Banking Concentration and Loan Market Power in a Frictional Loan Market *

Mei **Dong**† Stella **HuangFu**‡ Timothy **Kam**§ Sam **Ng**¶

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Abstract

Conventional models of imperfect competition, such as the Cournot model, often predict a positive relationship between concentration and market power. However, in the banking sector, empirical evidence on this relationship is mixed. To explore how banking concentration influences loan market power, measured by the loan rate markup, we develop a model featuring a frictional loan market. In our baseline model, a less concentrated banking sector with more banks makes it easier for entrepreneurs to find banks to get loans, enhancing their outside options and lowering loan rates. We refer to this mechanism as the "waiting" channel, which aligns with the conventional view. However, allowing entrepreneurs to use money as internal finance introduces an additional channel. As the number of banks increases, entrepreneurs hold less money as internal finance, weakening their outside options and driving loan rates higher – a mechanism we label as the "liquidity" channel. These two opposing effects result in a non-monotonic relationship between concentration and loan rates. We further extend the model to allow for free entry by banks, where banking concentration becomes endogenously determined. In this environment, the relationship between concentration and loan market power can be either positive or negative, depending on the forces driving the change. Ultimately, the impact of banking concentration on loan market power hinges on the *nature* of outside options available in the loan market.

JEL codes: D82, E41; E43, E44; E51; E63; G21

Keywords: banking, concentration, liquidity, loan rate, market power, outside option

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†University of Melbourne. Email: `mei.dong@unimelb.edu.au`

‡University of Sydney. E-mail: `stella.huangfu@sydney.edu.au`

§Australian National University; Sungkyunkwan University. E-mail: `timothy.kam@anu.edu.au`

¶University of Melbourne. E-mail: `samiengmanng@gmail.com`

1 Introduction

We develop a model of bank lending with a frictional loan market and imperfect competition to explore the relationship between banking concentration and loan-rate markup. Conventional models of imperfect competition, such as the Cournot model, suggest a positive relationship between concentration and markup if we use a concentration measure such as the Herfindahl-Hirschman index (HHI).[1] However, in the banking sector, empirical evidence on this relationship is mixed.[2] Despite this mixed evidence, there is a clear consensus that imperfect competition and market power exist in the banking sector, regardless of the specific loan or deposit market.

Among the empirical studies on banking competition, some provide evidence that aligns with the conventional view. For instance, Drechsler, Savov and Schnabl (2017) find that, in response to an increase in the Federal Funds rate, the deposit spread widens more and the deposit rate rises less in more concentrated deposit markets. Additionally, both deposit and loan volumes increase less under higher concentration. Scharfstein and Sunderam (2016) use mortgage lending data to investigate how banking concentration influences the transmission of monetary policy, as measured by the spread between mortgage rates and mortgage-backed securities (MBS) yields. They find that mortgage rates decrease less in response to a drop in MBS yields in more concentrated markets. Similarly, Wang, Whited, Wu and Xiao (2022) analyze the pass-through of monetary policy to both deposit and loan markets. Their results indicate that this pass-through is less than one-to-one, suggesting that banks possess market power. They also find that as the federal funds rate increases, the deposit spread widens, and the sensitivity of the deposit spread to the federal funds rate grows with market concentration.

Other research challenges the conventional Cournot wisdom. In the same study, Wang et al. (2022) document that the loan spread declines when the Federal Funds rate rises, and the sensitivity of the loan rate spread to the Federal Funds rate diminishes as market concentration increases. Beyhaghi, Fracassi and Weitzner (2023) focus on corporate loans

[1]In our model, the HHI turns out to be inversely related to the measure of banks (n), given a measure of entrepreneurs. (See Section 4.3 later for the formal definition.) We will also refer to the measure n as the "number of banks."

[2]A survey by Syverson (2019) discusses how concentration may not be an accurate measure of market power. It also includes empirical work and theoretical models that generate a positive relationship between competition and market power.

and find that a less concentrated loan market is associated with higher loan rates. They suggest that increased competition exacerbates information frictions, making it harder for banks to screen borrowers, leading to higher loan rates. Another recent study by Yannelis and Zhang (2023) empirically and theoretically shows that greater competition among lenders results in higher loan rates in consumer credit markets.

This mixed evidence suggests that multiple mechanisms may influence the relationship between market concentration and market power. The key issue we address in this paper is understanding how frictions in the loan market, such as search and matching frictions or inflation distortions, shape this relationship. To investigate this, we develop a baseline model where banking concentration measured by HHI is inversely related to the number of banks in the loan market, and market power is measured by the loan rate markup – the difference between the loan rate and the risk-free interest rate. Banking concentration is essentially exogenous and we examine how banking concentration affects market power. We then extend the model by considering free entry by banks, which gives rise to an endogenous banking concentration. We use the model to evaluate the effects of competition policy on banking concentration and market power. Our framework allows us to discover the underlying mechanisms driving these mixed findings.

In the baseline model, entrepreneurs search for banks to finance their investment projects, while banks search for entrepreneurs to issue loans. Once an entrepreneur secures financing from a bank, the entrepreneur uses the funds to purchase capital in a competitive capital market for production. After completing the project, the entrepreneur exits the economy and is replaced by a new-born entrepreneur with an investment opportunity. Entrepreneurs who do not obtain external finance continue searching for banks in the subsequent period. When an entrepreneur and a bank bargain over the loan terms, the entrepreneur evaluates the payoff from accepting the loan contract against the payoff from waiting to invest in the next period. The outside option value for the entrepreneur is endogenously determined and depends on the value of waiting. With a greater number of banks, it becomes easier for entrepreneurs to secure financing, increasing their outside option value of waiting, which leads to a lower loan rate. We label this the "waiting" channel. This result aligns with the conventional Cournot model's prediction that decreased concentration results in lower loan rates. Our model demonstrates that a frictional market with search and matching frictions can produce this conventional wisdom.

The presence of search and matching frictions implies that entrepreneurs might choose to hold internal liquidity if such assets are available. To address this, we extend our baseline model by incorporating money as a liquid asset. In this extended model, entrepreneurs have the option to use both internal liquidity (money) and external finance to purchase capital. The existence of money introduces an additional outside option for entrepreneurs. If an entrepreneur opts to hold money, the entrepreneur anticipates using it as the outside option during bargaining. Otherwise, the entrepreneur does not hold money and waiting is the outside option. Banking concentration and monetary policy affect the values of these outside options.

We find that as the number of banks increases, the economy switches from a monetary economy, where holding money serves as the relevant outside option, to a pure credit economy, where waiting becomes the relevant outside option. The intuition is straightforward: when there are only a few banks, entrepreneurs rely on money as internal finance. However, as the number of banks grows, accessing external finance becomes easier, reducing the need to hold internal liquidity. This lower liquidity weakens the value of the outside option, resulting in a higher real loan rate through bargaining – a mechanism we refer to as the "liquidity" channel.

