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THE ROLE OF FINANCIAL SECTOR COMPETITION FOR MONETARY POLICY

Edgar A. Ghossoub
Department of Economics
University of Texas at San Antonio
6900 North Loop 1604 West
San Antonio, TX 78249-0634

Thanarak Laosuthi
Kasetsart University

Robert R. Reed
University of Alabama
Tuscaloosa
AL, 35487
Tel: (205) 348-8667

*Department of Economics,
University of Texas at San Antonio,
San Antonio TX 78249 U.S.A*

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“The Role of Financial Sector Competition for Monetary Policy”*

Edgar A. Ghossoub Thanarak Laosuthi
University of Texas at San Antonio Kasetsart University

Robert R. Reed[†]
University of Alabama

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Abstract

In this paper, we examine the impact of competition in the banking industry on financial market activity. In particular, we explore this issue in a setting where banks simultaneously insure individuals against liquidity risk and offer loans to promote intertemporal consumption smoothing. In addition, spatial separation and private information generate a transactions role for money.

Interestingly, we demonstrate that the industrial organization of the financial system bears significant implications for the effects of monetary policy. Under perfect competition, higher rates of money growth lead to lower interest rates and a higher volume of lending activity. In contrast, in a monopoly banking sector, money growth restricts the availability of funds and raises the cost of borrowing.

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1 Introduction

Recent evidence indicates that the degree of financial sector competition varies markedly across countries. For example, within the European Monetary Union,

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[†]For correspondence: Robert R. Reed, Department of Economics, Finance, and Legal Studies, Culverhouse College of Business, University of Alabama, Tuscaloosa, AL 35487; Email: rreed@cba.ua.edu; Phone: 205-348-8667; Fax: 205-348-0590.

Greece and Belgium have highly concentrated industries while France and Germany are much less so.¹ Moreover, in the United States, a number of studies have documented that there are large differences in the degree of concentration in local markets. In particular, concentration is much higher in rural markets than in urban areas.^{2,3}

In light of these observations, this paper examines the impact of the competitive structure of the banking industry on financial market outcomes. Using a model of Bertrand competition, we compare economies with competitive banking sectors to fully concentrated industries.⁴ Under perfect competition, higher rates of money growth increase the amount of loans and lower interest rates. In contrast, in a monopoly banking economy, money growth leads to less lending activity and higher costs of borrowing.

Consequently, our results suggest that the industrial organization of the financial system should be an important factor in the determination of monetary policy. In particular, the findings for the monopolistic economy mirror recent empirical studies which emphasize that inflation generally inhibits financial sector performance. For example, Boyd, Levine, and Smith (2001) point out that the volume of lending to the private sector is lower in high inflation countries.⁵ This implies that noncompetitive behavior is a significant aspect of financial market activity.

In order to provide deeper insight into the results, we proceed by outlining the details of our framework. In the model, there are two types of agents who value different opportunities to smooth consumption. The first group of agents, depositors, experience liquidity risk and wish to smooth income fluctuations across states. As in Diamond and Dybvig (1983), financial institutions provide risk pooling services to help insure individuals against such risk.⁶ The second group of agents, borrowers, do not experience liquidity risk. However, loans

¹Beck, Demigruc-Kunt, and Levine (2003) report that over the period from 1990-1997, the average level of bank concentration across 99 countries was 0.72 but ranged from 1.0 to 0.2.

²Metropolitan Statistical Areas (MSAs) define the local market in urban areas while counties are used to measure activity in rural areas.

³Although the degree of concentration differs across economies, there is also concern that the industry is generally becoming less competitive over time. For example, there were around 19,000 different financial institutions in the United States in 1989. Nearly ten years later, only 10,000 were in operation. For more discussion, see the Bank for International Settlements (2001).

⁴Sharpe (1991) constructs a model with switching costs to determine the relationship between market structure and prices in retail bank deposit markets. In a partial equilibrium framework, Whitesell (1992) considers the deposit rates offered when banks experience competition for transactions services. Hutchison (1995) develops an intertemporal asset pricing model with Cournot competition to study deposit rates.

⁵See Huybens and Smith (1999) for more discussion on the relationship between inflation and financial markets.

⁶Fecht and Martin (2005) construct a model based upon Diamond and Dybvig (1983) to study the relationship between depositors' access to financial markets and the degree of competition among banks. Depending on the competitive structure of the banking industry, greater access to financial markets may lead to less risk sharing. However, in contrast to our framework, they do not consider the interactions between the degree of competition and monetary policy.

from banks help them to smooth consumption over time. Thus, the economy is composed of two different financial markets: a deposit market and a credit market. As we demonstrate, there are important linkages between the two markets.⁷ Notably, pricing decisions in the *deposit* market affect the availability of funds in the *credit* market.

Following Townsend (1987) and Schreft and Smith (1997), spatial separation and private information generate a transactions role for money. The economy consists of two geographically separated islands and communication across islands is not possible. This friction limits trading opportunities so that private liabilities do not circulate. In this manner, liquidity risk is motivated by relocation shocks which force individuals to move to the other island. Since money is the only asset that can be traded across locations, depositors who experience positive realizations of the relocation shock will seek to withdraw funds in the form of money balances. These individuals will consume less than depositors who do not move because money is dominated in rate of return. Nevertheless, banks must acquire money holdings in order to provide individuals with insurance against the liquidity risk that they encounter.

As a benchmark, we study the effects of money growth if the banking sector is perfectly competitive. Under perfect competition, banks provide lenders with an amount of insurance to maximize their expected utility. In this setting, a type of Tobin effect occurs. At higher rates of money growth, the costs of holding money increase. As a result, banks choose to reduce the liquidity of their portfolios and supply more loans to the credit market. This leads to an increase in lending activity and lower interest rates.

Next, we study the behavior of a monopolist bank. Since the monopolist seeks to maximize profits, it only provides enough insurance to induce individuals to deposit their funds. In this sense, market power imposes a pricing distortion in the deposit market.⁸ Consequently, the effects of monetary policy are significantly different than in a perfectly competitive financial system.⁹ At higher inflation rates, individuals who experience relocation shocks would receive a lower rate of return. In order to provide depositors with sufficient insurance, banks acquire additional money balances. The increase in money holdings reduces the availability of funds to borrowers. Moreover, interest rates are higher. In this manner, the competitive structure of the financial system has important

⁷Antinolfi and Kawamura (2008) discuss the relative importance of banks versus other types of financial markets for monetary policy. While banks help insure individuals against liquidity risk, financial markets allow banks to insure themselves against risks from investment opportunities.

