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Abstract

Do the distributional consequences of monetary policy depend on the extent of financial development? Should optimal monetary policy vary across countries? In order to answer these questions, we develop a monetary growth production model with heterogeneous agents. In our economy, optimal policy needs to weigh the effects of policy across two groups – capital owners and individuals who hold liquid assets. While banks help limit the exposure to inflation, there are limits because money alleviates the frictions of private information and limited communication. In this environment, we compare two economies that are identical in every aspect except for their level of financial development. In a country with limited financial development, a stock market is absent. In the other, an equity market is active.

In either economy, inflation adversely affects capital formation and output. Individuals who hold liquid assets are always adversely affected by inflation, but the attitude of capital owners depends on the level of financial development. In particular, in the presence of a stock market, the impact of inflation on the welfare of capital owners is non-monotonic. Nevertheless, optimal monetary policy is always more conservative at higher levels of financial development.

JEL Classification: E44, E52, E31, O16

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1 Introduction

Inflation varies significantly across countries. The distribution of income also varies across countries. In particular, average inflation rates tend to be higher in less developed countries compared to those in advanced countries. For example, data from the International Monetary Fund indicates that the average annual inflation rate in industrialized countries between 1969 and 2008 was 5.1% compared to 24.1% in developing countries.¹ In terms of income inequality, Greenwood and Jovanovic (1990) stress that financial development is likely to generate further income inequality. Monetary policy also plays a role – Romer and Romer (1998) contend that income inequality is exacerbated at high inflation rates. Moreover, previous studies attribute high inflation rates in less developed countries to repressive measures by policymakers. For instance, Roubini and Sala-i-Martin (1995) demonstrate that seigniorage taxation can be welfare improving when tax evasion is high.²

Do the distributional consequences of monetary policy depend on the extent of financial development? Should optimal monetary policy vary across countries? In this manuscript, we study the effects of monetary policy in economies with heterogeneous agents – capital owners and individuals who hold liquid assets. In particular, we seek to provide an explanation for variations in the stance of monetary policy across countries based on the extent of financial development. In fact, we demonstrate that inflation should be higher in economies where the financial sector is less developed. Notably, under-development is a primary characteristic of the financial sector in low income countries.³

We proceed by outlining the details of our modeling framework. We consider a two-period overlapping generations production economy inhabited by two types of agents: depositors and entrepreneurs. Following Townsend (1987), depositors are born on one of two geographically separated, yet symmetric locations. After portfolios are made, a group of depositors is randomly chosen to relocate to the other location. In the event of relocation, private information and limited communication require that individuals trade using money. Financial intermediaries are able to insure depositors against random relocation shocks. By comparison to depositors, entrepreneurs have the ability to invest in capital goods when young. Finally, there is a government that adjusts the bonds to money ratio in order to achieve an exogenous inflation target.

In order to study the interaction between monetary policy and the stages of financial development, we compare two economies that are identical in every aspect except for their level of financial development. In one economy (benchmark case), the financial sector is less developed as a stock market permitting specialized capital goods to be traded over time is not operative. In the other economy, an equity market is active.

As a benchmark, we assume that financial market frictions prevent entrepreneurs from trading capital goods in secondary markets. Given that capital investment is completely irreversible, it is also completely sunk. Under a technical condition, a stationary equilibrium exists and is unique. Higher inflation rates fuel inflation-financed government debt to the benefit of entrepreneurs – the crowding-out effect generates higher returns to capital. However, higher inflation rates hurt depositors who are exposed to liquidity risk. In this manner, inflation is a major source of income inequality in the under-developed economy. Notably, the ability of the government to collect seigniorage revenues declines

¹While many countries succeeded to tame inflation by pursuing an inflation targeting regime and solving fiscal problems, significant differences remain. For instance, in 2011 average inflation in advanced countries was 2.7% compared to 7% in developing countries.

²Bencivenga and Smith (1992) reach a similar conclusion.

³There is a large body of evidence that highlights the role of financial sector development for economic growth and development. Among previous studies we cite, King and Levine (1993), Levine and Zervos (1998), Levine (1997) and Levine, Loayza, and Beck (2000), Demirguc-Kunt and Levine (1996) and Rousseau and Wachtel (2000), and Shen and Lee (2006).

with the rate of money creation since money demand in the economy responds to the inflation rate. Optimal monetary policy balances the gains to capital owners versus those exposed to liquidity risk.⁴ If entrepreneurs have a slightly higher weight than the welfare of depositors, the Friedman Rule is not optimal.⁵

We proceed to study the behavior of an economy where entrepreneurs are capable of trading specialized capital goods in secondary markets. Since the stock market provides an opportunity for old entrepreneurs to sell their capital to the younger generation, equity markets raise the return to capital investment, which in turn stimulates capital formation. Driven by higher wages, the welfare of entrepreneurs and depositors is higher at higher stages of financial development. In this manner, the stock market leads to a Pareto superior allocation of resources. However, as the income of capital owners increases more than others, financial development as described by Greenwood and Jovanovic (1990) generates further income inequality. Moreover, because inflation distorts capital accumulation, inflation limits the gains from financial development. In particular, the marginal effects of inflation on the level of activity are much more pronounced in the stock market economy.

Furthermore, in contrast to the benchmark economy, the attitude of capital owners towards inflation is non-monotonic in the presence of a stock market. At low levels of inflation, inflation adversely affects the welfare of entrepreneurs. Advances of the inflation target from a low rate lower the resale value of capital because future generations do not have as much income. It is this channel that is distinct from the effects of monetary policy in the benchmark model. Though the Friedman Rule may not be optimal, the optimal inflation target is lower at high stages of financial development. This suggests that *monetary policy should be designed according to the stages of financial development*.

The results in this manuscript are consistent with empirical evidence that finds a negative correlation between inflation and the real economy. For example, Boyd, Levine, and Smith (2001) find that higher inflation is associated with lower levels of lending and bank deposits.⁶ Moreover, the authors find an inverse relationship between inflation and the volume of trade in the stock market. More importantly, the effects of inflation are non-linear. Specifically, the effects are decreasing with the level of inflation.

Furthermore, as discussed above, a large amount of literature highlights that the financial sector plays an important role in economic development. More recent work by Rousseau and Wachtel (2002) suggest that the effects of financial development on economic activity depend on monetary policy. In particular, when inflation exceeds a threshold level, financial development ceases to increase economic growth.

⁴As in standard overlapping generations models with money, the Golden rule is used as the welfare criterion. That is, the inflation rate is chosen by the monetary authority to maximize the ex-ante steady-state weighted welfare of all agents in the economy. Previous studies that follow a similar approach include Weiss (1980), Freeman (1993), Bhattacharya et al. (1997), and Edmond (2002).

⁵Focusing on the effects of inflation on income inequality, Albanesi (2007) examines an environment where agents differ by their labor productivity. Households can purchase goods using cash or credit (a costly transactions technology). Agents with high labor productivity gain more from the transactions technology as they have higher consumption levels. In this manner, poor agents rely more on cash, while rich households use more credit to fund their consumption. Therefore, the poor are more exposed to inflation relative to rich agents. In contrast to our work, the stance of monetary policy is determined in a political bargaining game between different income groups. Since the poor are more vulnerable to inflation, their bargaining power is weak, and the rich succeed in implementing high inflation.

Although we do not attempt to endogenize the weight assigned to the expected utility of each group of agents as in Albanesi (2007), similar insights can be generated in our environment. In particular, given that entrepreneurs do not hold money (as they are not subject to relocation shocks), they enjoy a much higher income when inflation is positive compared to depositors. Moreover, depositors are more exposed to inflation than entrepreneurs. In this manner, as in Albanesi (2007), entrepreneurs might enjoy more bargaining power if they were to enter a political bargaining game with depositors. Consequently, optimal monetary policy would always deviate from the Friedman rule.

⁶Other work includes De Gregorio (1992, 1993), Fischer (1993), Haslag and Koo (1999), and Bae and Ratti (2000).

Related Literature

This paper contributes to a growing literature that studies the effects of monetary policy on economic activity across countries. Available time-series evidence such as Ahmed and Rogers (2001) and Bullard and Keating (1995) suggests that inflation may be positively correlated with output in low inflation countries such as the United States. Other work addressing the impact of monetary policy across countries is cross-sectional. Fischer (1993) and Barro (1995) find that inflation is negatively related to the growth rate of output across countries. Ghosh and Phillips (1998) and Khan and Senhadji (2001) find evidence of threshold effects of inflation – the effects of inflation have little effect at low inflation rates, but it does impair growth beyond a threshold (which could be as low as 10%).

