive target (higher value of Z), the no-arbitrage curve will shift up. Under a fixed nominal interest rate, the real return to government debt will be lower. Consequently, entrepreneurs will acquire more capital. From this ‘partial equilibrium’ perspective, higher inflation targets induce a Tobin effect.

However, the bond supply effect encourages less capital accumulation. If the government adopts a higher inflation target, the nominal interest rate will rise and there will be more demand for money in the economy. In order for the bond market to clear, entrepreneurs must adjust their portfolios and hold more government debt. As a result, the bond supply curve shifts down which tends to lower capital accumulation. While both effects clearly indicate that higher inflation targets will lead to higher nominal interest rates, the effects on capital accumulation are ambiguous. However, we can draw some insights using numerical results. For example,

Example 1. Consider the following set of parameters: $A = .55$, $\alpha = .22$, $\pi = .5$, $\theta = 3$. If a market for capital exists, let the depreciation rate be equal to .95. If the inflation target is set at 1%, $k = .1325$. In the stock market economy, $k_S = .1414$. If the targeted rate is 16% (an increase by 15 percentage points), $k = .1210$ and $k_S = .1283$. Consequently, the effects of inflation are stronger in the stock market economy. The capital stock falls by 9.3% if capital may be transferred across generations. In the benchmark model, the capital stock is only 8.7% lower. Moreover, the difference is more significant at lower rates of depreciation.

Relationship to Empirical Literature on Inflation and Growth

In recent years, macroeconomists have made significant advances in determining the impact of inflation on economic growth. While a number of papers initially identified that inflation was associated with lower growth, additional research concludes the relationship is non-linear. The evidence points in two different directions. First, there may be threshold effects from inflation to growth. That is, beyond a particular amount of inflation, inflation causes growth to fall. Below the threshold rate, inflation has either no effect or it is growth-enhancing. This was initially pointed out by

Fisher (1993). In later work, Khan and Senhadji (2001) use conditional least squares estimation to statistically identify the inflation threshold. Notably, their analysis generates some significant findings. In particular, they estimate that the threshold differs significantly between developed and developing countries. While the threshold appears to be around 1% in industrialized countries, the number stands near 11% for developing economies.

From this perspective, the effects of inflation on growth are much stronger in countries at higher stages of economic development. Interestingly, our framework provides a useful interpretation of such results. As pointed out by King and Levine (1993) and Levine and Zervos (1998), financial development contributes to economic development. In our model, the stock market is associated with higher capital accumulation than the benchmark economy. Due to the higher amount of capital accumulation, expansionary monetary policy generally causes capital to fall more in the presence of a stock market. This illustrates that the adverse impact on growth may not appear to be statistically significant in developing countries until sufficiently high rates of inflation.¹⁹

In addition to threshold effects from inflation, Fisher (1993) and Ghosh and Phillips (1998) provide evidence suggesting that the inflation-growth relationship may be convex. That is, although inflation has an adverse impact on growth, the consequences are much stronger at lower rates of inflation. In particular, Ghosh and Phillips estimate the degree of convexity using non-linear least squares. Their analysis arrives to the following conclusion. While an increase in inflation from 10% to 20% would be associated with a decrease of per capita GDP growth by approximately .35 percentage points, an increase from 10% to 40% only causes growth to fall by 0.8 percentage points. Table 1 illustrates the linkages economic development, financial development and inflation in our framework. We use the same set of parameters from Example 1:

¹⁹Haslag (1998) constructs a representative agent, infinite horizon model of monetary policy and endogenous growth to examine the growth effects of inflation. In his calibration exercise, he is able to fit parameters of the model to match the quantitative impact of inflation on growth observed in previous studies. However, he assumes that all investment must be obtained through bank deposits. Fiat money is valued because banks must satisfy reserve requirements. In contrast, our approach explicitly incorporates the roles of financial assets such as bank deposits and fiat money to overcome information frictions in the economy. Nevertheless, we do not provide an explanation for perpetual growth.