Thus, when entrepreneurs rely on money as internal finance, the liquidity channel suggests that a less concentrated banking sector can unexpectedly lead to a higher loan rate and a higher loan rate markup, contrary to the conventional predictions of the Cournot model. However, once the number of banks becomes sufficiently large, entrepreneurs shift to viewing waiting as a more attractive outside option and stop using money. As a result, the equilibrium switches to a pure credit regime, as analyzed in the baseline model. Overall, the relationship between banking concentration and the loan rate is non-monotonic.

We also examine how monetary policy affects the loan market, where the central bank sets either the inflation rate or the risk-free interest rate. When inflation is low, a monetary equilibrium emerges in which entrepreneurs use money to purchase capital if they fail to secure financing from a bank. In this monetary equilibrium, higher inflation reduces the demand for liquidity, weakening the entrepreneurs outside option and leading to a higher loan rate. However, higher inflation discourages the use of money, creating a threshold level of inflation above which the economy shifts to a pure credit economy. Once the economy is in a pure credit economy, inflation no longer influences the economy, and the loan rate becomes independent of monetary policy.

The analysis above treats the number of banks as exogenous, modeling changes in banking concentration by varying the number of banks. Given the strict regulatory barriers to entry in the banking sector, this assumption provides a useful benchmark for studying banking concentration and loan market power. However, allowing for bank entry introduces endogenous banking concentration, which we incorporate by modeling free entry. In this extended framework, both the number of banks and the loan rate markup become endogenous, and the relationship between banking concentration and market power depends on the factors driving the changes.

We explore competition policies, such as reducing entry costs or banks' bargaining power, and find that the relationship between concentration and market power depends critically on the specific policy implemented. A notable feature of the model is that monetary policy also influences banking concentration and loan market power in a monetary equilibrium. For instance, higher inflation discourages entrepreneurs from holding money, increasing the surplus from loan contracts and raising banking fees. This attracts more banks into the market, yet the real loan rate rises due to the higher fees. Thus, a change in monetary policy can produce a negative relationship between banking concentration and loan market power.

Our work contributes to multiple strands of the literature. The baseline model extends Rocheteau, Wright and Zhang (2018) by incorporating an endogenous outside option channel, inspired by Choi, Bethune, Rocheteau and Lotz (2024), to investigate how banking concentration affects loan rates. Within the New Monetarist literature, Dong, Huangfu, Sun and Zhou (2021) develops a model of banking with search frictions and shows that it is optimal to have a finite number of banks. Chiu, Davoodalhosseini, Jiang and Zhu (2023) adopt a Cournot competition framework to model the deposit market, while Choi and Rocheteau (2023) analyze the role of search frictions in the deposit market. Similarly, Head, Kam, Ng and Pan (2023) explore imperfect competition in loan and deposit markets, building on the approach of Burdett and Judd (1983).

Beyond banking, our research contributes to the broader discussion of imperfect competition using search-theoretic models. As noted by Menzio (2024), monopolistic competition models are a standard approach to introducing market power, while search models offer an alternative approach. Traditional approaches to introduce imperfect competition also include models of monopoly and oligopoly. Our paper reflects recent developments in macroeconomics that model imperfect competition and examine its macroeconomic implications.

This paper makes three key contributions to the literature. First, it incorporates an endogenous outside option, capturing the interplay between banking concentration and the nature of outside options (money vs. waiting). This approach reveals a novel non-monotonic relationship between concentration and loan market power. Second, the model with free entry by banks highlights that both banking concentration and loan market power can be simultaneously determined as equilibrium outcomes. Competition policies such as lowering the entry barrier or bargaining power may not lead to a less concentrated market and a lower market power. Third, it integrates monetary policy into the analysis, discovering a threshold effect where inflation can change the nature of the equilibrium. In addition, monetary policy can affect banking concentration and loan market power when considering free entry by banks. Together, these contributions offer new insights into the mixed empirical evidence on competition and market power in banking.

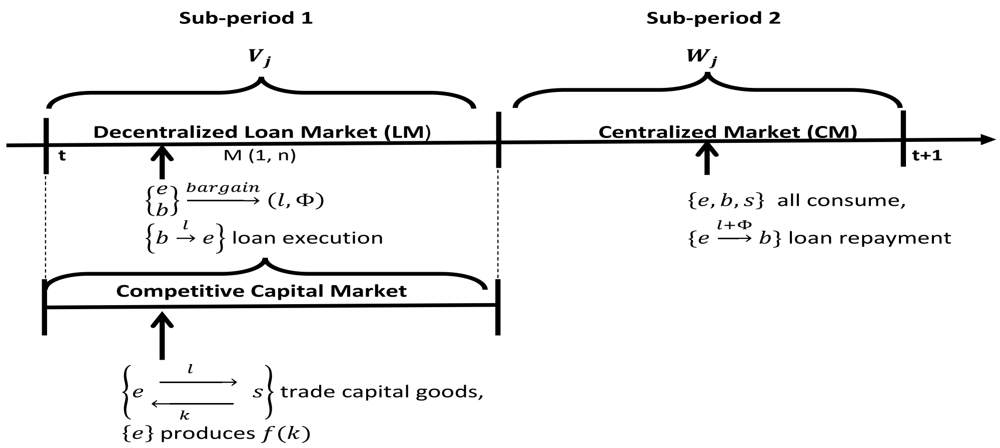
The paper is organized as follows: Section 2 describes the environment. Section 3 presents the baseline model, where the only outside option for entrepreneurs is waiting, and examines how banking concentration influences the loan rate. In Section 4, the model is extended to include money as internal finance. Section 5 allows free entry by banks. Finally, Section 6 concludes.

2 Environment

Our model builds on Rocheteau et al. (2018). Time is discrete and continues indefinitely. As illustrated in Figure 1, each period is divided into two sub-periods: a decentralized loan market (LM) and a centralized market (CM). The decentralized loan market operates concurrently with a competitive capital market.

There are three types of agents: entrepreneurs, capital suppliers, and banks. Each entrepreneur manages a single project. Upon completing the project, the entrepreneur exits the economy and is replaced by a new entrepreneur, also with one project. Thus, the measure of entrepreneurs remains constant and is e.[3] The measure of banks is b and banks live forever. All agents discount across periods at a rate $\beta \in (0, 1)$.

Figure 1: Timing of Events



LM. Entrepreneurs and banks search for each other to establish borrowing and lending relationships. With the measure of entrepreneurs (e) being E and the measure of banks (b) being B, the matching function $\mathcal{M}(E, B)$ determines the total measure of matches. This matching function exhibits constant returns to scale and satisfies the standard assumptions. The probability that an entrepreneur matches with a bank is $\alpha(n) = \mathcal{M}(E, B)/E = \mathcal{M}(1, n)$, where we define $n = B/E$ as the loan market tightness. The probability that a bank matches with an entrepreneur is $\alpha(n)/n = \mathcal{M}(1, n)/n$. The matching technology is such that α is continuously differentiable and $\alpha'(n) > 0$. We will assume $B > 1$ and $E \in (0, \infty)$ so that n is bounded below by $1/E > 0$ and $\alpha(n) > 0$ almost everywhere.