⁸In the United States, both Berger and Hannan (1989) and Neumark and Sharpe (1992) find that monopolistic banks exercise their influence by distorting prices. To be specific, Berger and Hannan observe that banks in markets with higher concentration pay lower rates on deposits. In contrast, Neumark and Sharpe find that concentration is associated with asymmetric price rigidities – banks generally pay higher rates of return when market rates increase, but monopolistic banks adjust them more slowly. In contrast, downward price adjustments are much more flexible.

⁹In contrast to imperfections from market power, Bhattacharya, Haslag, and Martin (2005) study the implications of private information for optimal monetary policy. Due to the friction of moral hazard, the Friedman Rule may not be the optimal monetary policy.

ramifications for the effects of monetary policy.

Related Literature

Our work contributes to a growing literature that investigates the economic impact of the industrial organization of the financial system. To begin, Boyd, DeNicolò, and Smith (2004) construct an overlapping generations model with *aggregate* liquidity risk to study how competition affects the probability of a banking crisis. If the inflation rate is sufficiently high, banking crises are more likely to occur in a monopolistic banking system. In addition, Paal, Smith, and Wang (2005) develop an endogenous growth model to study the impact of financial competition on economic growth. Interestingly, they point out that banking concentration may be growth-enhancing.¹⁰

While our research seeks to determine how banking competition affects financial market activity, there are important differences compared to previous work on the topic. For example, in Boyd, DeNicolò, and Smith, banks face an exogenous rate of return to investment projects. However, our framework incorporates a credit market in which the interest rate and volume of lending activity respond to the competitive structure of the financial system. Moreover, the impact of monetary policy depends on the degree of competition in significant ways.

Our work also contrasts with Paal, Smith, and Wang. Although their production economy generates an endogenous rate of return to investment, financial institutions provide different services compared to our model. Both papers consider the role of banks for providing insurance against liquidity risk, but Paal, Smith, and Wang view that financial institutions act as intermediaries which channel funds to promote capital accumulation and growth. By comparison, we emphasize that banks are important institutions which provide risk pooling services and *intertemporal* consumption smoothing. Notably, we show that pricing decisions in the deposit market can affect economic activity in the credit market. In doing so, we can further examine how monetary policy interacts with the competitive structure of the financial system. The results are qualitatively significant – frictions from monopoly power may be responsible for the detrimental impact of inflation on credit market activity observed in the empirical literature. In addition, we study the impact of monetary policy in economies where the government’s seigniorage revenues are redistributed to individuals in the private sector.

The paper is organized as follows. Section 2 describes the economic environment. Section 3 studies activity in a perfectly competitive banking system. Section 4 considers the impact of monetary policy in a monopolistic banking sector. Section 5 extends the model to examine the impact of monetary policy

¹⁰Pagano (1993) shows that market concentration has an adverse effect on economic growth. As a result of the higher rate on loans, Guzman (2000) finds that default is more likely to occur in an economy with a monopolistic banking industry.

in economies where the government's seigniorage revenues are redistributed to agents in the private sector. Section 6 provides concluding remarks. The proofs of major results are provided in the Appendix.

2 Environment

We consider a discrete-time economy populated by an infinite sequence of two-period lived overlapping generations, plus an initial old generation. In particular, the economy consists of two symmetric, geographically separated islands. On each island, there are three types of agents: depositors, borrowers, and bankers. While the population of both depositors and borrowers is equal to one, the population of bankers is given by N . The competitive structure of the financial system depends on the population of bankers. If $N = 1$, there is only one bank available to individuals. In contrast, if $N > 1$, the banking industry behaves in a perfectly competitive manner. Although the population resides in two separate locations, there is a single consumption good available on both islands. The price of one unit of goods in units of currency is common across locations and is defined by P_t .

Each depositor is born with x units of the consumption good but does not receive an endowment when old. In addition, depositors only derive utility from old-age consumption (c_2) with preferences $u(c_2) = \frac{c_2^{1-\theta}}{1-\theta}$, where $\theta \in (0, 1)$. In contrast to depositors, borrowers receive y units of the consumption good when old. Moreover, borrowers derive utility from consumption in both periods of their lives. The lifetime utility function of borrowers is expressed by: $U(c_1, c_2) = \frac{c_1^{1-\theta}}{1-\theta} + \beta \frac{c_2^{1-\theta}}{1-\theta}$. Finally, bankers do not have any endowments. Like depositors, they only value second period consumption. However, bankers are risk neutral.¹¹

Private information serves as the primary trade friction in the economy. Although each island is characterized by complete information, communication across islands is not possible. Consequently, private liabilities do not circulate. Moreover, depositors in the economy are subject to relocation shocks. Each period, a fraction of young depositors must move to the other island. The probability of relocation, π , is exogenous, publicly known, and the same in each island. Unlike depositors, borrowers are not subject to relocation.

As in standard random relocation models, money alleviates trade frictions made difficult by spatial separation. In particular, it is the only asset that can cross locations. 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).

Banks provide two major services in the economy. First, they insure depositors against liquidity shocks. Since banks provide insurance against the

¹¹If the banking system is fully concentrated, the monopoly bank earns positive profits. Since bankers derive utility in the second period, they retain their net revenues for consumption. This follows Boyd, De Nicolò, and Smith (2004) and Paal, Smith, and Wang (2005).

shocks, each young depositor will put all of her income in the bank. Second, as borrowers value consumption in both periods of their lives, financial intermediaries provide them with an opportunity to smooth their consumption by issuing loans. In this manner, banks offer a schedule of rates of return for each unit of deposits and charge interest rates for each unit of loans. With deposits received, banks allocate funds to real money balances, m_t , and loans, l_t .