Inflation Rate	Stock	Benchmark
1.02	-0.102241	-0.088294
1.03	-0.099831	-0.086363
1.04	-0.097482	-0.084496
1.05	-0.095216	-0.082614
1.06	-0.092981	-0.080885
1.07	-0.091043	-0.079171
1.08	-0.089021	-0.077606
1.09	-0.086916	-0.075990
1.1	-0.084987	-0.074427
1.11	-0.083430	-0.072824
1.12	-0.081415	-0.071479
1.13	-0.079801	-0.070181
1.14	-0.078372	-0.068636
1.15	-0.076563	-0.067504
1.16	-0.074943	-0.065991
1.17	-0.073607	-0.064918

Table 1: Inflation and Economic Development

The first column lists the value of the inflation target adopted by the central bank (which is taken to be exogenous). The second and third columns represent the change in capital accumulation corresponding to an increase of inflation by 1%. In this manner, the Table provides estimates of slopes in the inflation-capital relationship in our model. The results provides two different observations. First, the relationship between inflation and capital accumulation is convex in both types of economies. That is, the adverse impact of inflation on the capital stock is stronger at lower inflation rates. As the inflation rate increases, the slope falls. Second, inflation has a bigger impact in the stock market economy. Again, this demonstrates that monetary policy has a stronger effect in economies at higher stages of *financial* development.

4 Dynamical Equilibria

In the previous section, we demonstrated that multiple steady-states may exist if an economy establishes a market for capital across generations. In this manner, financial development can create uncertainty in the economy since there is the possibility for indeterminacy of monetary equilibria. Moreover, we now seek to establish that financial development can generate indeterminacy of dynamical equilibria. Furthermore, the stock market may also lead to endogenous volatility. Interestingly, this provides additional scope for monetary policy to stabilize the economy. Although financial development contributes to market instability, the central bank can reduce the degree of volatility by taking a sufficiently aggressive policy stance.

In order to make our analysis tractable, we continue to assume that $y_t = Ak_t^\alpha 2^{1-\alpha}$. We begin by describing the dynamical properties of the steady-state equilibria in the

benchmark economy. Since the benchmark setting is very close to the Schreft-Smith (1998) framework, we simply express the dynamical system for the economy in which capital may be traded. From the previous section, the evolution equations for cash reserves and capital are expressed by:

$$k_{t+1} = [2 - (1 + \beta) \gamma(I_t)] w(k_t) \quad (38)$$

$$\gamma(I_{t+1}) = \frac{(1 + \beta I_t) \gamma(I_t)}{(1 + \beta) I_t} \frac{w(k_t)}{w(k_{t+1})} [f'(k_{t+1}) + 1 - \delta] \quad (39)$$

Obviously, the benchmark economy is a special case of the above system. That is, if capital cannot be traded across generations, it is as if the depreciation rate is equal to one-hundred percent.

The stability properties of the steady state depend on the eigenvalues of the Jacobian matrix:

$$J(k, I) = \begin{vmatrix} \frac{\partial k_{t+1}}{\partial k_t} & \frac{\partial k_{t+1}}{\partial I_t} \\ \frac{\partial I_{t+1}}{\partial k_t} & \frac{\partial I_{t+1}}{\partial I_t} \end{vmatrix}_{ss}$$

We denote the determinant and trace of J by D and T respectively. The discriminant, Δ , is $\Delta = T^2 - 4D$. The elements of the Jacobian are given by:

$$\frac{\partial k_{t+1}}{\partial k_t} \Big|_{ss} = [2 - (1 + \beta) \gamma(I)] w'(k) \quad (40)$$

$$\frac{\partial k_{t+1}}{\partial I_t} \Big|_{ss} = -(1 + \beta) \gamma'(I) w(k) \quad (41)$$