Once an entrepreneur and a bank meet, they negotiate the terms of trade, including the size of the loan ℓ and the banking fee ϕ, using Kalai bargaining. In this context, banks provide

[3]Entrepreneurs always have projects, which means banks do not play a role in reallocating unproductive idle funds.

loans to entrepreneurs by crediting them with an amount of ℓ as inside money. In the baseline model, we consider a non-monetary (i.e., our pure credit) economy where entrepreneurs rely solely on external finance to fund their projects.

Capital Market. Entrepreneurs use bank loans in the form of inside money to purchase capital from capital suppliers. Capital suppliers produce capital on the spot, taking the price of capital, p_k as given. The technology requires one unit of capital to be produced from one unit of effort. The measure of capital suppliers is irrelevant due to the CRS production technology of capital.

CM. All agents have linear utility over a numeraire good x. Banked entrepreneurs use the acquired capital for production and repay the bank loan. The production technology converts capital k into $f(k)$ units of the numeraire good, where $f(0) = 0$, $f'(k) > 0$, and $f''(k) \leq 0$. Banks can enforce loan repayment from entrepreneurs and consume any profits. As mentioned, entrepreneurs who produce and repay their loans exit the economy after production and repayment, being replaced by new entrepreneurs with investment opportunities.

3 Baseline Model

Let W^j and V^j denote the value functions for the type-j agent, $j \in \{e, s, b\}$, upon entering the CM and LM, respectively. Here, e represents an entrepreneur, s a capital supplier, and b a bank. We begin by considering the value functions at the start of the CM. Then we describe the value functions in the subsequent LM.

Entrepreneur. Consider an entrepreneur entering the CM with k units of capital and a debt balance of $\ell + \phi$. The entrepreneur's value is[4]

$$W_1^e(k, \ell + \phi) = f(k) - \ell - \phi.$$

[4]This differs from the setting in Rocheteau et al. (2018), where entrepreneurs remain in the economy indefinitely.

By construction, entrepreneurs who have obtained capital (and produced) will exit the economy at the end of the CM. Hence, they do not save and they consume all of their wealth in the CM. Entrepreneurs entering the CM with no capital continue searching for a loan in the next LM. Their value function is simply $W_0^e = \beta V^e$.

In the LM, the entrepreneur's value is

$$V^e = \alpha(n) W_1^e(k, \ell + \phi) + [1 - \alpha(n)] \, W_0^e. \tag{1}$$

With probability $\alpha(n)$, the entrepreneur finds a bank and secures a loan to purchase capital k. With the remaining probability, the entrepreneur retains the investment opportunity and moves to the following CM. It's important to note that without internal finance, the entrepreneur's outside option is to keep the project. This baseline economy is also referred to as the pure credit economy.

Bank. The value function for a bank entering into the CM with a loan ℓ created in the previous LM is given by

$$W^b(\ell, \ell + \phi) = \max_x \{x + \beta V^b : x = \ell + \phi - \ell = \phi\}. \tag{2}$$

In (2), the first term, ℓ, in $W^b(\ell, \ell + \phi)$ represents the amount of inside money the bank redeems, while the second term, $\ell + \phi$, refers to the repayment the bank receives from the entrepreneur. The bank's value in the LM is

$$V^b = \frac{\alpha(n)}{n} W^b(\ell, \ell + \phi) + \left[1 - \frac{\alpha(n)}{n}\right] W^b(0, 0). \tag{3}$$

Here, the bank meets an entrepreneur with probability $\alpha(n)/n$ and negotiates the loan term (ℓ, ϕ). With probability $1 - \alpha(n)/n$, the bank does not find a match and moves to the CM without a loan.

Capital Supplier. In the CM, a capital supplier's value function is $W^s(\omega) = \omega + \beta V^s$, where ω represents the wealth accumulated from selling capital. In the baseline model, the capital supplier's wealth is in the form of inside money issued by banks. The capital supplier's value in the capital market is

$$V^s = \max_k \left\{-k + W^s(q_k k)\right\}.$$

Since the production technology for capital is linear, we have $q_k = 1$.

Loan Contract. Next, we determine the loan contract. When an entrepreneur and a bank meet, they negotiate the loan size and the banking fee through Kalai bargaining. The surplus for the entrepreneur from the loan contract is

$$W_1^e(k, \ell + \phi) - W_0^e = f(k) - \ell - \phi - \beta V^e.$$

Here, βV^e represents the value of the outside option if the entrepreneur does not accept the loan contract, and it is determined endogenously within the model. The surplus for the bank from the loan contract is

$$W^b(\ell, \ell + \phi) - W^b(0, 0) = \phi.$$

Thus, the total surplus from the loan contract is $f(k) - \ell - \beta V^e$.

Let θ denote the bank's share of the bargaining surplus. Both the entrepreneur and the bank take the market value of V^e as given. The Kalai bargaining problem is

$$\max_{\ell,\phi} \left\{\phi : \phi = \theta\left[f(k) - \ell - \beta V^e\right] \text{ and } \ell = k\right\}. \tag{4}$$

The solution to this problem is $f'(k) = 1$, corresponding to the first-best outcome where $k = k^*$. The banking fee is then $\phi = \theta[f(k^*) - k^* - \beta V^e]$.

Equilibrium. As a final step in describing the banking equilibrium, we solve for the endogenous value of the outside option βV^e. Using (1) and the bargaining solution, we have

$$V^e = \alpha(n)\left\{f(k^*) - k^* - \theta[f(k^*) - k^* - \beta V^e]\right\} + [1 - \alpha(n)]\,\beta V^e.$$

Solving for V^e yields

$$V^e = \frac{\alpha(n)(1-\theta)[f(k^*) - k^*]}{1 - \beta\alpha(n)\theta - \beta[1-\alpha(n)]}. \tag{5}$$

Proposition 1. *In the baseline model with only external finance available, both the banking fee ϕ and the real loan rate r^ℓ decrease as the number of banks increases, holding all other parameters fixed.*

Our model assumes a fixed measure of entrepreneurs. In what follows, an increase in the number of banks is equivalent to an increase in n. The solution in (5) gives $\partial V^e/\partial n > 0$, indicating that a higher number of banks in the economy improves the value of the outside option: with more banks, entrepreneurs have better access to financing, thereby improving the value of their outside bargaining option.