The final agent in the economy is a central bank that adopts a constant money growth rule. The total nominal amount of money in each location at time t is given by M_t . The evolution of the money supply on each island follows $M_t = \sigma M_{t-1}$, where σ is the gross rate of money creation. Money holdings by each old individual from the initial generation are equal to M_0 .

Next, we describe the timing of events and actions. At the initial stage of date t , young depositors receive their endowments and banks announce the schedule of interest rates (r_t^m if relocated and r_t^n if not relocated). Given interest rates in the deposit market, young depositors leave their d_t units of goods at local banks. With deposits received, banks choose portfolio allocations between money and loans. The amount of cash that banks acquire comes from two sources. First, money balances can be obtained by conducting trades with old movers. In particular, banks provide movers with $\frac{M_{t-1}}{P_t}$ units of goods in exchange for their currency holdings. Furthermore, financial institutions receive additional currency through monetary injections from the the government. With the remaining funds, banks issue loans to young borrowers.

After bank portfolios for the current period are established, old borrowers receive their endowments. Due to their obligations in the credit market, borrowers must pay back their loans along with interest to the bank. Banks use these funds to finance payments to old depositors or consume them directly as profits. At the end of period t , young depositors learn their location status. Those who must move will go to the bank and withdraw currency. At the end of the period, relocation occurs and all old agents consume and die.¹²

We continue by explaining the behavior of each group of individuals.

2.1 Depositors

Depositors are born with endowments but derive utility from consumption only in their old-age. As in Diamond and Dybvig (1983), depositors benefit from the risk pooling services of financial institutions. While individuals may deposit their funds with banks, they also have the option of choosing not to participate in the financial system. For example, depositors may possess storage technologies

¹²In our benchmark framework, we assume that the government retains its seigniorage revenues. In this manner, inflation tax revenues do not affect asset allocation decisions. This follows Paal, Smith, and Wang (2005). However, in Section 5 below, we extend the model to include inflation-financed government debt. Consequently, seigniorage revenues will be redistributed from old movers to old non-movers. That is, inflation taxes redistribute income across different groups of depositors. In the Appendix, we also demonstrate that our results are robust to settings in which seigniorage revenues are redistributed from old movers to old borrowers.

that allow them to transfer income over time. For simplicity, the utility from autarky (opting out of the banking system) is exogenous and given by \bar{u} .¹³ However, if the value of autarky is sufficiently low, depositors leave all of their funds at banks:

$$d_t = x \tag{1}$$

2.2 Borrowers

Borrowers receive endowments when old and do not experience liquidity shocks. Furthermore, they value consumption during their youth and old-age. In order to smooth consumption, they seek to obtain loans (l_t^d) from financial institutions. As R_t represents the real interest rate for each unit of loans, a borrower's objective is:

$$Max_{l_t^d} \frac{(l_t^d)^{1-\theta}}{1-\theta} + \beta \frac{(y - R_t l_t^d)^{1-\theta}}{1-\theta} \tag{2}$$

Therefore, individual loan demand is given by:

$$l_t^d = \frac{y}{(\beta R_t)^{\frac{1}{\theta}} + R_t} \tag{3}$$

Borrowers' loan demand functions have standard properties. For example, an individual's demand for funds is inversely related to the cost of borrowing. If agents obtain higher levels of income in old-age, they will borrow more. In contrast, if borrowers place more weight on old-age utility, the demand for loans will fall.

Depending on the degree of competition, banks will provide different levels of insurance against liquidity risk. As a result, the demand for money balances in the economy will be influenced by the industrial organization of the financial system. In turn, financial sector competition will determine the availability of funds to the credit market. Furthermore, through these features of financial market activity, we are able to demonstrate that market power leads to different effects of monetary policy.

3 Perfectly Competitive Banks

In a perfectly competitive banking industry, banks compete against each other for deposits. Intermediaries are Nash competitors; that is, banks announce rates of return (r_t^m, r_t^n), taking the announced rates of return of other banks as given.

¹³Notably, the value of autarky is independent of the rate of return to money. That is, as autarky represents a situation in which individuals do not participate in the financial system, they do not have access to money balances. We elaborate on this restriction in Section 4 below.

Then, each bank chooses a schedule (r_t^m, r_t^n, m_t, l_t) to maximize the expected utility of a representative depositor. A representative bank's objective is:

$$\underset{r_t^m, r_t^n, m_t, l_t}{Max} \quad \pi \frac{(r_t^m x)^{1-\theta}}{1-\theta} + (1-\pi) \frac{(r_t^n x)^{1-\theta}}{1-\theta} \quad (4)$$

subject to a balance sheet constraint:

$$x \geq m_t + l_t \quad (5)$$

Relocated agents cannot access their account in the other location due to limited communication. As a result, they must use money to trade for goods. Therefore, the return to relocated individuals depends on the amount of reserves and inflation:

$$\pi r_t^m x \leq m_t \frac{P_t}{P_{t+1}} \quad (6)$$

In contrast, agents who do not move can keep their funds in the bank. The rate of return will be determined by the bank's revenue from the credit market:

$$(1-\pi)r_t^n x \leq R_t l_t \quad (7)$$

In addition, if the return of relocated agents is more than the return of nonrelocated agents, individuals will lie about their types. Consequently, they would all seek to withdraw deposits at the end of the period. For these reasons, the following self-selection constraint must also hold:

$$r_t^m \leq r_t^n \quad (8)$$

Finally, in order to induce individuals to deposit their funds, the expected utility of each depositor must satisfy a participation constraint. In particular, young depositors may choose not to participate in the financial system. Consequently, the expected utility from depositing funds must be higher than the autarky level (\bar{u}):

$$\frac{\pi (r_t^m x)^{1-\theta} + (1-\pi) (r_t^n x)^{1-\theta}}{(1-\theta)} \geq \bar{u} \quad (9)$$

To maximize an individual's expected utility, banks allocate funds to currency reserves such that:

$$m_t = \frac{x}{\left[1 + \frac{1-\pi}{\pi} \left(R_t \frac{P_{t+1}}{P_t} \right)^{\frac{1-\theta}{\theta}} \right]} \quad (10)$$

As $\theta < 1$, the bank's money demand function is decreasing in its return to investment opportunities. This occurs for the standard reasons in monetary models – higher rates of return to interest-bearing assets raise the opportunity cost of holding money. Similar arguments apply to the effects of inflation. At higher

inflation rates, the value of real money balances will be lower. Consequently, each bank chooses to allocate less deposits to money holdings.