$$\frac{\partial I_{t+1}}{\partial k_t} \Big|_{ss} = \left\{ \frac{(1 + \beta I) \gamma(I)}{(1 + \beta) I \gamma'(I) w(k)} \right\} \left[\begin{array}{c} [w(k) f''(k) - w'(k) [f'(k) + 1 - \delta]] \frac{\partial k_{t+1}}{\partial k_t} \Big|_{ss} + \\ w'(k) [f'(k) + 1 - \delta] \end{array} \right] \quad (42)$$

$$\frac{\partial I_{t+1}}{\partial I_t} \Big|_{ss} = \left\{ \frac{1}{(1 + \beta) I \gamma'(I)} \right\} (f'(k) + 1 - \delta) \left(\frac{(1 + \beta I) I \gamma'(I) - \gamma(I)}{I} \right) + \quad (43)$$

$$\left\{ \frac{1}{(1 + \beta) I \gamma'(I)} \right\} (1 + \beta I) \gamma(I) \left[\frac{f''(k) w(k) - [f'(k) + 1 - \delta] w'(k)}{w(k)} \right] \frac{\partial k_{t+1}}{\partial I_t} \Big|_{ss}$$

Furthermore, the eigenvalues of J may be obtained by solving the following equation:

$$p(\lambda) = |J - \lambda I| = \begin{vmatrix} \frac{\partial k_{t+1}}{\partial k_t} \Big|_{ss} - \lambda & \frac{\partial k_{t+1}}{\partial I_t} \Big|_{ss} \\ \frac{\partial I_{t+1}}{\partial k_t} \Big|_{ss} & \frac{\partial I_{t+1}}{\partial I_t} \Big|_{ss} - \lambda \end{vmatrix}_{ss} \quad (44)$$

We are particularly interested in illustrating how financial development can affect the scope for dynamical equilibria. Recall that Proposition 2 provides conditions in which the number of monetary steady-states can be indeterminate. Interestingly,

Table 2 below provides an example of both types of indeterminacies – for some values of the depreciation rate, multiple steady-states occur in the stock market economy. However, as may be observed, the steady-state in the benchmark economy is unique.

	Unique	Low k	High k	Low k	High k
A	0.55				
δ	1	0.95	0.95	0.9	0.9
α	0.335				
β	1				
π	0.48				
θ	2				
k	0.0673	0.072074	0.160626	0.078198	0.148573
l	7.2806	6.392435	1.073946	5.4639	1.320618
P_{t+1}/P_t	4.1403	3.696218	1.0370	3.23195	1.160309
Δ	5.348078	4.150649	0.046432	2.988115	-0.07046
λ_1	2.647591	2.37967	0.294765	2.079909	Complex
λ_2	0.335	0.34235	0.079284	0.351292	Complex

Table 2: Indeterminacy of Equilibria

If the depreciation rate is equal to 0.95, multiple steady-states occur. The steady-state with a low level of development and a high nominal interest rate is saddle-path stable while the other steady-state is a sink. In this manner, the gains from financial development are unclear. That is, suppose that capital cannot be transferred across generations. In particular, the benchmark economy is at its steady-state. Next, consider the effects of establishing a stock market. Both steady-states are approachable – as a result, neither the short-run or long-run gains from financial development can be determined.

Furthermore, if the depreciation rate is sufficiently low, the market may also generate excessive fluctuations. In this manner, financial development would lead to oscillatory behavior since the eigenvalues corresponding to the high capital steady-state become complex conjugates. However, since the determinant of the Jacobian is less than one, paths approaching the high capital steady-state will display damped oscillatory behavior.

Due to the potential for endogenous volatility in the economy, our results illustrate that there is additional scope for monetary policy to promote stabilization at higher

levels of financial development. In Table 3 below, we obtain:

<i>Low-Interest Equilibrium</i>						
\mathbf{A}	1					
δ	0.9					
α	0.335					
β	0.926	0.99	0.995	1	1.005	1.01
π	0.5					
θ	2					
\mathbf{k}	0.3676	0.318437	0.31318	0.307439	0.301061	0.293694
\mathbf{l}	1.2933	1.615843	1.662283	1.716568	1.781684	1.863972
$\mathbf{P}_{t+1}/\mathbf{P}_t$	1.1411	1.306374	1.330312	1.358284	1.391816	1.434135
Δ	0.0013	-0.0791	-0.06785	-0.05016	-0.02348	0.01736
λ_1	0.2145	complex	complex	complex	complex	0.568278
λ_2	0.1635	complex	complex	complex	complex	0.43651

Table 3: Monetary Policy and Stability

Notably, if the stance of monetary policy is sufficiently aggressive, the oscillations around the high-capital steady-state do not occur. Thus, at higher levels of economic and financial market development, monetary policy will be required to play a stronger role in stabilizing the economy.