The banking fee ϕ can be determined as:

$$\phi = \frac{\theta(1-\beta)[f(k^*) - k^*]}{1 - \beta\alpha(n)\theta - \beta[1-\alpha(n)]}. \tag{6}$$

It is not surprising that $\partial\phi/\partial n < 0$, meaning that banks reduce the banking fee as the number of banks increases. Consequently, the real loan rate, defined as $r^\ell = \phi/\ell$, decreases with n because $\partial\phi/\partial n < 0$ and $\ell = k^*$. In our model, the loan size is the same across matched banks. We can calculate the HHI as a measure of banking concentration being $1/[e\alpha(n)]$, where each matched bank has a market share of $1/\mathcal{M}(e, b)$. A higher n means a less concentrated banking sector. Our finding $\partial\phi/\partial n < 0$ aligns with the conventional view that decreased concentration reduces prices, as predicted by the Cournot competition model. However, our results highlight an alternative mechanism – the "*waiting*" channel – which links market concentration to pricing. This channel has also been recently explored in Bethune, Choi, Lotz and Rocheteau (2024).

In the limit where $\theta = 0$ and $\alpha(n) = 1$, the economy approaches the allocation in a competitive economy: $\phi = 0$ and $V^e = f(k^*) - k^*$. Banks earn zero profits, as issuing k^* units of the inside money earns k^* units of the numeraire good and no extra banking fee.

4 Liquidity, Internal Finance and Monetary Policy

The baseline model represents a pure credit economy. It highlights the role of the outside option in a search model by linking the number of banks with the endogenous value of the outside option. We now extend the model by introducing money, allowing entrepreneurs to accumulate money balance (i.e., internal finance) to purchase capital. This extended model is referred to as a monetary economy.

In this monetary economy, the government acts as a consolidated monetary and fiscal authority, issuing fiat money and implementing lump-sum taxes/transfers in the CM. The money supply grows according to $M_+ = \tau M$, where $\tau \geq \beta$, and the government budget constraint is $T = M_+ - M = (\tau - 1)M$, with T being the lump-sum transfers (or taxes) to agents in the CM. We focus on a stationary equilibrium where the inflation rate equals the growth rate of the money supply.

With these changes, if an entrepreneur decides not to take a bank loan, they have two options: wait to fund the project in the next LM or use their own money to purchase capital. This additional option means that the entrepreneurs bargaining position now depends on their cash holdings, allowing monetary policy to influence loan terms.

4.1 Money as Internal Finance

Entrepreneur. At the start of the CM, an entrepreneur with capital k, unused money balance m, and loan repayment liability $\ell + \phi$ has a value of

$$W_1^e(k, m, \ell + \phi) = f(k) - (\ell + \phi) + \frac{m}{p} + T,$$

where m/p represents the real value of the money balance in terms of the numéraire good, and T is some real (seigniorage) transfer from the government. Since all entrepreneurs with capital exit at the end of CM, they will consume their entire wealth.

For an entrepreneur without capital, the value function is given by

$$W_0^e(m) = \max_{x, \hat{m}} \left\{ x + \beta V^e(\hat{m}) : x + \frac{\hat{m}}{p} = \frac{m}{p} + T \right\}.$$

This entrepreneur chooses the optimal money balances $\hat{m}$ to carry over to the next LM with the project at hand. The first order condition for a maximum with respect to $\hat{m}$ is

$$\beta \frac{\partial V^e(\hat{m})}{\hat{m}} = \frac{1}{p}. \tag{7}$$

This condition implies that the present value of the marginal benefit from holding money for the next period's LM should equal the marginal cost of accumulating it (i.e., the numéraire value of a unit of money).

In turn, the value to an entrepreneur for having carried some money balance $\hat{m}$ into LM is

$$V^e(\hat{m}) = \alpha(n) W_1^e(k^b, \hat{m} - d^b, \ell + \phi) + [1 - \alpha(n)] \max \left\{ W_0^e(\hat{m}), W_1^e(k^m, \hat{m} - d^m, 0) \right\}.$$

The introduction of money provides an alternative outside option for the entrepreneur. Here, k^b and k^m represent the capital the entrepreneur can acquire with bank lending and without bank lending, respectively, while d^b and d^m denote the cash the entrepreneur will pay to capital suppliers in each corresponding scenario. If the entrepreneur successfully matches with a bank, the entrepreneur will purchase k^b units of capital using his own cash holding, d^b (outside money), along with bank lending, ℓ (inside money).[5]

If the entrepreneur does not match with a bank, he can either wait to search again in the next LM (with a corresponding value of $W_0^e(\hat{m})$) or use his own funds, d^m, to purchase k^m units of capital (with a corresponding value of $W_1^e(k^m, \hat{m} - d^m, 0)$). These options make the entrepreneurs bargaining threat point endogenous and depend on monetary policy.

Bank. The value functions for a bank in both the CM and LM remain the same as in the baseline model, as shown in equations (2) and (3), respectively. Banks have no incentive to hold money balances themselves.

Capital Suppliers. With the introduction of money, capital suppliers receive both inside and outside money in exchange for providing capital to entrepreneurs. As a result, their

[5]Alternatively, d^b can be seen as a down payment made by the entrepreneur to the bank, after which the bank pays the full purchase price, $d^b + \ell$, to capital suppliers. Both interpretations yield the same outcome.

wealth in the CM consists of both forms of money.

Loan Contract. Given Kalai bargaining outcome (k^b, d^b, ℓ), the bank's profit (i.e., its share of the Kalai bargaining surplus) is

$$\phi = \theta \min\left\{ f(k^b) - \ell - \frac{d^b}{\hat{p}} - [f(k^m) - k^m], f(k^b) - \ell - \frac{d^b}{\hat{p}} - \left[\beta V^e(\hat{\hat{m}}) - \frac{\hat{\hat{m}}}{\hat{p}}\right] \right\}, \quad (8)$$

where $\hat{\hat{m}}$ denotes money balance two periods ahead. The curly braces in (8) contains two possible cases. The first term represents the total surplus when the entrepreneur prefers to use money to purchase capital as the outside option. Specifically, the entrepreneur's surplus is given by $f(k^b) - \ell - d^b/\hat{p} - \phi - [f(k^m) - k^m]$, where $f(k^m) - k^m$ reflects the value of the self-finance option. The bank's surplus, in this case, is the loan fee ϕ. The sum of these two gives the total surplus for this scenario.

The second term in (8) represents the total surplus when the entrepreneur prefers waiting to match again as the outside option. In this case, the bank's surplus remains ϕ. The entrepreneur's surplus is given by $f(k^b) - \ell - d^b/\hat{p} - \phi - [\beta V^e(\hat{\hat{m}}) - \hat{\hat{m}}/\hat{p}]$, where $\beta V^e(\hat{\hat{m}}) - \hat{\hat{m}}/\hat{p}$ represents the value of waiting.

The use of the min operator can be understood by comparing the two outside options. If the entrepreneur finds that self-financing offers a higher value than waiting, then the total surplus will be lower when self-financing is chosen as the outside option, and vice versa.