Equilibrium We proceed to examine economic outcomes in the steady-state. Given the monetary authority's fixed money growth rule, it is easily shown that the gross inflation rate, $\frac{P_{t+1}}{P_t}$, is equal to σ .

Definition 1. *A steady-state equilibrium in a perfectly competitive banking industry is an economy such that:*

1. *depositors put all of their endowments in banks, (1) and (9);*
2. *each bank's objective is to maximize the expected utility of a representative depositor, (4), and*
3. *the self-selection condition for depositors holds (8).*

Proposition 1. *Assume that \bar{u} is sufficiently small. In addition, suppose that the money growth rate and borrowers' endowments are such that $\frac{y}{x} > \left((\beta \frac{1}{\sigma})^{\frac{1}{b}} + \frac{1}{\sigma} \right) (1 - \pi)$. Under this condition, a steady-state equilibrium in a perfectly competitive banking sector exists and is unique.*

To provide interpretation for the conditions in the Proposition, it is useful to recognize that we seek to study economies in which money is dominated in rate of return. Moreover, the economy should have an active banking sector. In this manner, the first condition guarantees that individuals deposit their funds at banks. In addition, the interest rate on loans will be higher if there is more demand by borrowers. This occurs if borrowers receive a large amount of income in old-age. As a result, the second condition establishes that money is dominated by the rate of return in the credit market.

We continue by investigating the effect of monetary policy on credit market outcomes.

Proposition 2. *Suppose that a steady-state under perfect competition exists. If this occurs, higher inflation leads to an increase in the amount of loans. Furthermore, there is a negative relationship between the growth rate of money and the interest rate in the credit market.*

When inflation rates are higher, the cost of holding money increases. In order to maximize the expected utility of a representative depositor, perfectly competitive banks devote less funds to money balances. As a result, the amount of loans increases and interest rates in the credit market fall.

4 A Monopoly Bank

We now examine an economy in which the banking sector is fully concentrated. In our framework, monopoly power leads to two important considerations for

financial market activity. First, because there is only one bank available to depositors, the monopolist is the only financial institution that provides insurance against liquidity risk in the economy. Second, as the monopolist is also the only supplier of credit, it takes into account that the interest rate it charges will affect the total demand for funds by borrowers. Notably, money holdings and loans are the only two investment opportunities available to the bank. Consequently, the pricing distortions across financial markets are linked together. These distortions bear significant ramifications for the impact of monetary policy on credit market activity.

In the economy with a perfectly competitive financial system, each bank chooses its loan supply and interest rates in the deposit market to maximize the expected utility of depositors. That is, taking the price of loans in the credit market as given, perfectly competitive banks design portfolio allocations to appropriately insure depositors against liquidity risk. In contrast to perfectly competitive banks, the monopolist exploits market power by choosing the interest rate in the credit market to earn positive profits. In particular, it sets a schedule (r_t^m, r_t^n, m_t, R_t) to maximize profits:

$$\underset{r_t^m, r_t^n, m_t, R_t}{Max} R_t l_t^d(R_t) - (1 - \pi)r_t^n x + m_t \frac{P_t}{P_{t+1}} - \pi r_t^m x \quad (11)$$

As in the economy with perfectly competitive banks, depositors must receive sufficient incentives to deposit funds in the bank. Since there is only one bank available, the monopolist can extract all of the gains from using the financial system. Therefore, it offers rates of return such that the expected utility from depositing funds is equal to the autarky level. As a result, the participation constraint in equation (9) is binding.¹⁴

Because money is dominated in rate of return, the monopolist will only devote funds to money balances in order to make payments to depositors who experience relocation shocks. Consequently, monopoly profits come from excess credit market revenues after payments to nonrelocated depositors. Furthermore, substituting from the binding participation constraint (9), the bank's problem reduces to choosing R_t to maximize profits:

$$\underset{R_t}{Max} R_t l_t^d(R_t) - (1 - \pi)r_t^n(R_t)x$$

In order to determine the impact of monetary policy under a fully concentrated banking sector, we proceed to study the economy's steady-state:

Definition 2. *A steady-state equilibrium in a fully concentrated banking sector is an economy such that:*

1. *depositors put all of their funds in an account at the bank, (1) and (9);*
2. *the bank chooses a schedule (r^m, r^n, m, R) to maximize profits, (11);*

¹⁴Since the expected utility in autarky only depends on exogenous parameter values, it is possible to obtain a closed form solution for either the return to movers or non-movers. In this manner, limited participation provides additional analytical tractability.

3. the self-selection condition for depositors holds, (8), and
4. the bank earns positive profits.

Proposition 3. Suppose that $\bar{u} < \frac{\pi^\theta (\frac{x}{\sigma})^{1-\theta}}{1-\theta}$. Also, let

$$y > \left(x - \pi \sigma \left((1-\theta) \bar{u} \right)^{\frac{1}{1-\theta}} \right) \left(1 + \left(\frac{\beta}{\sigma} \right)^{\frac{1}{\theta}} \right).$$

Under these conditions, a steady-state in the monopoly banking economy exists and is unique. In particular, the monopolist provides depositors with full insurance against liquidity risk.

As shown in the proof of Proposition 3, the monopolist's profit maximizing choice for the interest rate in the credit market is constrained by the requirement that payments to non-movers must be at least as large as payments to movers. That is, (unconstrained) profits are high when the monopolist charges a high interest rate in the credit market. At high interest rates, the bank supplies a relatively low amount of funds to borrowers. Since banks only value second period profits, its cash holdings ($m = x - l^d$) will be high when it distorts the credit market.

Therefore, at high interest rates in the credit market, the monopoly bank provides depositors with a high degree of insurance against liquidity risk. Prior to their realization of the need for liquidity, depositors would choose to put their funds in the bank. In fact, ex-ante, individuals would be willing to accept a higher rate of return in the event that relocation occurs. However, payments to non-movers would not be sufficient to induce them to leave their funds at the bank. That is, the self-selection constraint, (8), would not hold and all depositors would seek to liquidate their funds early.