Several recent papers attempt to explain why the effects of monetary policy vary across countries. On the basis of the time-series evidence, Ghossoub and Reed (2010) discuss how individuals in poor countries are more susceptible to liquidity risk, forcing agents to hold more liquid assets as a result. Since the degree of liquidity risk varies across countries, the effects of monetary policy also vary. Ghossoub and Reed (2012) develop a neoclassical growth model with a cash-in-advance constraint where the reliance on cash is inversely related to the level of economic development. In rich countries with little reliance on cash as a medium of exchange, a Tobin-effect prevails. In poor countries, a reverse-Tobin effect occurs.

This paper follows directly from Ghossoub and Reed (2013) who argue that the transmission channels vary across countries due to the availability of equity markets. In poor countries without stock markets, a reverse-Tobin effect occurs but the presence of a stock market may lead to a Tobin effect. However, in Ghossoub and Reed (2013), the authors primarily study the effects of open market operations in which the economy’s inflation rate is an endogenous variable, responding to the exogenous gross liabilities of the government across the levels of development. By comparison, we study the effects of inflation targeting so that the liabilities of the government respond to the economy’s money growth rule. Moreover, this paper is primarily concerned with the welfare consequences of financial development and the *formation of optimal monetary policy across the stages of economic development*. While it is hard to interpret the optimal bonds-money ratio in a model of open market operations, an economy’s optimal money growth rule is easily understood.

In this paper, the transmission channels of policy also vary depending on the availability of equity markets. With an eye towards the available cross-sectional evidence that generally finds that inflation is negatively related to economic activity, regardless of the level of development, *we seek to understand why advanced countries systematically have lower inflation rates than poor countries*.

Our work also contributes to a growing literature on optimal monetary policy in the presence of heterogeneity.⁷ Notably, the bulk of previous studies focused on the redistributive effects of inflation resulting from different levels of money holdings across agents.⁸ For example, in a recent study by Bhattacharya et al. (2008), agents differ by their marginal utilities from real money balances. Therefore, some agents hold little cash, while others hold a large amount of cash in equilibrium. In an inflationary environment, the contribution of each group of agents to total seigniorage depends on their level of

⁷Previous work includes Freeman (1985), Edmond (2002), Erosa and Ventura (2002), Ireland (2005), Doepke and Schneider (2006), and Albanesi (2007)

⁸For instance, Erosa and Ventura (2002) introduce heterogeneity in transaction patterns and portfolio holdings across individuals. They find that the burden of inflation is substantially higher for individuals at the bottom of the income distribution than for those at the top. By comparison in Albanesi (2007) agents are either rich or poor. Households’ level of income affects their choice between cash and other costly financial arrangements.

money holdings. In comparison to our framework, the monetary authority rebates back all seigniorage income in equal lump sum transfers. Consequently, an inflationary policy redistributes wealth from those who hold too much cash to those who hold little cash. In this manner, the Friedman rule does not maximize type-specific welfare. Moreover, it is possible for the redistributive effect of an increase in the money growth rate to dominate the rate-of-return effect for some types of agents.

As in previous studies, we demonstrate that the Friedman rule may not be optimal when heterogeneity is considered. However, we also show that the attitude of different groups towards inflation may significantly vary with the level of financial development. More importantly, optimal policy depends on the provisions of financial services in the economy. Specifically, it is optimal to set higher inflation rates in economies with a poorly developed financial system.

The paper is organized as follows. Section 2 describes the environment in the benchmark model and studies the effects of monetary policy. Section 3 studies the implications financial development for different economic outcomes and monetary policy. Finally, we conclude in Section 4. Most of the technical details are presented in the Appendix.

2 The Benchmark Model

In order to highlight the importance of financial development for monetary policy, we study a modified Diamond (1965) production economy. As in Townsend (1987), spatial separation and informational constraints generate a role for money. However, unlike standard neoclassical models, we consider that physical capital is completely specialized and irreversible. Such frictions in the market for inputs provide a role for the stock market in our environment. As a benchmark, we assume that there are no equity markets for trading undepreciated heterogeneous capital goods. This approach follows Magill and Quinzii (2003) and Ghossoub and Reed (2013).

2.1 The Environment in the Benchmark Economy

We consider a discrete-time economy with two geographically separated, yet symmetric locations. Let $t = 1, 2, \dots, \infty$, index time. At each location, there is an infinite sequence of two-period lived overlapping generations plus an initial group of old individuals. In each generation, there are two types of agents: ex-ante identical depositors and entrepreneurs indexed by $j \in [0, 1]$. At the beginning of each period $t > 0$, a continuum of young agents is born. The population of each group of agents is equal to one.

Depositors and entrepreneurs are assumed to derive utility from consuming the single perishable good in old-age. Let c_t represent consumption per person in period t . The lifetime utility of an agent is given by $u(c_t) = \ln c_t$.⁹ Moreover, each young agent is endowed with one unit of labor, which she supplies inelastically.

While depositors are identical ex-ante, entrepreneurs differ by their ability to run specific production technologies. In particular an entrepreneur of type j will be able to run a constant returns to scale production technology j when old. Unlike previous work by Diamond (1967), each production technology utilizes specialized capital goods, K_t^j and labor, L_t^j to produce a homogeneous output, $Y_t^j = F^j(K_t^j, L_t^j)$. During the production process, only a fraction $\delta \in [0, 1]$ of the capital stock breaks down. Furthermore, we assume that F^j is increasing in each argument, quasiconcave, twice continuously differentiable, and satisfies standard Inada conditions. As we discuss below, entrepreneurs are

⁹The primary insights in this paper can be obtained under general CRRA preferences, with a coefficient of risk aversion greater than one.

the sole holders of physical capital. Therefore, we 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 $f^j(k_t^j, l_t^j) \equiv \frac{F^j(K_t^j, L_t^j)}{L_t^e}$.

When young, entrepreneurs have access to a linear production technology that converts goods into capital. In particular, one unit of investment by a young entrepreneur j in period t becomes one unit of capital of type j next period. Capital is also assumed to be completely irreversible. That is, agents cannot convert matured capital goods back into the consumption good. As discussed in Pindyck (1988), irreversibility is a by-product of the specialized nature of capital employed in specific production technologies. In this environment, unless there is a mechanism (market) that enables specialized capital goods to be traded, investment is completely sunk.

There are three types of assets in this economy: fiat money, government bonds, and capital. Denote the total amount of nominal money balances and government debt by M_t and B_t , respectively. 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, for reasons discussed below, old depositors are endowed with the initial aggregate money stock, $M_0 > 0$.

Let $P_t \in (0, \infty)$ denote the price of a unit of goods in units of currency at time t , which is common across locations. Thus, in real terms, the supply of money and government bonds is $m_t = M_t/P_t$ and $b_t = B_t/P_t$, respectively. Moreover, the return to money between period t and $t + 1$ is $\frac{P_t}{P_{t+1}}$. Furthermore, a government security held in period t yields I_t units of currency in period $t + 1$. Equivalently, the gross real interest on government debt in period $t + 1$ is $R_t = I_t \frac{P_t}{P_{t+1}}$.

Following Townsend (1987) and Schreft and Smith (1997), depositors are subject to random relocation shocks. 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. Moreover, the realization of the shock takes place after all markets close. Assuming the law of large numbers holds, π also reflects the number of relocated depositors. Due to limited communication and private information, agents cannot trade claims to assets they own on the other location. As in standard random relocation models, fiat money is the only asset that can be carried across locations.^{10,11} Furthermore, financial intermediaries arise endogenously in this environment to insure depositors against idiosyncratic risk. Therefore, all savings of depositors are intermediated. By comparison to depositors, entrepreneurs are not subject to relocation shocks. Therefore, they do not allocate funds into banking accounts.

The final agent in the economy 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:

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

We assume that the monetary authority implements an inflation targeting regime. Specifically, the central bank conducts open market operations by adjusting the bonds to currency ratio, $\mu_t \equiv \frac{b_t}{m_t}$ to achieve a particular inflation target, $\sigma = \frac{P_{t+1}}{P_t}$. The approach of conducting open market operations through changing the composition of government liabilities was introduced by Wallace (1984). Throughout the analysis, we focus on equilibria

¹⁰That is, government debt is not as liquid as cash to be carried costlessly to the other location. This restriction on asset portability is standard in random relocation models.