Given the value function $V^e(\cdot)$, the Kalai bargaining problem between the bank and the entrepreneur can be formulated as

$$\max_{\phi, k^b, d^b, \ell} \left\{ \phi : (8) \text{ and } d^b \leq \hat{m} \right\}. \quad (9)$$

Note that the values of (ϕ, k^b, ℓ, d^b) may vary depending on the relevant outside option. In what follows, we restrict attention to equilibria away from the Friedman rule, i.e., there is an intertemporal inflation-tax distortion to carrying money, $\tau > \beta$.

Lemma 1. *For a given set of parameter values, if waiting is the optimal outside option, the terms of the loan contract do not depend on the entrepreneur's money balance.*

Proof. If waiting is a better outside option, the total trading surplus is given by

$$f(k^b) - k^b + \frac{\hat{\hat{m}}}{\hat{p}} - \beta V^e(\hat{\hat{m}}).$$

since $\ell = k^b - d^b/\hat{p}$. The Kalai bargaining problem is

$$\max_{\phi, k^b} \left\{ \phi : \phi = \theta \left[f(k^b) - k^b + \frac{\hat{\hat{m}}}{\hat{p}} - \beta V^e(\hat{\hat{m}}) \right] \right\}.$$

By substituting ϕ from the constraint into the objective function, we find k^b by solving $f'(k^b) = 1$, which gives the first-best value $k^b = k^*$. The banking fee ϕ is then determined from the constraint. It is evident that (k^b, ϕ) is independent on the entrepreneur's current money balance $\hat{m}$. The entrepreneur's d^b is indeterminate as any $d^b \leq \hat{m}$ satisfies the solution. Without loss of generality, we set $d^b = \hat{m}$, which implies $\ell = k^b - \hat{m}/\hat{p}$. Thus, the entrepreneur's money balance $\hat{m}$ affects (d^b, ℓ) but does not influence (k^b, ϕ). Moreover, $\hat{m}$ does not affect the total trading surplus or the entrepreneur's surplus. □

From Lemma 1, we know that $\hat{m} = 0$ when waiting is the preferable outside option, provided $\tau > \beta$, as carrying money is costly for the entrepreneur in this scenario. With $\hat{m} = 0$, the banking fee is given by $\phi = \theta \left[f(k^b) - k^b - \beta V^e \right]$, where V^e can be derived from (5). Thus, the banking fee ϕ is determined by (6).

If the parameters indicate that using internal finance (money) is the preferable outside option, the Kalai bargaining problem is then formulated as

$$\max_{\phi, k^b, d^b, \ell} \left\{ \phi : \phi = \theta \left[f(k^b) - \ell - \frac{d^b}{\hat{p}} - (f(k^m) - k^m) \right] \right\}$$

where $k^m = \hat{m}/\hat{p}$. Again, $k^b = k^*$. Thus, $\phi = \theta \left\{ f(k^*) - k^* - [f(k^m) - k^m] \right\}$. As in Lagos and Wright (2005), the constraint $d^b \leq \hat{m}$ is binding given $\gamma > \beta$. We have $\ell = k^b - k^m$. With this bargaining solution, we can express $V^e(\hat{m})$ as

$$\begin{aligned} V^e(\hat{m}) &= \alpha(n) W_1^e(k^*, 0, \ell + \phi) + [1 - \alpha(n)] W_1^e(k^m, 0, 0) \\ &= \alpha(n) \left\{ (1 - \theta)[f(k^*) - k^*] + \theta[f(k^m) - k^m] + k^m \right\} + [1 - \alpha(n)] f(k^m). \end{aligned}$$

This yields

$$\frac{\partial V^e(\hat{m})}{\partial \hat{m}} = \{[1-\alpha(n)+\theta\alpha(n)][f'(k^m)-1]+1\}\frac{\partial k^m}{\partial \hat{m}}.$$

Since $\partial k^m/\partial \hat{m} = 1/\hat{p}$, we can then use (7) to solve for k^m such that

$$i = [1-\alpha(n)(1-\theta)][f'(k^m)-1], \tag{10}$$

where $i = \tau/\beta - 1$ represents the risk-free nominal interest rate as per the Fisher equation. In (10), the left-hand side denotes the cost of holding one unit of money and the right-hand side denotes the benefit of holding that money.

4.2 Monetary Equilibrium versus Pure Credit Equilibrium

In the LM, an entrepreneur without capital chooses the maximum between $W_0^e(\hat{m})$ and $W_1^e(k^m, 0, 0)$. Since agents are fully rational, the entrepreneur should not carry money if waiting is the better option and should hold $\hat{m}$ consistent with (10) if using money is the better option. This implies that the entrepreneur must fully anticipate the terms of trade in the LM to determine the optimal money balance. Specifically, the entrepreneur will choose $\hat{m} = 0$ or $\hat{m} = \hat{p}k^m$ in the CM based on a comparison between the outside option of waiting, $\beta V^e(0)$, and the outside option of using money, $-\hat{m}/\hat{p} + \beta V^e(\hat{m})$.

When waiting is the optimal outside option, $\beta V^e(0)$ is derived from (5). When using money is preferable, we have:

$$-\frac{\hat{m}}{\hat{p}}+\beta V^e(\hat{m}) = \beta\{-ik^m+\alpha(n)(1-\theta)[f(k^*)-k^*]+[1-\alpha(n)(1-\theta)][f(k^m)-k^m]\} \equiv \beta S^m.$$

For given parameters, the choice between $S^w \equiv V^e$ from (5) and S^m determines the preferred outside option. Note that S^w and S^m depend on (n, θ, β) and the production function, with only S^m depends on i. The value of waiting S^w is independent of the monetary policy as the entrepreneur does not hold money when waiting is the optimal choice.

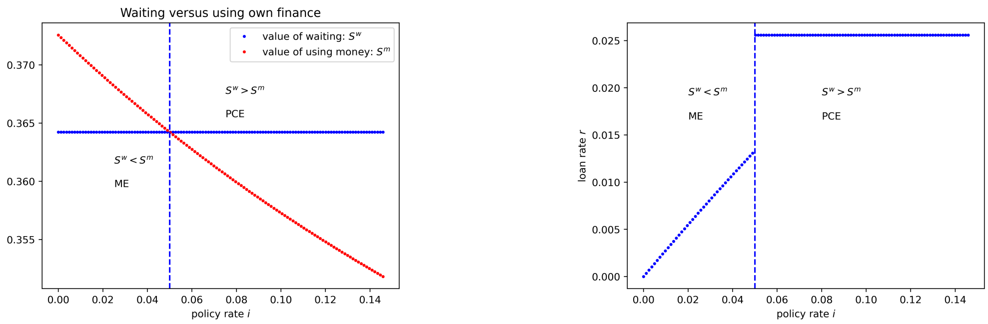
Proposition 2. *For a given set of parameters, there exists a threshold value $i = \bar{i} > 0$ such that $S^w = S^m$. When $i < \bar{i}$, a monetary equilibrium exists in which entrepreneurs prefer to use money as the outside option. Conversely, when $i > \bar{i}$, a pure credit equilibrium exists in* *which entrepreneurs prefer to wait as the outside option.*