Consequently, the (constrained) profit-maximizing interest rate occurs where non-movers and movers earn the same rate of return. As a result, the self-selection constraint binds:

$$r^m = r^n = r$$

Because depositors receive the same rate of return regardless of the realization of their location status, the monopoly bank provides depositors with full insurance against liquidity risk. Nevertheless, while they receive a deterministic amount of income, they obtain a low rate of return.

In particular, as there is only one financial institution that provides risk pooling services, the monopolist will only offer enough income to induce lenders to deposit their funds. That is, it will only offer a sufficient return so that the expected utility from participating in the financial system is equal to the autarky level, \bar{u} :

$$r = [(1-\theta) \bar{u}]^{\frac{1}{1-\theta}} \left(\frac{1}{x} \right)$$

In order to provide depositors with full insurance against relocation shocks, the bank sets currency reserves equal to:

$$m = [(1 - \theta) \bar{u}]^{\frac{1}{1-\theta}} (\pi\sigma) \quad (12)$$

In turn, the volume of loans and interest rate in the credit market are given by:

$$l = x - [(1 - \theta) \bar{u}]^{\frac{1}{1-\theta}} (\pi\sigma) \quad (13)$$

$$\frac{y}{(\beta R)^{\frac{1}{\theta}} + R} = x - \pi\sigma [(1 - \theta) \bar{u}]^{\frac{1}{1-\theta}} \quad (14)$$

With this background, it is possible to provide interpretation behind the conditions for existence of a monetary steady-state. The first condition, $\bar{u} < \frac{\pi^\theta (\frac{x}{\sigma})^{1-\theta}}{1-\theta}$, is a sufficient condition for positive profits. Consequently, the bank can profitably operate as long as interest rates are positive in the credit market. Moreover, as in the case of the perfectly competitive economy, the interest rate on loans is higher when borrowers receive a large amount of income in old-age. Thus, the second condition guarantees that money is dominated in rate of return.

At this juncture, we offer the following Proposition that describes the effects of monetary policy in a monopolistic banking sector:

Proposition 4. *In a fully concentrated banking economy, monetary policy generates a reverse-Tobin effect. That is, an increase in the rate of money growth is associated with a lower amount of loans and higher interest rates in the credit market.*

In contrast to perfectly competitive banks, a monopolist seeks to acquire additional cash reserves under higher inflation rates. For a given level of money holdings, an increase in the inflation rate reduces the return to movers. Since non-movers would earn a higher rate of return than depositors who experience liquidity shocks, higher rates of money growth provide the bank with an opportunity to further distort the credit market. That is, at higher rates of money growth, the bank can issue even less loans. Because the bank acquires more cash, movers will not experience a consumption loss from inflation.

Interestingly, our results demonstrate that the competitive structure of the financial system should be an important factor in the determination of monetary policy. If the financial sector is perfectly competitive, higher rates of money growth raise the cost of holding money and increase the supply of funds to the credit market. In contrast, in a monopoly system, money growth reduces the availability of credit.¹⁵

¹⁵In order to promote the tractability of our framework, we have assumed that individuals may only obtain access to money balances through financial institutions. Therefore, the

5 An Economy with Government Debt

The preceding sections examine how the impact of monetary policy depends upon the industrial organization of the financial system. In economies where financial institutions have market power, pricing distortions can occur. As a result, the effects of monetary policy can be substantially different in economies where banks engage in non-competitive behavior.

In this section, we extend our analysis to consider the possibility of government debt. Following Schreft and Smith (1997), the government finances interest payments on previously issued debt through seigniorage revenues and new bonds. Accordingly, banks can acquire three different types of financial assets: money, loans to the private sector, and government bonds. In this manner, seigniorage revenues transfer income between depositors who experience different realizations of the relocation (i.e., liquidity) shock.¹⁶

The primary purpose of this section is to illustrate that our previous insights are robust to the possibility of inflation-financed government debt. As a starting point, we focus on the case of a perfectly competitive financial system. The section concludes with some remarks about the effects of money growth in the presence of a monopoly bank.

Government bonds mature after one period and are default-free. In particular, one unit of goods held in bonds at t constitutes a sure claim to R_t^b units of goods at $t + 1$.¹⁷ In this setting, the government's budget constraint becomes:

$$R_{t-1}^b b_{t-1} = \frac{(M_t - M_{t-1})}{P_t} + b_t \quad (15)$$

Since banks can allocate funds to an additional financial asset, a perfectly competitive bank's balance sheet constraint is given by:

$$m_t + l_t + b_t \leq x \quad (16)$$

Furthermore, banks issue loans and acquire government bonds until both types of investments yield the same rate of return. That is, a no-arbitrage condition must hold:

$$R_t = R_t^b$$

expected utility of autarky is independent of monetary policy. We could also consider that $m = \pi \left[(1 - \theta) \bar{u}(\sigma) \right]^{\frac{1}{1-\theta}} \sigma$ where \bar{u} is decreasing in the rate of money growth. Keeping the expected utility from autarky constant, the monopolist can acquire more money if inflation is higher. By comparison, inflation would also lower the value of autarky and reduce the need for the monopolist to provide insurance against liquidity risk. However, as long as expected utility is not too sensitive to inflation, our results continue to hold.

¹⁶As previously mentioned, the Appendix demonstrates that the impact of monetary policy on credit market activity also applies to economies in which seigniorage revenues are redistributed from old movers to old borrowers.

¹⁷Alternatively, one unit of bonds held in period t yields I_t units of currency in period $t + 1$. Thus, we can express the real return to bonds as $R_t^b = I_t \frac{P_t}{P_{t+1}}$.

Finally, the demand for cash reserves is the same as Section 3.