¹¹Random relocation shocks play a similar role to liquidity preference shocks in Diamond and Dybvig (1983).

where inflation is non-negative, $\sigma > 1$.¹²

2.2 Trade

2.2.1 A Typical Entrepreneur's Problem

At the beginning of period t , a young entrepreneur works and earns the wage rate w_t , which is entirely saved. The savings' portfolio of a typical entrepreneur consists of investment in new capital, i_t^j and government bonds, b_t^e . Therefore, the following budget constraint must hold:

$$w_t = i_t^j + b_t^e \quad (2)$$

As entrepreneurs cannot trade undepreciated capital, the capital stock in period $t + 1$ is solely determined by the level of investment in the previous period:

$$k_{t+1}^j = i_t^j \quad (3)$$

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:

$$c_{t+1}^j = f(k_{t+1}^j, l_{t+1}^j) - w_{t+1}l_{t+1}^j + b_t^e R_t \quad (4)$$

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:

$$\underset{i_t, l_{t+1}}{Max} \ln c_{t+1}^e \quad (5)$$

subject to the resource constraints (2)-(4). Substituting the constraints into the objective function, the problem may be expressed as:

$$\underset{i_t, l_{t+1}}{Max} \ln [f(i_t, l_{t+1}) - w_{t+1}l_{t+1} + (w_t - i_t) R_t] \quad (6)$$

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

$$w_{t+1} = \frac{[f(k_{t+1}, l_{t+1}) - k_{t+1}f_1(k_{t+1}, l_{t+1})]}{l_{t+1}} \quad (7)$$

where $f_1(k_{t+1}, l_{t+1}) = \frac{\partial f(k_{t+1}, l_{t+1})}{\partial k_{t+1}}$. From an entrepreneur's perspective, physical capital and government debt are perfect substitutes. Therefore, both assets are held in equilibrium up to the point where they yield the same rate of return. This leads to the no-arbitrage condition:

$$f_1(k_{t+1}, l_{t+1}) = R_t \quad (8)$$

Finally, using (2) – (5), (7), and (8), the maximized welfare of a typical entrepreneur is such that:

$$u_{t+1}^e = \ln f_1(k_{t+1}, l_{t+1}) w_t \quad (9)$$

¹²We relax this assumption when conducting welfare analysis.

2.2.2 A Representative Bank's Problem

Analogous to entrepreneurs, a young depositor works and earns the market wage rate, w_t . Exploiting the law of large numbers implies that there is no aggregate risk and banks are able to insure their depositors against idiosyncratic risk. Given that financial intermediation is costless, banks are able to offer deposit contracts that dominate any direct investment by an individual depositor. Therefore, risk averse depositors choose to intermediate all their savings.

In this environment, banks are Nash competitors. That is, each bank promises a gross real return r_t^m if a young individual will be relocated and a gross real return r_t^n if not, taking the real return offered by other banks as given. As the market for deposits is perfectly competitive, banks earn zero profits and choose portfolios to maximize the expected utility of each depositor.

Announced deposit returns must satisfy the following constraints. First, deposits received by a bank are allocated towards real money balances, m_t , and government debt, b_t^d .¹³ Therefore, the following balance sheet condition must hold:

$$m_t + b_t^d = w_t \quad (10)$$

Second, the bank needs to hold enough cash reserves to meet the anticipated demand for liquidity by movers in $t + 1$:

$$\pi r_t^m w_t = m_t \frac{P_t}{P_{t+1}} \quad (11)$$

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

$$(1 - \pi)r_t^n w_t = R_t b_t^d \quad (12)$$

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

$$\underset{r_t^m, r_t^n, m_t, b_t^d}{Max} \quad \pi \ln r_t^m w_t + (1 - \pi) \ln r_t^n w_t \quad (13)$$

subject to (10) - (12). The solution yields the bank's money demand function:

$$m_t = \pi w_t \quad (14)$$

Because depositors have logarithmic preferences, banks allocate a constant fraction of their deposits towards money balances.

Furthermore, using (10) - (12) and (14), the relative return to depositors is such that:

$$\frac{r_t^n}{r_t^m} = R_t \frac{P_t}{P_{t+1}} = I_t \quad (15)$$

which indicates that depositors receive a lower amount of insurance when government bonds pay a relatively higher rate of return. Finally, using (10) - (14), the maximized expected utility of a typical depositor is expressed by:

$$u_t^d = \pi \ln \frac{P_t}{P_{t+1}} w_t + (1 - \pi) \ln R_t w_t \quad (16)$$

¹³As the total number of depositors is unity, m_t and b_t^d reflect the amount of real cash and government debt per depositor as well as their aggregate levels for this particular group of agents.

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 (7). Furthermore, the labor market clears:

$$L_t = L_t^e + L_t^d = 2 \quad (17)$$

From the bank's balance sheet, (10) and entrepreneurs' budget constraint, (2), we can obtain the total demand for government bonds, with $b_t^D = b_t^e + b_t^d$. Using the expression for the bonds to reserves ratio, μ_t , the total supply of bonds can be expressed as $b_t^S = \mu_t m_t$. By clearing the bond market, we obtain the law of motion of capital:

$$k_{t+1} = [2 - (1 + \mu_t) \pi] w(k_t) \quad (18)$$

In addition, the demand for capital goods by entrepreneurs is expressed by (8).

Finally, imposing equilibrium on the money market by using the expression for money demand, (14) along with the debt to reserves policy and the no-arbitrage condition, (8) into the government's budget constraint, (1) to obtain the evolution of the degree of liquidity:

$$\mu_{t+1} = \frac{w(k_t)}{w(k_{t+1})} \left(\frac{1}{\sigma} + \mu_t f_1(k_{t+1}) \right) - 1 \quad (19)$$

Conditions (8), (18), and (19) characterize the behavior of the economy at each point in time.

In this manuscript, we focus primarily on the stationary behavior of the economy. We proceed to study the steady equilibrium in the following section.

2.3.1 Steady-State Analysis

Imposing steady-state (19), the degree of liquidity is expressed by:

$$\mu = \frac{1 - \frac{1}{\sigma}}{R - 1} \quad (20)$$

which indicates that for all $\sigma > 1$, $\mu > (<) 0$ when $R > (<) 0$. That is, the government is a net borrower (lender) in financial markets when real interest rates are positive (negative). Furthermore, the degree of liquidity is a decreasing function in R . For instance, when $R > 1$, a higher real interest rate on government bonds raises the government's payment obligations. However, the inflation tax rate is fixed at rate σ . 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.

Furthermore, incorporating (20) into (8) and (18), the following two loci characterize the stationary behavior of the economy:

$$\Omega(k) \equiv \frac{k}{w(k)} = 2 - \left(\frac{R - \frac{1}{\sigma}}{R - 1} \right) \pi \quad (21)$$

and

$$R = f_1(k) \quad (22)$$

We begin by characterizing each loci in the following Lemma.

Lemma 1.

i. The locus defined by (21) satisfies: $\frac{dk}{dR} > 0$, $\lim_{R \rightarrow \infty} k \rightarrow \Omega^{-1}(2 - \pi)$, $\lim_{R \rightarrow 1} k \rightarrow \infty$, and $k = \Omega^{-1}(2)$ at $R = \frac{1}{\sigma}$.

ii. The locus defined by (22) satisfies: $\frac{dk}{dR} < 0$, $\lim_{R \rightarrow \infty} k \rightarrow 0$, $\lim_{R \rightarrow 0} k \rightarrow \infty$, and $k = \tilde{k}_0$ at $R = \frac{1}{\sigma}$.

Equation (21) describes how k and R adjust to clear the bond market. When the government is a net borrower in credit markets ($R > 1$), the government reduces its debt holding under higher interest rates. The lower supply of bonds frees up resources in agents' portfolios. In particular, entrepreneurs are able to raise their investment in private capital formation by holding less public debt. The lower demand for government debt clears the bond market. By comparison, in economies where the government is a net creditor ($R < 1$), a higher real interest rate raises the amount of transfers to the private sector. This in turn provides entrepreneurs with more resources to allocate towards capital investment, which in turn clears the bond market.