Proof. When $i \to 0$, $S^m = f(k^*) - k^*$. Given that $\alpha(n)(1-\theta)/\{1-\alpha(n)\theta\beta-[1-\alpha(n)]\beta\} < 1$, it follows that $S^w < S^m$. Conversely, as $i \to \infty$, $S^m = \alpha(n)(1-\theta)[f(k^*)-k^*] < S^w$. Moreover, we can show that S^m is decreasing in i, while S^w is independent of i. Therefore, there must exist a threshold value $i = \bar{i}$ where $S^w = S^m(\bar{i})$. When $i < \bar{i}$, entrepreneurs hold money because $S^w < S^m$ and use it to purchase capital if they don't match with a bank. When $i > \bar{i}$, entrepreneurs prefer to wait until the next period if they don't match with a bank. $\square$

Proposition 2 indicates that a monetary equilibrium exists only when the nominal interest rate i is sufficiently low. Specifically, if i is too high, holding money becomes less attractive, and entrepreneurs prefer to delay investment until the next period and seek bank financing instead. In this scenario, monetary policy can no longer influence the economy.

Panel (a) of Figure 2 provides a numerical illustration of this relationship. It shows how the values of S^w (in blue) and S^m (in red) vary with i. The threshold value $\bar{i}$ is determined by the intersection of S^w and $S^m(i)$, representing the point at which the decision to use money or wait changes.

Figure 2: Monetary Equilibrium versus Pure Credit Equilibrium



(a) S^w and $S^m(i)$ (b) real loan rate

It is interesting to examine how the policy rate i affects the loan rate in the monetary equilibrium. In our model, the real loan rate is given by:

$$r^\ell = \frac{\phi}{\ell} = \frac{\theta\{f(k^*) - k^* - [f(k^m) - k^m]\}}{k^* - k^m}. \tag{11}$$

Differentiating this with respect to i, we get:

$$\frac{\partial r^\ell}{\partial i} = \frac{\theta[f(k^*) - f(k^m) - f'(k^m)(k^* - k^m)]}{(k^* - k^m)^2}\frac{\partial k^m}{\partial i}.$$

Given that $f(k)$ is concave, we have $f(k^*) - f(k^m) - f'(k^m)(k^* - k^m) < 0$. Since $\partial k^m/\partial i < 0$, it follows that $\partial r^\ell/\partial i > 0$. A higher nominal interest rate or inflation rate leads to a higher real loan rate. In our model, a higher inflation rate set by the central bank discourages entrepreneurs from holding money as internal finance. The reduced money balance weakens the entrepreneur's bargaining position, resulting in a higher real loan rate. Consequently, the nominal loan rate also increases since both the real loan rate and the inflation rate rise. Panel (b) of Figure 2 illustrates that the real loan rate increases with i in the monetary equilibrium and remains unaffected by i in the pure credit equilibrium.

4.3 Banking Concentration and Market Power

Since we are interested in the effect of banking concentration on the loan market, we now investigate the impact of n on equilibrium, where $1/[E\alpha(n)]$ is the measure of concentration. From the baseline model without money, we know that S^w is increasing in n because having more banks improves the value of waiting. We now need to determine how the number of banks affects the value of S^m. In a monetary equilibrium, a higher n has two effects. The direct effect is that it increases $\alpha(n)$, the probability that an entrepreneur meets a bank, which makes S^m higher. The indirect effect is through the impact of n on k_m. From (10), we know that $\partial k_m/\partial n < 0$, meaning that entrepreneurs carry lower money balances when it is easier for them to find banks. The direct effect always dominates the indirect effect, so S^m is increasing in n.

As $n \to 0$, we have $S^w < S^m$. As $n \to \infty$, we have

$$S^w(n)\mid_{n\to\infty} = \frac{(1-\theta)[f(k^*) - k^*]}{1-\theta\beta}$$
$$S^m(n)\mid_{n\to\infty} = -ik^m + (1-\theta)[f(k^*) - k^*] + \theta[f(k^m) - k^m]$$

where k^m solves $i = \theta[f'(k^m) - 1]$. Notice that when $i \to 0$, $S^w(n)\mid_{n\to\infty} < S^m(n)\mid_{n\to\infty}$. Since

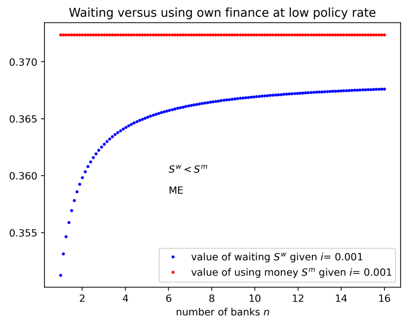
$S^m(n)\mid_{n\to\infty}$ is decreasing in i, it is generally possible that $S^w(n)\mid_{n\to\infty} < S^m(n)\mid_{n\to\infty}$ when i is small and $S^w(n)\mid_{n\to\infty} > S^m(n)\mid_{n\to\infty}$ when i is large. This suggests that a monetary equilibrium exists when n is small, but it may no longer exist if n becomes sufficiently large. The equilibrium also depends on other parameters, such as the nominal interest rate i. We rely on numerical examples in Figure 3 to illustrate how n influences the nature of the equilibrium.

For the numerical exercise, we specify the functional forms of the production function and the matching function. The production function is a standard concave function, $f(x) = Ax^{\omega}$. The matching function follows Kiyotaki and Wright (1993), $\mathcal{M}(1, n) = n/(1 + n)$, where the measure of entrepreneurs is 1 and the measure of banks is n. We need to assign values to six parameters: $(\beta, \theta, A, \omega, n, i)$. We set $\beta = 0.96$, implying an annual risk-free interest rate of 4%. The production function parameters are $A = 1$ and $\omega = 0.33$. The bargaining share $\theta = 0.2$. We experiment with A ranging from 1 to 5, ω ranging from 1/3 to 0.7, and θ ranging from 0.1 to 0.3. Our results are robust across all these specifications.

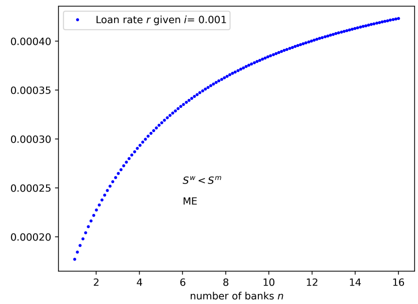
Panel (a) of Figure 3 shows the values of S^w and S^m when $i = 0.001$, which is close to 0. Consistent with our theoretical predictions, S^m is always greater than S^w, implying that the economy is always in a monetary equilibrium. Instead, for a moderate $i = 0.042$ shown in panel (c) of Figure 3, $S^w > S^m$ when n is sufficiently large. The economy switches from a monetary equilibrium to a pure credit equilibrium for sufficiently high n. A less concentrated banking sector allows entrepreneurs to find a bank more easily and improves the outside option value of waiting sufficiently. Lastly, panel (e) of Figure 3 illustrates the values of S^w and S^m for a high $i = 0.146$. Although it is less evident in the figure, $S^m > S^w$ only when n is very small. The economy is mostly in a pure credit equilibrium as n increases.