The following Lemma considers the impact of monetary policy in the economy with government debt:

Lemma 1. *Suppose $\theta = \frac{1}{2}$ and $\sigma > 1 + \sqrt[2]{\frac{1}{1-\pi}}$. Under these conditions, a steady-state in a perfectly competitive banking economy exists in the presence of government debt. Furthermore, lending activity increases and interest rates in the credit market decrease at higher rates of money growth.*

Notably, Lemma 1 provides *sufficient* conditions in which the effects of money growth from Section 3 extend to the possibility of government debt. In Section 3, inflation raises the cost of holding money and leads banks to issue more loans to borrowers. If the government issues bonds, seigniorage revenues provide the government with the ability to borrow funds and crowd out loans to the private sector. However, if the government imposes a higher inflation tax, the seigniorage tax base falls because banks reduce their money holdings. *Consequently, this restricts the ability to issue more bonds at higher inflation rates.* As a result, the impact of monetary policy is qualitatively the same as Section 3.

Using analogous reasoning, introducing government debt reinforces the effects of monetary policy on credit market activity in a concentrated financial system. Due to the pricing distortions in the deposit market, a monopoly bank acquires more money balances and issues less loans if money growth is higher. Since money holdings increase, the seigniorage tax base is also higher, allowing the government to supply more bonds. Therefore, at higher rates of money growth, the crowding out effect becomes more significant. In this manner, our results are robust to the possibility of inflation-financed government debt.

6 Conclusions

Recent evidence indicates that the competitive structure of the financial system varies both within and across countries. In order to explore the impact of competition in the financial sector, we develop a model of Bertrand competition. In our framework, banks provide two different types of financial services. In the deposit market, banks insure individuals against liquidity risk. Alternatively, in the credit market, financial institutions offer loans so that agents can smooth consumption over time. Notably, pricing decisions across markets affect overall financial market outcomes. For example, under perfect competition, higher rates of money growth generate an increase in lending along with lower costs of borrowing. However, in a monopoly banking sector, money growth reduces the amount of loans and raises interest rates. Interestingly, the latter prediction echoes recent empirical studies which emphasize that inflation adversely affects financial sector performance. In this manner, our results suggest that noncompetitive behavior is a significant aspect of activity in the financial system.

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7 Technical Appendix

1. Proof of Proposition 1. Using a typical bank's balance sheet, (5) and the demand for cash reserves, (10), the supply of loans in the steady-state is expressed by:

$$l^s = (1 - \gamma(R, \sigma))x \quad (17)$$

where γ is the fraction of deposits allocated to real money balances, with $\gamma(R, \sigma) = \frac{m}{x}$. The steady-state behavior of the economy is characterized by the equilibrium in the loan market. That is, the intersection of the demand and supply of loans, (3) and (17), respectively.

First, it is clear that $\frac{\partial l^s}{\partial R} > 0$ while $\frac{\partial l^d}{\partial R} < 0$. Furthermore, $\lim_{R \rightarrow \infty} l^s \rightarrow x$ and $\lim_{R \rightarrow \infty} l^d \rightarrow 0$. Consequently, a steady-state where money is dominated in rate of return exists and is unique if at $R = \frac{1}{\sigma}$, the loan market is in excess demand. Evaluating the credit market at $R = \frac{1}{\sigma}$, an excess demand occurs when the condition in Proposition 1 is satisfied. This completes the proof of Proposition 1.

2. Proof of Proposition 2. From the loan market clearing condition we have:

$$\frac{y}{(\beta R)^{\frac{1}{\theta}} + R} = (1 - \gamma(R, \sigma))x$$

Taking the derivative with respect to σ :

$$\frac{\partial R}{\partial \sigma} = \frac{\frac{\partial \gamma}{\partial \sigma}}{\frac{y}{x} \left(\frac{1}{\theta} \beta^{\frac{1}{\theta}} R^{\frac{1-\theta}{\theta}} + 1 \right) \left[(\beta R)^{\frac{1}{\theta}} + R \right]^{-2} - \frac{\partial \gamma}{\partial R}} < 0$$

Furthermore, it is easy to verify that banks supply more loans under higher rates of money growth, for a given R . Consequently, lending activity rises and real interest rates fall under higher σ . This completes the proof of Proposition 2.

3. Proof of Proposition 3. Imposing steady-state on the bank's objective function and upon the substitution of (3) and (9), the problem can be expressed as:

$$\Pi(R) = \max_R \frac{y}{1 + \beta^{\frac{1}{\theta}} R^{\frac{1-\theta}{\theta}}} - \frac{\left[(1 - \theta)\bar{u} - \pi^\theta \left[\frac{1}{\sigma} \left(x - \frac{y}{(\beta R)^{\frac{1}{\theta}} + R} \right) \right]^{1-\theta} \right]^{\frac{1}{1-\theta}}}{(1 - \pi)^{\frac{\theta}{1-\theta}}}$$

Next, define $TR(R)$ and $TC(R, \sigma)$ to be total revenue and total cost, respectively, where:

$$TR(R) = \frac{y}{1 + \beta^{\frac{1}{\theta}} R^{\frac{1-\theta}{\theta}}}$$

$$TC(R, \sigma) = \frac{\left[(1 - \theta)\bar{u} - \pi^\theta \left[\frac{1}{\sigma} \left(x - \frac{y}{(\beta R)^{\frac{1}{\theta}} + R} \right) \right] \right]^{1-\theta}}{(1 - \pi)^{\frac{\theta}{1-\theta}}}$$

The bank's total revenue comes from income in the credit market and the total costs come from payments to nonrelocated depositors. It is easy to verify that the total revenue curve and the total cost curve are decreasing in R . In addition, $\lim_{R \rightarrow 0} TR(R) = y$, $\lim_{R \rightarrow 0} TC(R, \sigma) \rightarrow \infty$, $\lim_{R \rightarrow \infty} TR(R) = 0$, and

$$\lim_{R \rightarrow \infty} TC(R, \sigma) \rightarrow \Phi(\sigma) = (1 - \pi) \left[\frac{(1 - \theta)\bar{u} - \pi^\theta \left(\frac{x}{\sigma} \right)^{1-\theta}}{1 - \pi} \right]^{\frac{1}{1-\theta}}.$$

The monopolist's optimal choice depends on the sign of Φ . Specifically, if $\bar{u} < \frac{\pi^\theta \left(\frac{x}{\sigma} \right)^{1-\theta}}{1 - \theta}$, $\Phi < 0$.