Analogously, the pricing condition, (22) indicates how the demand for capital by entrepreneurs adjusts to a change in the return on government bonds. Specifically, agents hold more government debt and less capital when the interest on government debt is higher. The lower amount of capital investment raises its return up to the point where both capital and bonds yield the same rate of return. An illustration of (21) and (22) is presented in Figure 1 below.

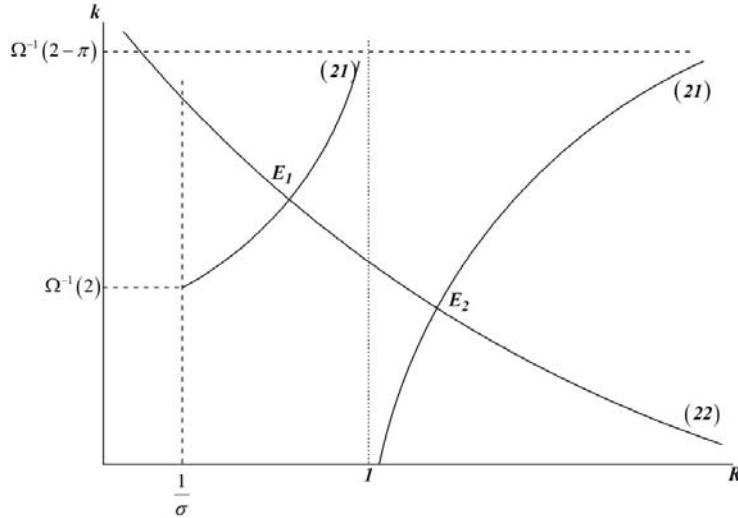


Figure 1: Equilibrium in the Benchmark Economy

Proposition 1. Suppose $\sigma < \underline{\sigma}_0$, where $\underline{\sigma}_0 : \tilde{k}_0 = \Omega^{-1}(2)$. Under this condition, a steady-state where $R > 1$ exists and is unique. By comparison, if $\sigma \geq \underline{\sigma}_0$, two equilibria exist. In one equilibrium the real return on government bonds is positive. In the other equilibrium, the real interest rate is negative.

From our characterization of (21) and (22), both loci intersect twice at E_1 and E_2 , as illustrated in the Figure above. Given that inflation is non-negative, the economy with a

positive real interest rate, E_2 always exists as money is dominated in rate of return and all assets are held in non-negative quantities. However, in an economy like E_1 where the government is a net creditor, the real return to capital and bonds might fall short that on money balances. As we demonstrate in the appendix, money is dominated in rate of return at E_1 if the inflation target is above some threshold level, $\underline{\sigma}_0$. Therefore, two equilibria exist when $\sigma \geq \underline{\sigma}_0$. This case is illustrated in Figure 1 above. Moreover, for all $\sigma < \underline{\sigma}_0$, economy E_2 only exists and is unique.

We proceed to examine the effects of setting a higher inflation target on different economic outcomes in the following proposition:

Proposition 2.

- i. In economies where the government is a net debtor, $\frac{dk}{d\sigma} < 0$, $\frac{dR}{d\sigma} > 0$, and $\frac{dI}{d\sigma} > 0$.*
- ii. In economies where the government is a net creditor, $\frac{dk}{d\sigma} > 0$, $\frac{dR}{d\sigma} < 0$, and $\frac{dI}{d\sigma} > 0$.*

It can be easily verified that locus (21) shifts downwards (upwards) under a higher inflation rate when $R > (<)1$. As illustrated in Figure 2 below, the economy with a positive real return to bonds ends up with higher interest rates and a lower capital stock, represented by a movement of the economy from E_2 to E_4 . Intuitively, in order to achieve a higher inflation target, the monetary authority needs to raise the supply of money. This in turn generates additional seigniorage revenue to the government, which enables it to expand its indebtedness. The higher amount of debt crowds out capital formation in entrepreneurs' portfolios. Moreover, by diminishing returns, the lower level of capital investment raises its return. Finally, driven by a higher supply of government debt, the bonds to reserves ratio is also higher from a general equilibrium perspective.

By comparison, in economies where the government is a net creditor, the additional revenue from money creation permits the government to issue more loans to the private sector. Consequently, capital formation increase by setting a higher inflation target. The higher inflation rate also puts upwards pressures on nominal interest rates. This result is illustrated as a movement of the economy from E_1 to E_3 .

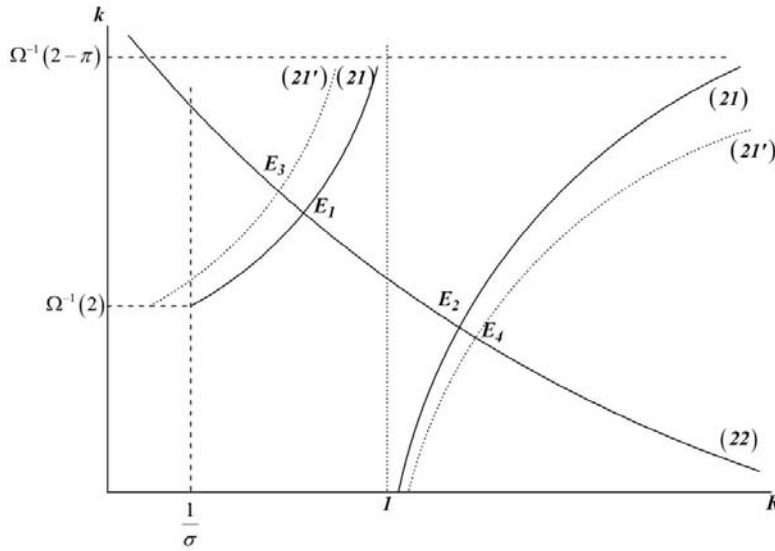


Figure 2: The Effects of Targeting a Higher Inflation Rate

We now turn our attention to the implications of inflation for economic welfare.

Inflation and Welfare:

For the remainder of this section, we assume that the production function is of the Cobb-Douglas form such that: $f(k) = 2^{1-\alpha} Ak^\alpha$. The parameter A reflects the level of total factor productivity and $\alpha \leq \frac{1}{2}$ is capital's share of total output. Furthermore, we focus on equilibria where the real interest rate is non-negative. That is, on the economy that exhibits a reverse-Tobin effect. The proof for the following result appears in the appendix:

Proposition 3. *Suppose $\sigma > 1$. Under this condition: $\frac{du^d}{d\sigma} < 0$, $\frac{du^e}{d\sigma} \geq 0$, and $\frac{dW}{d\sigma} < 0$, where $W = u^d + u^e$.*

Interestingly, unlike previous work such as Schreft and Smith (1997), inflation has distributional effects in the economy. While setting a higher inflation target raises the welfare of entrepreneurs, it has adverse consequences on the welfare of depositors. The cumulative effect of inflation on total welfare is negative.

As discussed in Proposition 1, targeting a higher inflation rate hinders capital formation and total output. The lower amount of output reduces the demand for labor exerting downwards pressures on wages and savings of all agents in the economy. However, driven by a higher return to capital and government debt, the total income generated by a typical entrepreneur is higher. Therefore, total consumption and welfare of entrepreneurs are also higher under a higher inflation target. By comparison, a less restrictive inflation target reduces the value of money and the amount of insurance received by depositors. Combined with lower income, the expected utility of a typical depositor is adversely affected by inflation. As we demonstrate in the appendix, total welfare is lower under a higher inflation rate.

Although our analytical result focuses on cases where $\sigma > 1$, numerical work indicates that the result above holds for all $\sigma > 0$. Consequently, type-specific optimal policies differ significantly. While an inflationary environment is preferred on welfare grounds for entrepreneurs, depositors' welfare is maximized at the Friedman rule rate of money creation. Finally, the inflation target that maximizes social welfare is the one that achieves the Friedman rule. When money and government debt yield the same rate of return, all agents in the economy receive the same level of consumption ex-ante. Moreover, depositors are completely insured against random relocation shocks. Notably, the Friedman rule may or may not be deflationary. In the example illustrated in Figures 3 and 4 below, the Friedman rule is achieved at an inflation target slightly above zero, $\sigma = 1.0001$. The following parameters are used to construct this example: $A = 1$, $\alpha = .33$, and $\pi = .5$.