Figure 3: Concentration and Equilibrium

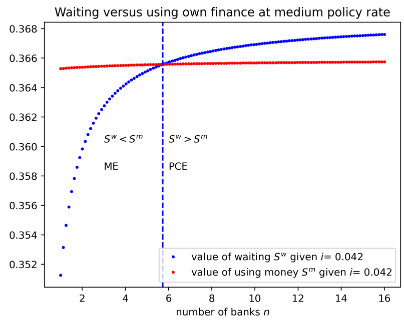
(a) near FR: S^w and S^m



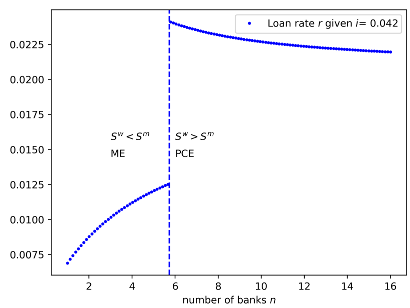
(b) near FR: real loan rate



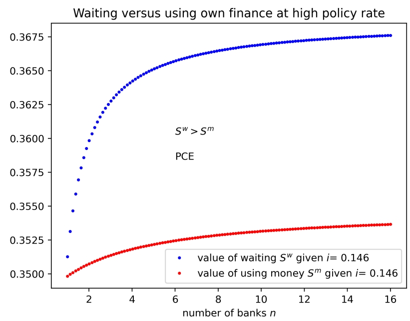
(c) moderate i: S^w and S^m



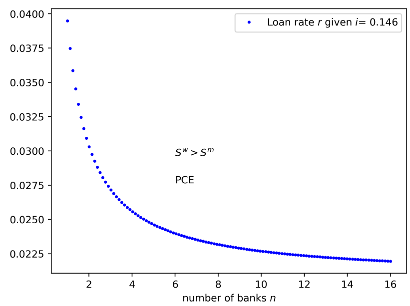
(d) Moderate i: real loan rate



(e) very high i: S^w and S^m



(f) very high i: real loan rate



It is crucial to explore how banking concentration affects the real loan rate for a given nominal interest rate. Using the definition of the real loan rate in monetary equilibrium from (11), we can derive:

$$\frac{\partial r^\ell}{\partial n} = \frac{\theta[f(k^*) - f(k^m) - f'(k^m)(k^* - k^m)]}{(k^* - k^m)^2} \frac{\partial k^m}{\partial n}.$$

From (10), $\partial k^m / \partial n < 0$. Intuitively, this reflects that as the number of banks increases, the banking sector is less concentrated. Entrepreneurs hold less money as accessing external finance becomes easier. Given a concave production function, we have $\partial r^\ell / \partial n > 0$.

Proposition 3. *When money is used as internal finance, the real loan rate always increases with n in the monetary equilibrium, but decreases with n in the pure credit equilibrium.*

Our model shows that in a monetary equilibrium, a less concentrated banking sector results in a higher real loan rate. This finding stands in sharp contrast to the baseline model, where waiting is the entrepreneur's only outside option. To understand the intuition, when entrepreneurs can hold money as internal finance to purchase capital, with a less concentrated banking sector, the likelihood of an entrepreneur failing to match with a bank is low. As a result, entrepreneurs have less incentive to accumulate real money balances for internal financing. With reduced liquidity held by entrepreneurs, their bargaining position weakens, enabling banks to impose a higher real loan rate.

Panel (b) in Figure 3 confirms the theoretical relationship between n and r^ℓ in a monetary economy, while panel (f) confirms our theoretical finding that a higher n leads to a lower r^ℓ when waiting is the outside option. In panel (d), it is interesting that r^ℓ first increases and then decreases as n increases due to the equilibrium switch from a monetary equilibrium to a pure credit equilibrium.

The use of money as internal finance disciplines the bargaining outcome of the loan contract, introducing a new channel, which we refer to as the "*liquidity*" channel. This channel creates a negative relationship between banking concentration and the real loan rate, challenging both the baseline model and conventional insights from the Cournot framework.

Our findings emphasize that market concentration impacts prices and market power through the outside option, but the *nature* of the outside option plays a pivotal role in shaping this relationship. When both internal finance and waiting are available as outside options, entrepreneurs select the better option, given the parameter values. If waiting is the better option, reduced banking concentration lowers the real loan rate, as more banks enhance the value of waiting. Conversely, if internal finance is the better option, less banking concentration raises the loan rate because more banks reduce entrepreneurs' incentives to hold liquidity, weakening the value of the outside option.

5 Free Entry by Banks

Until now, we have treated the number of banks, n, as exogenous in our analysis. Since loan sizes are homogeneous across banks, the measure of banking concentration, $1/\alpha(n)$, has also been considered exogenous. This assumption aligns with the reality of regulatory barriers that often restrict new entrants in the banking sector. For example, Benson, Bord, Garner and Taragin (2023) highlight that even when existing banks open new branches, these branches face significant challenges, including long growth periods and high failure rates.

Over the longer term, however, it may be more realistic to allow for the possibility of bank entry. We examine how changes in competition policy, such as adjustments to entry costs or banks bargaining shares, influence banking concentration and loan market power. Additionally, in a monetary equilibrium, monetary policy plays a key role in shaping both banking concentration and loan market dynamics.

We now introduce the possibility of bank entry into the CM, where banks incur a cost c per period to participate. After entry, banks proceed to the LM to search for entrepreneurs. The free-entry condition,

$$c = \beta V^b = \frac{\alpha(n)}{n}\phi, \tag{12}$$

determines the equilibrium number of banks. Consequently, banking concentration becomes endogenous. We first analyze this mechanism in a pure-credit economy (without money), followed by an extension to an economy with money.

5.1 Pure Credit Economy

When only bank loans are available for entrepreneurs to make investment, we have an additional equilibrium condition (12) determine n. Substituting from (6), we have:

$$c = \frac{\alpha(n)}{n} \frac{\theta(1-\beta)[f(k^*) - k^*]}{1 - \beta\alpha(n)\theta - \beta[1-\alpha(n)]}. \tag{13}$$

In this expression, the right-hand side decreases as n increases. When $n \to 0$, $\alpha(n) \to 0$

and $\alpha(n)/n \to 1$. For an equilibrium to exist, we require:

$$\theta[f(k^*) - k^*] > c.$$

5.1.1 Impact of Entry Costs

Suppose the entry cost c decreases, making it easier for banks to enter the market. Since $\partial n/\partial c < 0$ and $\partial \phi/\partial c > 0$, a reduction in c leads to an increase in the equilibrium number of banks n and a decrease in the banking fee ϕ. As a result, the real loan rate r^ℓ decreases, as the loan size k^* does not depend on c.