Moreover, note that the monopolist's profit function is continuous and twice differentiable in R . From the above, $\lim_{R \rightarrow \infty} \Pi \rightarrow -\Phi$ and $\lim_{R \rightarrow 0} \Pi \rightarrow -\infty$. In this manner, $\Pi(R) < 0$ if $\Phi > 0$. Therefore, a solution to the monopolist problem exists if $\Phi < 0$. That is, if $\Phi < 0$, it is clear that $\frac{\partial \Pi(R)}{\partial R} > 0$. If the monopolist is unconstrained, it would choose $R \rightarrow \infty$ to minimize the cost of issuing loans since $\frac{\partial r^n}{\partial R} < 0$. However, this is not feasible because (8) must hold in equilibrium. Since the lower bound on r^n is r^m , the monopolist will choose $R : r^n = r^m = r$.

Using the fact that the self-selection constraint binds in equilibrium along with (9), (6), and (7), we obtain the supply of loans, $l^s = x - \pi\sigma \left[(1 - \theta)\bar{u} \right]^{\frac{1}{1-\theta}}$. Furthermore, money is dominated in rate of return if at $R = \frac{1}{\sigma}$, there is an excess demand for loans. Upon imposing $R = \frac{1}{\sigma}$ on the loan market, an excess demand for loans occurs when the condition in Proposition 3 is satisfied. This completes the proof of Proposition 3.

4. Proof of Proposition 4. The equilibrium interest rate in the credit market is such that $l^d = l^s$:

$$\frac{y}{(\beta R^*)^{\frac{1}{\theta}} + R^*} = x - \pi\sigma \left[(1 - \theta)\bar{u} \right]^{\frac{1}{1-\theta}}$$

It is clear from the above polynomial that the equilibrium interest rate increases under higher rates of money growth. Moreover, from the expression for loan supply above, inflation adversely affects lending activity. This completes the proof of Proposition 4.

5. Proof of Lemma 1. Using the government budget constraint, (15), and a typical bank's balance sheet, (16), the total supply of loans by banks can be expressed by:

$$l^s = \left(1 - \left[R - \frac{1}{\sigma} \right] \frac{\gamma(R, \sigma)}{(R - 1)} \right) x$$

Moreover, taking the derivative with respect to R :

$$(R-1) \frac{1}{x} \frac{\partial l^s}{\partial R} = \left[\frac{\sigma-1}{\sigma(R-1)} \right] \gamma(R, \sigma) - \frac{\partial \gamma}{\partial R} \left[R - \frac{1}{\sigma} \right] > 0$$

In this manner, the supply of loans is strictly increasing in R for $\sigma > 1$.

Next we differentiate the supply of loans with respect to σ , at a given R , to obtain:

$$\sigma^2 \frac{(R-1)}{\gamma} \frac{1}{x} \frac{\partial l^s}{\partial \sigma} = -1 + [R\sigma - 1] \frac{1-\theta}{\theta} (1-\gamma)$$

The sign of $\frac{\partial l^s}{\partial \sigma}$ depends on the sign of the term on the right hand side of the equation. In particular, banks supply more loans under higher rates of money growth if:

$$[R\sigma - 1] (1-\gamma) > \frac{\theta}{1-\theta}$$

Substituting the expression for γ and letting $\theta = 0.5$, this condition can be written as:

$$I^2 - 2I - \frac{\pi}{1-\pi} > 0$$

where $I = R\sigma$.

Clearly, if $I > 1 + \sqrt[2]{\frac{1}{1-\pi}}$, banks supply more loans under higher rates of money growth. However, since we are interested in cases where $I > \sigma > 1$ (equivalently, $R > 1$), a sufficient condition for a Tobin effect is that $\sigma > 1 + \sqrt[2]{\frac{1}{1-\pi}}$. This completes the proof of Lemma 1.

6. Proofs for economies where seigniorage revenues are redistributed directly to old borrowers. First, we consider the existence and uniqueness of a steady-state equilibrium under perfect competition. If old borrowers receive transfers from the government, the demand for loans will be higher relative to the economy without transfers. Consequently, at $R = \frac{1}{\sigma}$, if an excess demand for loans occurs in the economy without seigniorage transfers, this necessarily implies there is excess demand in the economy with seigniorage transfers.

We proceed by considering the effects of monetary policy on the credit market. In the steady-state, the amount of transfers (τ) is such that $\tau = \frac{\sigma-1}{\sigma} m$. Substituting this expression into the demand for loans and imposing equilibrium in the loan market:

$$\frac{y + \frac{(\sigma-1)}{\sigma} \gamma x}{(\beta R)^{\frac{1}{\theta}} + R} = (1-\gamma) x \quad (18)$$

Using the expression for money demand, (10), it can be verified that $\frac{(1-\gamma)}{\gamma} = \frac{1-\pi}{\pi} (R\sigma)^{\frac{1-\theta}{\theta}}$. Combining with the loan market clearing condition, we get:

$$\frac{y}{x} + \left(1 - \frac{1}{\sigma}\right) = \left[(\beta R)^{\frac{1}{\theta}} + R - \frac{y}{x}\right] \frac{1-\pi}{\pi} (R\sigma)^{\frac{1-\theta}{\theta}} \quad (19)$$

where $(\beta R)^{\frac{1}{\theta}} + R > \frac{y}{x}$. Note that this condition always holds as total deposits must exceed the amount of loans issued and $R > 1$.

Next, we differentiate (19) with respect to σ :

$$\frac{\partial R}{\partial \sigma} = \frac{\left(\frac{1}{\sigma^2} - \left[(\beta R)^{\frac{1}{\theta}} + R - \frac{y}{x}\right] \frac{1-\pi}{\pi} \frac{1-\theta}{\theta} (R\sigma)^{\frac{1-\theta}{\theta}} \frac{1}{\sigma}\right) R}{\left(\frac{1}{\theta} (\beta R)^{\frac{1}{\theta}} + R + \left[(\beta R)^{\frac{1}{\theta}} + R - \frac{y}{x}\right] \frac{1-\theta}{\theta}\right) \frac{1-\pi}{\pi} (R\sigma)^{\frac{1-\theta}{\theta}}}$$

Since the denominator is positive, the sign of $\frac{\partial R}{\partial \sigma}$ depends on the sign of the numerator. Using (19), it can be verified that $\frac{\partial R}{\partial \sigma} < 0$ if:

$$\sigma > \frac{1}{(1-\theta)\left(1 + \frac{y}{x}\right)}$$

Subsequently, we study the effects of money growth on the amount of loans.