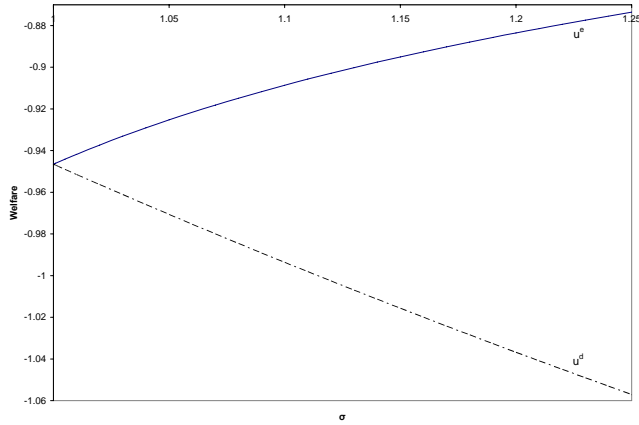


Figure 3. Inflation and Type Specific Welfare when $R > 1$

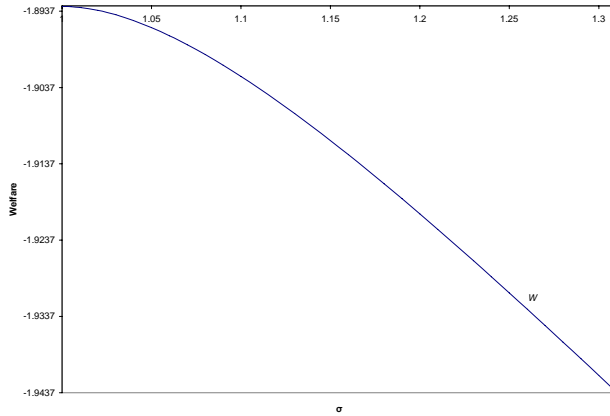


Figure 4. Inflation and Total Welfare

It is important to note that the optimality of the Friedman rule in this economy depends on the weight allocated to each group of agents. In our setting, the expected utility of depositors and entrepreneurs is weighted by the size of each group, which is equal by assumption. Interestingly, the Friedman rule will no longer be optimal if policymakers put a slightly higher weight on the welfare of entrepreneurs.¹⁴ For example, suppose total welfare is such that: $W = \rho u^d + (1 - \rho) u^e$, where $\rho \in (0, 1)$ is the weight associated to the welfare of depositors.¹⁵ Using the same example above, if $\rho = .4$, the Friedman rule is no longer the optimal policy. Numerical work indicates that the optimal inflation rate is 10%.

¹⁴Edmond (2002) studies optimal monetary policy in a two-period overlapping generations economy. In his economy, people are born with different endowment levels during their young and old age, which they invest in cash and government bonds. Such endowment differences render agents to become either lenders or borrowers. Although some agents with low young age income want to borrow to smooth their consumption levels, they are unable to due to market incompleteness. In this environment, borrowers gain from higher inflation due to higher transfers received from the government. By comparison, lenders' welfare is adversely affected from inflation because they face a lower return on their savings and contribute more to total transfers. Under certain conditions, the author demonstrates that the Friedman rule might not be optimal.

¹⁵The environment can be slightly changed by assuming a total population size equal to one. Moreover, ρ can reflect the fraction of agents that are depositors. Such changes should generate similar insights.

Finally, it is easily verified that the expected income of entrepreneurs relative to depositors can be expressed as: $[\frac{\pi}{7} + 1 - \pi]^{-1}$. Given that nominal interest rates are increasing with the inflation rate, income inequality rises with inflation. This is driven by the inability of depositors to completely hedge against inflation when money is dominated in rate of return. Ex-post, entrepreneurs and non-relocated agents receive higher consumption under a higher inflation tax. By comparison the consumption of relocated agents is significantly adversely affected. In this manner, our results in the benchmark economy are consistent with recent empirical evidence that find a positive correlation between inflation and income inequality across countries. For instance, in a sample of 76 countries, Romer and Romer (1998) find that income inequality deteriorates at high levels of inflation.¹⁶

3 The Economy with a Stock Market

We proceed to study the linkages between financial development, economic development, and monetary policy. Unlike the benchmark economy, we permit the formation of secondary markets that permit specialized and irreversible capital goods to be traded between different generations of entrepreneurs.^{17,18} In particular, we assume that old entrepreneurs are capable of forming coalitions that intermediate trading between old sellers and young buyers. As intermediaries act on behalf of sellers, they are capable of exerting their market power by extracting all surplus from buyers and charging them the monopoly price. Therefore, the price of a unit of capital is equal to one unit of goods.

Given that only entrepreneurs participate in the market for physical capital, the stock market only affects their portfolio choice. Therefore, we only study their choices. Depositors' problem carries on from the previous section. We begin with the set of constraints facing a typical entrepreneur.

At the beginning of period t , an entrepreneur works and earns the market wage, w_t . In contrast to the benchmark economy, a young entrepreneur allocates her savings between the purchases of government debt, new capital investment, and the purchase of undepreciated capital goods from an old entrepreneur:

$$w_t = b_t^e + i_t + (1 - \delta) k_t \quad (23)$$

As old agents are able to sell their capital in equity markets, their old-age income includes the value of undepreciated capital, $(1 - \delta) k_{t+1}$:

$$c_{t+1}^e = f(k_{t+1}, l_{t+1}) - w_{t+1} l_{t+1} + R_t b_t^e + (1 - \delta) k_{t+1} \quad (24)$$

Therefore, the evolution of a particular type of capital between periods t and $t + 1$ is expressed by:

$$k_{t+1} = i_t + (1 - \delta) k_t \quad (25)$$

A typical entrepreneur maximizes her lifetime utility (26) subject to (23)-(25):

¹⁶Easterly and Fischer (2001) and Albanesi (2007) reach similar conclusions.

¹⁷Studying a non-monetary economy, Greenwood and Smith (1997) highlight the intra-generational liquidity role of the stock market. In contrast, we study the role of the stock market as a mechanism that generates liquidity across generations.

¹⁸Bencivenga, Smith, and Starr (1995) consider the stock market as a mechanism that permits the transfer of capital in progress over time. In their setting, capital goods are homogeneous and depreciate completely in the production process. However, there are different investment technologies that convert the consumption good into physical capital. The technologies differ by their gestation period. In this manner, the stock market provides intergenerational liquidity by allowing agents to trade claims to capital goods. In our framework agents trade the unused capital stock.

$$\underset{i_t, (1-\delta)k_t, l_{t+1}}{Max} \ln c_{t+1}^e \quad (26)$$

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

$$R_t = f_1(k_{t+1}, l_{t+1}) + 1 - \delta \quad (27)$$

As in the previous section, capital and bonds are perfect substitutes. Therefore, they are held in equilibrium up to the point where they both yield the same rate of return at the margin. However, in contrast to the benchmark economy, the marginal return from a unit of capital also includes the resale value of a unit of capital, $(1 - \delta)$. Consequently, for a given level of investment, it is clear from (27), that the stock market raises the return to capital.

3.1 General Equilibrium

In equilibrium, the law of motion of capital is the same as the benchmark economy:

$$k_{t+1} = [2 - (1 + \mu_t) \pi] w_t \quad (28)$$

In addition, the no-arbitrage condition, (27), along with the government's budget constraint (1), and the definition of the debt to reserves policy tool, yield the evolution of the reserves to deposits ratio:

$$\mu_{t+1} = \left[\frac{1}{\sigma} + (f_1(k_{t+1}) + 1 - \delta) \mu_t \right] \frac{w(k_t)}{w(k_{t+1})} - 1 \quad (29)$$

Conditions (28) and (29) characterize the economy's equilibrium conditions at each point in time.

3.1.1 Steady-State Analysis

Imposing steady-state on (28) and (29), the following two loci characterize the long-run behavior of the economy:

$$\Omega(k) \equiv \frac{k}{w(k)} = 2 - \left(\frac{R - \frac{1}{\sigma}}{R - 1} \right) \pi \quad (30)$$

and

$$f_1(k) + 1 - \delta = R \quad (31)$$

Obviously, if $\delta = 1$, (31) corresponds to the no-arbitrage condition for the benchmark economy, (22). The behavior of each loci is qualitatively identical to those in the benchmark economy. The following Proposition establishes existence and uniqueness in the stock market economy:

Proposition 4. *Suppose $\sigma < \underline{\sigma}_1$, where $\underline{\sigma}_1 : \tilde{k}_1 = \Omega^{-1}(2)$ and $\tilde{k}_1 : f_1(k) + 1 - \delta = \frac{1}{\sigma}$. Under this condition, a steady-state where $R > 1$ exists and is unique. By comparison, if $\sigma \geq \underline{\sigma}_1$, two equilibria exist.*

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

5. Since the market for capital raises its return, the no-arbitrage curve in the stock market economy lies above that in the benchmark economy.