5 Conclusions

Recent empirical work finds that financial market activity can play an important role in helping countries reach higher stages of economic development. In particular, Levine and Zervos (1998) observe that higher levels of stock market liquidity can generate faster growth. Moreover, there is ample evidence that inflation interferes with the growth process. Notably, there may be threshold effects from inflation to growth. As the inflation rate increases above 1% - 3% in developed countries, inflation impedes growth. However, the threshold is much higher in developing countries – around 11%. This suggests that the impact of monetary policy across countries is likely to depend on the stage of financial market development. In an effort to address these important issues, we construct a dynamic general equilibrium model which incorporates explicit economic functions of different types of financial institutions. As a benchmark, we assume that the economy is at a primitive stage of financial development in which banks are the only types of financial institutions available. Although banks provide risk pooling services, money overcomes difficulties with incomplete information to facilitate transactions between individuals. In this limited setting, we examine the effects of monetary policy on long-run capital accumulation and inflation.

In contrast to previous work, we proceed by introducing a market for equity which allows individuals to trade capital across generations. In this manner, we follow the work of Bencivenga, Smith, and Starr (1995) and Greenwood and Smith (1997) that represents the stock market as a set of trading institutions. Interestingly, we find the

quantitative impact of this type of financial development may be indeterminate – the economy may respond with substantial gains in capital accumulation or relatively little. As a result, it is not clear how *much* financial development will drive down inflation in the long-run. However, in the case of unique steady-states (corresponding to the benchmark and stock market economies), monetary policy has a stronger impact on capital accumulation in the presence of a stock market. If the stock market generates multiple steady-states, financial development will also lead to a different *qualitative* response to changes in monetary policy. Finally, by studying dynamics, we demonstrate that financial markets and monetary policy can have a significant impact on volatility in the economy. Therefore, monetary policy is more important for financial stabilization at higher levels of financial and economic development.

6 Appendix

1. Proof of Proposition 1. A steady-state in which $I > 1$ exists when the bond market clearing, (21) and no-arbitrage, (22) loci intersect to the right of the $I = 1$ line. The first condition for existence guarantees that the balance sheet curve intersects the I axis to the right of the $I = 1$ line. Furthermore, it is simple to show that the no-arbitrage locus is convex, whereas the bond market clearing graph is concave. Two cases arise. First, when $\Omega^{-1}(2 - (1 + \beta)\pi) > f_k^{-1}(1)$, the intersection of the bond market clearing locus with the $I = 1$ line occurs above the intersection of the no-arbitrage curve with the $I = 1$ line. Thus, there exists only one steady-state with positive nominal interest rates. Conversely, when $\Omega^{-1}(2 - (1 + \beta)\pi) < f_k^{-1}(1)$, the intersection of the bond market clearing locus with the $I = 1$ line occurs below the intersection of the no-arbitrage curve with the $I = 1$ line. In this case, the two curves might not intersect and a steady-state might not exist. On the other hand, if a steady state with a high capital stock and positive interest rate exists, then there must exist at least one additional steady state with a lower capital stock and higher interest rate. This completes the proof of Proposition 1.