Lower entry costs encourage more banks to enter, reducing both banking concentration and banks market power. If reducing entry costs is interpreted as a competition policy, our model suggests that such a policy would result in a less concentrated banking sector and diminished market power among banks.

5.1.2 Impact of Banks Bargaining Power

Next, consider an increase in the banks bargaining power, θ. In this case, the equilibrium results indicate that $\partial n/\partial \theta > 0$, meaning that a higher θ encourages more banks to enter the market. Additionally, $\partial r^\ell/\partial \theta > 0$, reflecting that the real loan rate increases as banks gain greater bargaining strength.

With greater bargaining power, the number of banks, n, and the real loan rate, r^ℓ, both increase, creating a positive relationship between banking concentration and market power. Conversely, if a competition policy reduces banks bargaining share, the model predicts a more concentrated banking sector but a lower loan rate, as weaker bank bargaining power improves the outside options for borrowers.

To summarize, the model highlights that the relationship between banking concentration and market power depends on the underlying factors driving the change. Lower entry costs produce a negative relationship, where decreased concentration leads to reduced market power. Conversely, increased bargaining power generates a positive relationship, where both concentration and market power rise. This dynamic illustrates that banking concentration alone may not reliably indicate market power. By incorporating endogenous bank entry, the model captures both positive and negative relationships between concentration and market power, depending on the specific policy or market changes at play.

5.2 Monetary Economy

In a pure credit economy, where entrepreneurs rely exclusively on bank loans for investment, the equilibrium number of banks, n, is determined by the free-entry condition (12). Under a pure credit equilibrium, this condition simplifies to (13). In a monetary equilibrium, however, (12) becomes:

$$c = \frac{\alpha(n)}{n}\theta[f(k^*) - k^* - f(k^m) + k^m], \tag{14}$$

where k^m is derived from (10). In this case, the conditions (10) and (14) jointly determine (k^m, n), with $\partial k^m/\partial n < 0$ for a given set of parameter values.

For a monetary equilibrium to exist, the entry cost c cannot be too high, requiring $c \leq \theta[f(k^*) - k^*]$. When $n \to 0$, $\alpha(n)/n \to 1$, and k^m satisfies $c = \theta[f(k^*) - k^* - f(k^m) + k^m]$ as given by (14). As n increases, there exists a threshold $n = \bar{n}$ such that $k^m = 0$, where $\bar{n}$ satisfies

$$\frac{\alpha(n)}{n} = \frac{c}{\theta[f(k^*) - k^*]} \leq 1.$$

From (10), k^m satisfies $i = f'(k^m) - 1$ as $n \to 0$ and $i = \theta[f'(k^m) - 1]$ as $n \to \infty$. Therefore, at least one solution of (k^m, n) exists, and if multiple solutions exist, we focus on the one with the largest n.

5.2.1 Impact of Entry Costs

Consider a decrease in the entry cost c. From (10) and (14), we find that $\partial k^m/\partial c > 0$ and $\partial n/\partial c < 0$. A lower entry cost allows more banks to enter the market, which reduces the amount of money entrepreneurs hold as their outside option worsens. This reduction in money holding increases the banking fee, ϕ, and the loan size. The concave production function implies that the real loan rate, r^ℓ also rises ($\partial r^\ell/\partial c < 0$). Thus, a competition policy that lowers entry costs reduces banking sector concentration but increases both the loan rate and the markup. This contrasts with the pure credit economy, where reduced concentration lowers bank markups.

5.2.2 Impact of Banks Bargaining Power

Now, consider an increase in banks bargaining power, θ. Unlike in a pure credit economy, the effects of θ on n, k^m, and ϕ in a monetary equilibrium are ambiguous. In a pure credit equilibrium, the outside option for entrepreneurs is waiting. Higher bargaining power worsens this outside option, increasing both the total surplus from bargaining and banks share of that surplus. As a result, the number of banks, n, increases, along with higher ϕ, while the loan size remains constant.

In a monetary equilibrium, however, entrepreneurs can hold money as an alternative to borrowing. An increase in θ reduces the benefit of the loan contract, encouraging entrepreneurs to hold more money as internal finance. This increases money holding, reducing the total surplus from the loan contract. While banks capture a larger share of the reduced surplus, the overall effects of θ on n, k^m, and ϕ are ambiguous. Consequently, the relationship between n and r^ℓ could be either positive or negative. A more concentrated banking sector does not necessarily imply lower markups if changes in bargaining power are the driving force.

5.2.3 The Role of Monetary Policy

An interesting feature of the monetary equilibrium is that monetary policy directly influences market concentration and markups. When the central bank raises the risk-free interest rate i, we find that $\partial n/\partial i > 0$ and $\partial k^m/\partial i < 0$, focusing on a unique equilibrium or the one with the highest n. Higher inflation or interest rates discourage entrepreneurs from holding money, worsening their outside option and increasing the total surplus from the loan contract. This leads to a higher banking fee, encouraging more banks to enter the market. Both the banking fee and the loan size increase, and due to the concave production function, r^ℓ also rises ($\partial r^\ell/\partial i > 0$).

This result indicates that monetary policy can make the banking sector less concentrated while simultaneously increasing banks loan market power. The ability of monetary policy to influence competition and markups in the banking sector is a unique feature of this model with endogenous bank entry, highlighting its potential role in shaping competition within the banking sector.

6 Conclusion

Motivated by mixed empirical evidence on the relationship between banking concentration and market power in the banking sector, we develop models of banking featuring a frictional loan market. Our analysis reveals that reduced banking concentration results in lower loan rates due to search frictions. More banks make it easy for entrepreneurs to find financing, thus improving the value of waiting during negotiations. The endogenous outside option links the number of banks to the loan rate.

When money is available as a liquid asset, the entrepreneur's outside option can either involve waiting or using the money. When there are fewer banks or inflation rates are low, money is valued and used by entrepreneurs as internal finance. As the number of banks increases, the higher probability of getting bank loans discourages entrepreneurs from holding money, which worsens their loan terms. This liquidity effect creates a negative relationship between banking concentration and loan rates, contrary to conventional wisdom. When considering free entry by banks, both banking concentration and loan market power are endogenous and we can generate any relationship between them, depending on the specific competition policy or monetary policy. Our model highlights that the relationship between banking concentration and the loan market power hinges on the frictions inherent in the loan market and government policies.

Regarding future research directions, the current paper assumes that entrepreneurs have identical productivity for their investment opportunities and borrow the same amount of loans. In reality, however, investment projects differ in productivity, and banks often face incomplete information about each project's potential. Information frictions are prevalent in borrowing and lending relationships, as noted by Beyhaghi et al. (2023). To address this, we plan to explicitly model information frictions and incorporate entrepreneurs private information about their productivity. This approach could offer valuable insights into how optimal screening mechanisms – such as credit rationing and non-linear pricing – affect loan terms and borrowing decisions.

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