As observed in the Figure, the economy with an active stock market, E_2^S , has a higher real return to capital and a higher level of investment in private capital compared to economy E_2^B , where a stock market is absent. Consequently, total income and welfare of entrepreneurs is higher when capital is traded across generations. Furthermore, for a fixed inflation tax rate, the nominal interest rate will be higher if a market for capital exists. Although depositors receive a lower amount of insurance against idiosyncratic risk, their welfare is also driven higher by higher wages. Therefore, financial development leads to a Pareto superior outcome.

Interestingly, the gains from financial development are not symmetric across different groups of agents. Given that entrepreneurs do not participate in money markets, their expected income rises faster than that of depositors.¹⁹ Therefore, as in Greenwood and Jovanovic (1990), income inequality rises with the stages of financial development.²⁰

In addition, by no-arbitrage between physical capital and public debt, the real return to government bonds will be higher if a stock market exists. Consequently, in an economy with an active secondary market for capital, the debt to reserves ratio must be lower. This implies that it takes a less restrictive monetary policy to achieve a particular inflation target when the financial system is more advanced. Moreover, entrepreneurs devote fewer resources towards unproductive assets such as government debt in economies with better developed financial systems.²¹

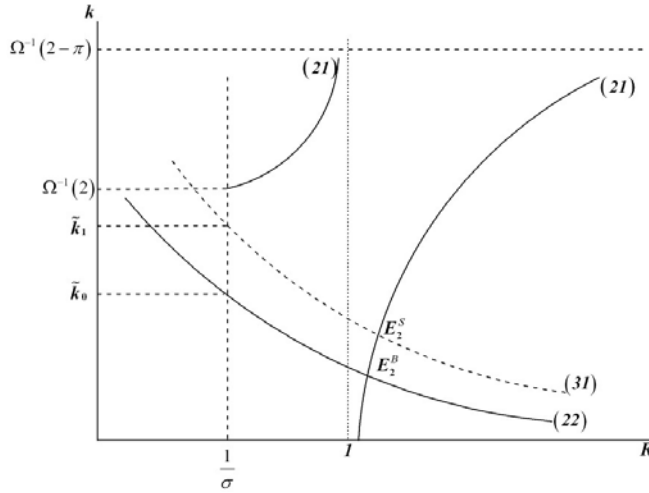


Figure 5. The Effects of Financial Development at Low Inflation Targets

¹⁹Ex-post, the income of entrepreneurs and non-movers rises faster compared to that of relocated agents.

²⁰Greenwood and Jovanovic (1990) study a non-monetary endogenous growth economy where agents differ by their initial capital endowments. In their setting, agents can invest in a low yield riskless project or a risky high yielding projects. Although financial intermediation is capable of diversifying risk, it is costly to participate in. Therefore, financial intermediation only arises when growth is high enough. However, not all agents can afford to participate. At a particular point in time, only wealthy agents intermediate their savings. Consequently, rich agents enjoy higher saving rates and income growth compared to poor individuals.

In our setting, agents have the same level of endowment. However, income inequality arises because money is dominated in rate of return. Financial development contributes to income dispersion among different groups of agents.

²¹In contrast, Roubini and Sala-i-Martin (1995) show that financial development will lead to a net increase in payment obligations of the government.

Given that the stock market raises the real interest rate on government bonds for any level of investment, multiple steady-states are more likely to occur in the presence of the stock market. That is, the parameter space under which an economy with negative real interest rates also exists is much larger when capital is traded between generations. Therefore, if the inflation target is sufficiently high, the impact of financial development on different outcomes may become indeterminate as illustrated in Figure 6. In this example, the steady-state is unique in the benchmark economy. However, we have two equilibria in the presence of equity markets. Consequently, in the presence of a secondary market for capital, the capital stock might slightly increase as in the case of a unique steady-state (movement from E_2^B to E_2^S) or it might increase significantly (movement from E_2^B to E_1^S) exerting downward pressures on real interest rates. We state this result in the following Lemma.²²

Lemma 2. *In either the benchmark or the stock market economies, multiple steady-states may exist if the inflation target is sufficiently high. However, the required lower bound for the target is higher in the benchmark economy. That is, $\underline{\sigma}_1 < \underline{\sigma}_0$.*

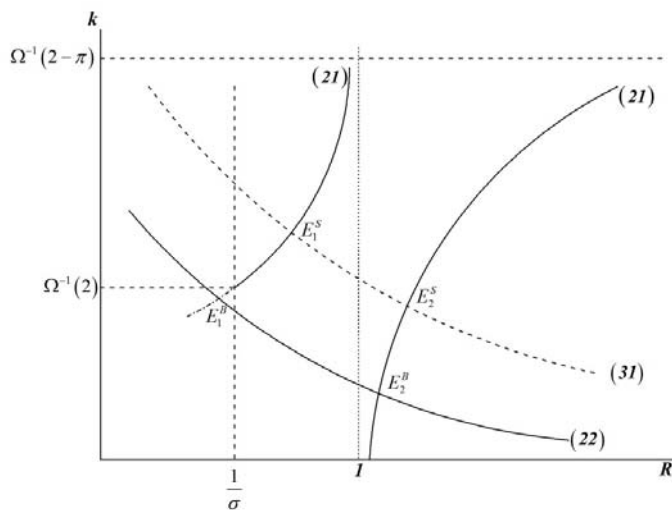


Figure 6. The Effects of Financial Development at Intermediate Inflation Targets

Financial Market Development and the Effects of Monetary Policy

We next discuss the interactions between monetary policy and financial development. We focus primarily on the case where there is a unique steady-state in the benchmark economy and the economy with a stock market. We begin with the following result:

²²Minier (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.

Proposition 5. *The effects of inflation on capital formation are much stronger when capital is traded across generations. Consequently, the gains from financial development are eroded at high inflation rates.*

With the exception of the welfare of entrepreneurs, it is easily verified that the qualitative effects of inflation on different economic outcomes are analogous to those obtained in the benchmark economy. However, as we demonstrate below, inflation has a bigger impact on capital formation in the presence of the stock market.

To draw more insights into the linkages between economic development, financial development and inflation, we construct the following example which we illustrate in Figure 7 below. The following parameters are used along with a Cobb-Douglas production function described above: $A = 1$, $\alpha = .33$, and $\pi = .5$. Moreover, $\delta = .9$ for the stock market economy compared to $\delta = 1$ for our benchmark case. The y-axis represents the elasticity of the capital stock with respect to inflation. The gross inflation rate is on the horizontal axis.

The results provide three 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. Second, inflation has a bigger impact in the stock market economy as discussed above. Again, this demonstrates that monetary policy has a stronger effect in economies at higher stages of financial development. Finally, the effects of financial development on capital formation are diminishing with the inflation rate.

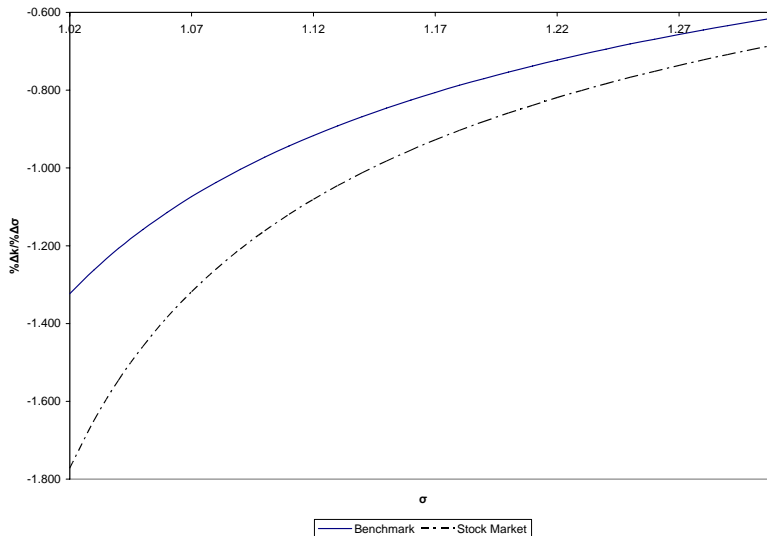


Figure 7: Financial Development and Monetary Policy

Why is the relationship between inflation and the capital stock (or output) convex? Furthermore, why are the effects of monetary policy stronger at higher stages of financial and economic development? The answer to both questions lies in the market for government bonds. From a general equilibrium perspective, the supply of government debt as a fraction of wages, $\frac{b^s}{w} \equiv \beta^S$ and the demand for bonds to savings ratio, $\frac{b^d}{w} \equiv \beta^D$ are respectively:

$$\beta^S = \frac{1 - \frac{1}{\sigma}}{R(k) - 1} \pi \quad (32)$$

$$\beta^D = 2 - \pi - \Omega(k) \quad (33)$$

Therefore, (32) and (33) provide a solution for k and β . Both loci indicate how the capital market has to adjust to conditions in the market for public debt. Clearly, the supply of bonds is strictly increasing in k (or decreasing in R), while the demand for bonds is inversely related to the amount of capital in the economy.