2. Proof of Proposition 2. In the text, we showed that the market for capital shifts the no-arbitrage locus upward. In particular, the curve shifts out more when the depreciation rate is lower. When a unique steady state in the benchmark economy exists, two cases arise in the stock market economy. There exists a $\delta, \bar{\delta}$, such that $\Omega^{-1}(2 - (1 + \beta)\pi) \geq f_k^{-1}\left(\bar{\delta}\right) > f_k^{-1}(1)$, where a unique steady state also exists in the stock market economy. Conversely, when $\delta < \bar{\delta}$, the no-arbitrage curve will intersect the $I = 1$ line from above the intersection of the bond market clearing locus with the $I = 1$ line. As a result, multiple steady states arise with financial development. This completes the proof of Proposition 2.

3. The Effect of the Stock Market on the No-Arbitrage Curve. For tractability, we prove this result for a Cobb-Douglas production function of the form, $y = k^\alpha 2^{1-\alpha}$. It is easy to show that this result also holds for more general production functions. Under a functional form, the no-arbitrage relationship in the stock market economy becomes:

$$k^{1-\alpha} = \frac{(1 + \beta I)}{(1 + \delta\beta)I - (1 - \delta)} \alpha 2^{1-\alpha} \quad (45)$$

It is clear that for a given I , k is decreasing in δ . Consequently, the no-arbitrage curve shifts out the slower capital depreciates. Next we need to show that capital is more responsive to the nominal interest rate in a more developed financial system. Differentiating (45) with respect to I :

$$\frac{\partial k}{\partial I} = -\frac{\alpha 2^{1-\alpha} k^\alpha}{(1 - \alpha)} \frac{(1 + \beta)}{[(1 + \delta\beta)I - (1 - \delta)]^2}$$

Substitute for the expression of k from the no-arbitrage condition:

$$\frac{\partial k}{\partial I} = -\frac{\alpha^{\frac{1}{1-\alpha}} 2}{(1-\alpha)} \frac{(1+\beta)}{[(1+\delta\beta)I - (1-\delta)]^{\frac{2-\alpha}{1-\alpha}}} \{(1+\beta I)\}^{\frac{\alpha}{1-\alpha}}$$

For a given nominal interest rate, it is simple to show that:

$$\left| \frac{\partial k}{\partial I} \right|^{NA} < \left| \frac{\partial k}{\partial I} \right|_S^{NA}$$

This completes the proof that the no-arbitrage curve is steeper in the stock market model.

4. Proof of Proposition 3. By the discussion in the text, the no-arbitrage curve rotates out as the debt-reserves ratio increases. In particular, for a given nominal interest rate, the capital stock increases. It is sufficient to show that the effect on the capital stock is stronger in the stock market economy. As in the previous proof, we demonstrate this proposition for a Cobb-Douglas production function but the result can be generalized for more general production functions. Differentiating (45) with respect to β :

$$\frac{\partial k}{\partial \beta_S} = \frac{\alpha 2^{1-\alpha}}{(1-\alpha)} \frac{I^2 - I}{[(1+\delta\beta)I - (1-\delta)]^2} k^\alpha$$

Substitute for the expression of k from the no-arbitrage:

$$\frac{\partial k}{\partial \beta_S} = \frac{\alpha^{\frac{1}{1-\alpha}} 2}{(1-\alpha)} \frac{I(I-1)}{[(1+\delta\beta)I - (1-\delta)]^{\frac{2-\alpha}{1-\alpha}}} [(1+\beta I)]^{\frac{\alpha}{1-\alpha}}$$

In the benchmark economy:

$$\frac{\partial k}{\partial \beta} = \frac{\alpha^{\frac{1}{1-\alpha}} 2}{(1-\alpha)} \frac{I(I-1)}{[(1+\beta)I]^{\frac{2-\alpha}{1-\alpha}}} [(1+\beta I)]^{\frac{\alpha}{1-\alpha}}$$

Obviously:

$$\left| \frac{\partial k}{\partial \beta_{nostock}} \right|^{NA} < \left| \frac{\partial k}{\partial \beta_{stock}} \right|^{NA}$$

The rest of the proof is in the text. This completes the proof of Proposition 3.

5. Proof of Proposition 4. The result in Proposition 3 holds for all I and regardless of the number of steady states.

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