From the expression for money demand, (10), and some algebra, we can re-write the loan market clearing condition, (18), as:

$$\left(\beta^{\frac{1}{\theta}} \left(\frac{\pi}{1-\pi}\right)^{\frac{1}{\theta}} \left(\frac{1}{\sigma}\right)^{\frac{1-\theta}{\theta}} \left(\frac{l}{x-l}\right) + \frac{\pi}{1-\pi}\right) \left(\frac{l}{x-l}\right)^{\frac{1}{1-\theta}} = \left(1 + \frac{y}{(x-l)}\right) \sigma^{-1}$$

Taking the derivative with respect to money growth:

$$\frac{\partial l}{\partial \sigma} = \frac{1 + \frac{y}{(x-l)} + \frac{1-\theta}{\theta} \left(\frac{\pi}{1-\pi} \frac{\beta}{\sigma}\right)^{\frac{1}{\theta}} \left(\frac{l}{x-l}\right)^{\frac{1}{1-\theta}+1}}{x \left(\frac{1}{\sigma}\right)^{\frac{1-\theta}{\theta}} \left(\beta \frac{\pi}{1-\pi}\right)^{\frac{1}{\theta}} (x-l)^2 \left[\left(\frac{l}{x-l} + \frac{\pi}{1-\pi} \sigma^{\frac{1-\theta}{\theta}}\right) \frac{1}{1-\theta} \left(\frac{l}{x-l}\right)^{\frac{\theta}{1-\theta}} + \left(\frac{l}{x-l}\right)^{\frac{1}{1-\theta}} - \frac{\sigma^{\frac{1}{\theta}}}{\left(\beta \frac{\pi}{1-\pi}\right)^{\frac{1}{\theta}}} \frac{y}{x}\right]}$$

Clearly, the sign of the denominator determines the sign of $\frac{\partial l}{\partial \sigma}$. In particular, using (3) and (18), lending activity increases if:

$$(\beta R)^{\frac{1}{\theta}} + \frac{1}{1-\theta} \left((\beta R)^{\frac{1}{\theta}} + R\right) > \frac{y}{x}$$

which holds since $(\beta R)^{\frac{1}{\theta}} + R > \frac{y}{x}$ and $\theta < 1$.

We proceed to determine the impact of redistribution to old borrowers in a monopolistic banking sector. Since the bank takes the amount of transfers by the government as given, the bank's problem is identical to the case without transfers. Therefore, the bank's problem pins down the amount of loans in the economy. Further, the return on loans is obtained by loan-market clearing:

$$\frac{y + \tau}{(\beta R)^{\frac{1}{\theta}} + R} = x - \pi \sigma [(1-\theta) \bar{u}]^{\frac{1}{1-\theta}}$$

For money to be dominated in rate of return, the demand for loans must be significant at $R = \frac{1}{\sigma}$. A shortage in the loans market occurs at $R = \frac{1}{\sigma}$ if:

$$\frac{y + \frac{\sigma-1}{\sigma}x}{\left(\left(\beta\frac{1}{\sigma}\right)^{\frac{1}{\theta}} + 1\right)} > x - \pi\sigma [(1-\theta)\bar{u}]^{\frac{1}{1-\theta}}$$

This condition can be written as:

$$y > \left(x - \pi\sigma [(1-\theta)\bar{u}]^{\frac{1}{1-\theta}}\right) \left(\left(\beta\frac{1}{\sigma}\right)^{\frac{1}{\theta}} + 1\right) - \frac{\sigma-1}{\sigma}x$$

Note that in the case without transfers, $\tau = 0$, existence requires:

$$\frac{y}{(\beta R)^{\frac{1}{\theta}} + R} > x - \pi\sigma [(1-\theta)\bar{u}]^{\frac{1}{1-\theta}}$$

$$y > \left(x - \pi\sigma [(1-\theta)\bar{u}]^{\frac{1}{1-\theta}}\right) \left(\left(\beta\frac{1}{\sigma}\right)^{\frac{1}{\theta}} + 1\right)$$

Therefore, since $x > 0$ and $\sigma > 1$, a steady-state under $\tau > 0$ exists if the condition for existence under $\tau = 0$ is satisfied. That is, if a steady-state exists without transfers, it is also exists in the presence of transfers.

From previous work, the supply of loans is:

$$x - \pi\sigma [(1-\theta)\bar{u}]^{\frac{1}{1-\theta}}$$

which implies there is a reverse-Tobin effect in a monolistic banking sector. The impact of inflation on real interest rates can be examined from the loan market clearing condition:

$$\frac{y + \frac{\sigma-1}{\sigma}x}{\left((\beta R)^{\frac{1}{\theta}} + R + \frac{\sigma-1}{\sigma}\right)} = x - \pi\sigma [(1-\theta)\bar{u}]^{\frac{1}{1-\theta}}$$

First, we need to examine the impact of money growth on the demand for loans:

$$\frac{\partial l^d}{\partial \sigma} = \frac{\frac{1}{\sigma^2}x \left((\beta R)^{\frac{1}{\theta}} + R\right) - y\frac{1}{\sigma^2}}{\left((\beta R)^{\frac{1}{\theta}} + R + \frac{\sigma-1}{\sigma}\right)^2}$$

The sign of $\frac{\partial l^d}{\partial \sigma}$ depends on the term in the numerator. With some algebra, the sign of the numerator depends on:

$$x \leq \frac{y}{\left((\beta R)^{\frac{1}{\theta}} + R\right)}$$

Since the bank holds a positive amount of money balances in equilibrium, we know that $x > \frac{y+\tau}{\left((\beta R)^{\frac{1}{\theta}} + R\right)}$. Therefore, the numerator above is strictly positive

in cases where $\tau > 0$. This indicates that the demand for loans is higher. Unambiguously, the interest on loans is higher as well.

These arguments demonstrate that our results in the main text are robust to economies in which the government's seigniorage revenues are redistributed from depositors (movers) to old borrowers.