As discussed in the previous section, inflation affects the economy through the government's budget, (32). For a given supply for government debt:

$$\frac{\partial k}{\partial \sigma} = \frac{1}{\sigma^2} \frac{\pi}{\beta^S} \frac{1}{f_{11}} < 0 \quad (34)$$

which indicates that the capital stock must decline to absorb the additional debt that comes about with a higher tax on money. However, it is clear that the capital stock needs to adjust by less as inflation increases. Intuitively, the ability of the government to collect seigniorage revenue declines with the level of inflation. Consequently, for a given change in the inflation rate, the capital stock needs to adjust less when inflation is initially high to clear the bond market.

Furthermore, for a given inflation target, it is clear from (34) that the capital stock needs to adjust significantly more when the financial system is more developed. This occurs because capital investment is higher in the presence of the stock market. Therefore, f_{11} is smaller in absolute terms. Moreover, the government is able to supply less government debt as a fraction of deposits when a secondary market for capital exists as it drives nominal interest rates higher. This in turn renders the capital stock more sensitive to changes in the stock of government bonds and inflation.

Interestingly, in contrast to our benchmark economy, entrepreneurs are more exposed to inflation when capital is traded across generations. From (24) and (27), the steady-state consumption of entrepreneurs is expressed by: $c^e = (f_1(k) + 1 - \delta)w(k)$. The effects of inflation on rental income are qualitatively the same as the economy without a stock market. Higher inflation rates fuel government debt to the benefit of entrepreneurs. *However, in the presence of a market for capital, the income from capital also comes from the ability to sell it to future generations.* Since the crowding-out effect leads to lower wage income from the current young, savings will be lower and the ability of future generations to purchase capital is compromised. Therefore, as we demonstrate in the appendix, the effects of inflation on the welfare of entrepreneurs is non-monotonic in a financially developed economy. The following Proposition summarizes this result:

Proposition 6. *Suppose $\delta < \frac{\alpha}{1-\alpha}$. Also, let $\sigma > 1$. Under this condition, $\frac{du^e}{d\sigma} \leq (>) 0$ if $\sigma \leq (>) \hat{\sigma}$. By comparison if $\delta \geq \frac{\alpha}{1-\alpha}$, $\frac{du^e}{d\sigma} > 0$.*

When the capital stock is more durable, entrepreneurs would obtain more income from selling their capital (after depreciation) to the next generation. However, once inflation reaches a particular threshold, the crowding-out effect becomes quite strong. In fact, capital accumulation reaches levels that are so distorted it is almost as if a secondary market for capital does not even exist. *That is, the distortionary effects of inflation can reach a point that they outreach the gains from financial development.*

Consequently, at a certain rate, the effects of inflation become qualitatively the same as the benchmark economy. Then, the welfare calculation is very similar. However, the marginal effects of inflation on the capital stock do weaken as inflation increases.

Thus, entrepreneurs locally prefer the Friedman in a more advanced financial system. That is, slight deviations from the Friedman Rule lower the welfare of entrepreneurs. Nevertheless, inflation is not globally optimal from the perspective of entrepreneurs. Eventually, inflation becomes high enough that the gains from rental income strongly dominate the losses from the re-sale value on the secondary market. Finally, although inflation has non-monotonic effects on the welfare of entrepreneurs, the welfare of depositors is strictly decreasing with the level of inflation.

Proposition 6 requires that there is positive net money creation. An example that also considers negative net money creation is illustrated in Figures 8 and 9 below. The parameters used to construct this example are identical to those used in the previous section. However, $\delta = .25$ in the stock market economy:

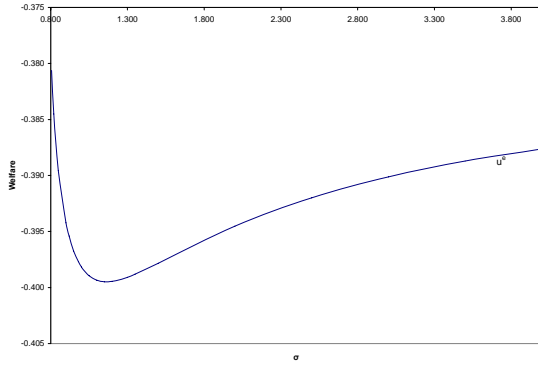


Figure 8. Inflation and Entrepreneurs' Welfare

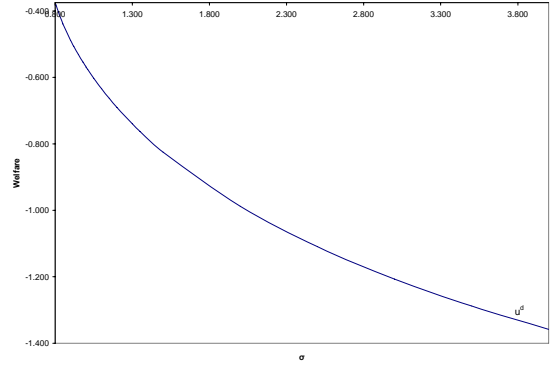


Figure 9. Inflation and Depositors' Welfare

It could also be shown that the welfare of an entrepreneur would exceed the Friedman Rule money growth rate once the inflation rate is sufficiently high.

We turn to our final question: *Does optimal monetary policy depend on an economy's stage of financial development?* The answer is yes. First, consider the case of an equally weighted social welfare function as initially introduced in the benchmark economy. In that setting, the Friedman Rule is still optimal. *Given that the real return to capital is higher in the presence of a secondary market for capital, the rate of money creation (contraction) that achieves the Friedman rule is much smaller when capital is traded across generations.* Therefore, optimal monetary policy should be more restrictive when the financial system is more developed.

However, optimal policy is still more restrictive even if the Friedman Rule is not optimal. Suppose that the monetary authority caters more towards capital owners. In the example considered in the benchmark economy, the weight associated to entrepreneurs' welfare is 0.6. In the benchmark economy, the optimal inflation target is 10%. Using the same parameters, along with $\delta = .95$, it is easy to verify that the optimal inflation target in the stock market economy is 8.6%. Even though policy is tilted towards the interests of entrepreneurs, it still takes workers into account. And, workers benefit from higher levels of the capital stock. As inflation has a larger impact on investment in a financially developed economy, the optimal inflation target is also lower. Consequently, our work clearly suggests that optimal policy depends on a country's level of economic development.

4 Conclusions

Do the distributional consequences of monetary policy depend on the extent of financial development? Should optimal monetary policy vary across countries? In order to answer these questions, we develop a monetary growth production model with heterogeneous agents. In our economy, optimal policy needs to weigh the effects of policy across two groups – capital owners and individuals who hold liquid assets. While banks help limit the exposure to inflation, there are limits because money alleviates the frictions of private information and limited communication. In this environment, we compare two economies that are identical in every aspect except for their level of financial development. In a country with limited financial development, a stock market is absent. In the other, an equity market is active. In either economy, inflation adversely affects capital formation and output. Individuals who hold liquid assets are always adversely affected by inflation, but the attitude of capital owners depends on the level of financial development. In particular, in the presence of a stock market, the impact of inflation on the welfare of capital owners is non-monotonic. Nevertheless, optimal monetary policy is always more conservative at higher levels of financial development

5 Appendix

1. **Proof of Proposition 3.** We begin by demonstrating that entrepreneurs' welfare is increasing with inflation. Imposing a Cobb-Douglas production function of the form described in the text on the welfare function of entrepreneurs, (9), we get:

$$u^e = \ln R w = \ln 2^{1-2\alpha} A^2 \alpha (1-\alpha) k^{2\alpha-1} \quad (35)$$

Given that $\frac{dk}{d\sigma} < 0$, $\frac{du^e}{d\sigma} \geq 0$ for all $\alpha \leq \frac{1}{2}$.

From (16) and some algebra, the steady-state expected utility of a depositor is:

$$u^d = \ln w - \pi \ln \sigma + (1-\pi) \ln R(k)$$

Differentiating with respect to σ to obtain:

$$\frac{du^d}{d\sigma} = \frac{dw}{dk} \frac{dk}{d\sigma} \frac{1}{w} - \pi \frac{1}{\sigma} + (1-\pi) \frac{dR}{dk} \frac{dk}{d\sigma} \frac{1}{R} \quad (36)$$

where $\frac{dw}{dk} = \frac{(1-\alpha)f_1}{2}$ and $\frac{dR}{dk} = f_{11} = -(1-\alpha)k^{-1}f_1$. Using this information into (36):

$$\frac{du^d}{d\sigma} = \left(\frac{(1-\alpha)f_1}{2} \frac{1}{w} - (1-\pi) \frac{1}{R} (1-\alpha)k^{-1}f_1 \right) \frac{dk}{d\sigma} - \pi \frac{1}{\sigma} \quad (37)$$

In absence of the stock market, $f_1 = R$. Combining this information with some algebra, (37) becomes:

$$\frac{du^d}{d\sigma} = \frac{\pi}{\sigma} \left[\left(\frac{\alpha - (1-\pi)(1-\alpha)}{\pi} \right) \frac{\sigma}{k} \frac{dk}{d\sigma} - 1 \right] \quad (38)$$

Therefore, $\frac{du^d}{d\sigma} < 0$ if:

$$\left(\frac{\alpha - (1-\pi)(1-\alpha)}{\pi} \right) \frac{\sigma}{k} \frac{dk}{d\sigma} < 1 \quad (39)$$

We proceed to derive an expression for $\frac{\sigma}{k} \frac{dk}{d\sigma}$. From (21) and (22), and under a Cobb-Douglas production function, the steady-state capital stock is the solution to the following polynomial:

$$\frac{2\alpha}{(1-\alpha)f_1(k)} + \left(1 + \frac{1 - \frac{1}{\sigma}}{f_1(k) - 1} \right) \pi = 2 \quad (40)$$

By taking the total derivative of (40) with respect to σ , we get:

$$\frac{dk}{d\sigma} = \frac{\frac{1}{\sigma^2} [R-1]}{f_{11}} \frac{1}{\left(\frac{2\alpha[R-1]^2}{\pi(1-\alpha)f_1^2} + \left(1 - \frac{1}{\sigma} \right) \right)} < 0 \quad (41)$$

Some simplifying algebra yields:

$$\frac{\sigma}{k} \frac{dk}{d\sigma} = -\frac{1}{\sigma} \frac{1}{(1-\alpha)} \frac{\left[1 - \frac{1}{R} \right]}{\left(1 - \frac{1}{\sigma} \right) + \frac{2\alpha \left[1 - \frac{1}{R} \right]^2}{\pi(1-\alpha)}} \quad (42)$$

We next substitute (42) into (39) to get the following condition: $\frac{du^d}{d\sigma} < 0$ if:

$$\frac{(R-1)(1-2\alpha)}{R} < \left(\frac{R - \frac{1}{\sigma}}{R} \right) \pi (1-\alpha) \sigma + \sigma 2\alpha \left[\frac{R-1}{R} \right]^2 \quad (43)$$

Unambiguously, the term on the right-hand side of (43) is positive for all $\sigma > 0$ and $1 > R > \frac{1}{\sigma}$, while $\frac{(R-1)(1-2\alpha)}{R} \leq 0$ for $\alpha \leq \frac{1}{2}$. This indicates that the inequality always holds for an equilibrium where $1 > R > \frac{1}{\sigma}$ and therefore $\frac{du^d}{d\sigma} < 0$. By comparison, suppose $R > 1 > \frac{1}{\sigma}$. Using the equilibrium condition,(40) into (43), $\frac{du^d}{d\sigma} < 0$ if:

$$\frac{(1-2\alpha)}{2} < \sigma \left(1 - 2\frac{\alpha}{R}\right)$$

which always holds under the conditions above. This completes the proof that the welfare of depositors is decreasing with the inflation rate when $R \geq \frac{1}{\sigma}$, $\alpha \leq \frac{1}{2}$, and $\sigma > \frac{1}{2}$.

Finally, we show that total welfare, W , is also lower under a higher inflation rate. By definition, $W = u^d + u^e$. Using (9) and (16) :

$$W = 2 \ln w - \pi \ln \sigma + (2 - \pi) \ln R \quad (44)$$

Differentiating with respect to σ to get:

$$\frac{dW}{d\sigma} = \left[2 \frac{dw}{dk} \frac{1}{w} + (2 - \pi) \frac{dR}{dk} \frac{1}{R} \right] \frac{dk}{d\sigma} - \pi \frac{1}{\sigma} \quad (45)$$

Using the information derived above, $\frac{dW}{d\sigma} < 0$ if:

$$\frac{2(1-2\alpha)(R-1)}{R} < \left[\frac{R\sigma-1}{R} \right] (1-\alpha)\pi + \sigma 2\alpha \left[1 - \frac{1}{R} \right]^2$$

Clearly, for all $\frac{1}{\sigma} < R < 1$, the above always holds as under the case for depositors. Furthermore, for $R > 1$, the condition can be written as:

$$R > \frac{2\alpha}{\left[1 - \frac{1}{\sigma} [1 - 2\alpha] \right]}$$

which always holds as $\frac{2\alpha}{\left[1 - \frac{1}{\sigma} [1 - 2\alpha] \right]} < 1$ for $\sigma > 1$ and $\alpha < \frac{1}{2}$. This completes the proof of Proposition 3.

2. Proof of Lemma 2. From the result in Proposition 1, a unique steady-state exists in the benchmark economy if $\sigma < \underline{\sigma}_0$, where $\underline{\sigma}_0 : k_0 = \Omega^{-1}(2)$. As indicated in Lemma 1, \tilde{k}_0 is such that $f_1(k) = \frac{1}{\sigma}$. Therefore, \tilde{k}_0 is strictly increasing in σ . In the presence of the stock market, uniqueness of stationary equilibrium occurs when $\sigma < \underline{\sigma}_1$, where $\underline{\sigma}_1 : \tilde{k}_1 = \Omega^{-1}(2)$ and \tilde{k}_1 solves $f_1(k) + 1 - \delta = \frac{1}{\sigma}$, with $\frac{d\tilde{k}_1}{d\sigma} > 0$. In this manner, it is obvious that $\tilde{k}_1 > \tilde{k}_0$ for any given σ . Consequently, $\underline{\sigma}_1 < \underline{\sigma}_0$. Therefore, the parameter space under which multiple steady-states occur is much larger when capital is traded across generations. This completes the proof of Lemma 2.

3. Proof of Proposition 6. As discussed in the text, the consumption of an entrepreneurs in the presence of a stock market is: $c^e = (f_1(k) + 1 - \delta)w(k)$. By differentiating the utility of entrepreneurs with respect to σ we get:

$$\frac{du^e}{d\sigma} = \frac{du^e}{dk} \frac{dk}{d\sigma}$$

Upon using a Cobb-Douglas production function, we get:

$$\frac{du^e}{dk} = \frac{(2\alpha - 1) 2^{1-\alpha} A \alpha k^{2\alpha-2} + \alpha(1-\delta) k^{\alpha-1}}{c^e}$$

With some simplifying algebra, $\frac{du^e}{dk} \leq 0$ if:

$$k^{1-\alpha} \leq \frac{(1-2\alpha) 2^{1-\alpha} A}{(1-\delta)}$$

Therefore, when a reverse Tobin effect is present, $\frac{du^e}{d\sigma} > 0$ if the condition above holds

Equivalently using the fact that: $R = 2^{1-\alpha} A \alpha k^{\alpha-1} + 1 - \delta$. The condition above can be written as:

$$R \geq (1-\delta) \left(\frac{1-\alpha}{1-2\alpha} \right) \equiv \hat{R}$$

where $\hat{R} > 1$ if:

$$\frac{\alpha}{1-\alpha} > \delta$$

The result in Proposition 6 directly follows. This completes the proof of Proposition 6.

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