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ABSTRACT

In my Ph.D. dissertation, “**Essays on Incompleteness in Financial Markets and Contracts**”, which consists of four chapters, I study how incomplete markets and contracts interact with two core issues in finance: liquidity and debt capacity.

1. Bank Liquidity

In providing liquidity insurance to households and credit to finance illiquid projects, banks are subject to liquidity problems and thus have a concern about their short-term funding conditions.

In Chapter 1 of my dissertation, “**Optimal Banking System for Private Money Creation**”, I study how should the banking system be designed under a setting where markets and contracts are incomplete, to most efficiently create the private money in an economy (i.e., bank deposits), which need to be made both *liquid* and *safe*. I identify three market failures: 1) an incentive problem, 2) a commitment problem, and 3) a coordination problem, as consequences of the combination of a safe asset creation constraint under liquidity risks with certain markets (and contracts) being missing. A competitive banking market is shown to have a mixed effect on efficiency: It alleviates the incentive problem, which is more economically relevant when the economy is subject to idiosyncratic shocks; but it exacerbates the commitment problem, which becomes more relevant when the economy is subject to systemic shocks. Finally, I show that a coordination problem arises when banking markets become sufficiently competitive: no private safe assets can be created in the economy without proper liquidity regulations (e.g. uniform reserve requirements) being imposed.

Two salient features of the banking sector are its heavy reliance on short-term funding and the existence of imperfect competition in banking markets. Chapter 2 of my dissertation, “**Bank Liquidity Price and Banking Market Competition**”, empirically investigates how competition in bank funding markets generates real impact through affecting the determination of short-term liquidity prices for banks. Exploiting the exogenous variation in banking market competition resulting from the US banking deregulation in 80s and early 90s, I document two novel facts. First, while banks’ loan making is generally less local than

deposit taking, more competitive banking market enlarges this geographic mismatch. Second, examination of the lending dynamics of banks hit by the 1986 oil price shock reveals a mixed effect of banking market competition on economy's resilience to unexpected shocks—it attenuates idiosyncratic shocks but amplifies systemic shocks. I provide evidences that these real effects of banking market competition are generated through its impact on how supply/demand shocks on bank short-term funding are transmitted to banks' short-term (retail/wholesale) liquidity prices.

These two essays provide concrete examples related to the point made in Hart (1975)—that under certain market settings, introducing certain spot markets could have a mixed effect on welfare.

2. Corporate Debt Capacity

Like its central position in corporate finance theory, corporate debt capacity plays a critical role in affecting the transmission and allocation of the hot money flowing to emerging market economies (EMEs), as well as the credit intermediation in these economies after the hot money leaves. However, this important role has received little attention to in the previous literature of international finance. In the two essays co-authored with Sheila Jiang, we fill this gap in the international finance literature.

The world is becoming increasingly inter-connected. In Chapter 3, **“Rise of Domestic Banks in EME Cross-border Credit Intermediation”**, we document the rise of domestic global banks in EMEs and the increasingly important role they play in channeling cross-border capital since 1990s. We show that this structural change in the cross-border credit flow to EMEs is likely to be driven by the transformation in the U.S. money market since around 1990. Importantly, we find that domestic banks from EMEs, who are replacing foreign banks' role of channeling cross-border capital to EME firms, behave drastically differently in choosing their lending bases. We further show that due to this difference in lending technologies— that foreign lenders exhibit much higher reluctance towards lending against hard assets as collateral, the rise of domestic banks in the transmission of cross-border capital to EMEs has a far-reaching impact on these economies. In particular, we find

that it reshaped industry structure of these economies and increased their susceptibility to global financing cycles.

Despite our robust empirical findings on both the time trend and cross-country patterns, identifying the exact channel through the structural changes in cross-border credit flow to EMEs generate real impact to these economies remains a challenge. For this purpose, Chapter 4 of my dissertation, **“Domestic Bank-Channeled Foreign Credit– A Blessing or a Curse: Evidence from China”**, exploits a unique cross-region heterogeneity of domestic global bank distribution in China and based on which, we investigate the real effects of the structural difference in cross-border credit across cities in China during the 2003-2009 global financing cycle. This allows us to empirically identify a “collateral channel” through which the rise of domestic banks in cross-border credit transmission to EMEs generates welfare impact on the real economy. Our empirical findings show that the enlarged flexibility in cross-border credit contracting, which is made possible by the rise of domestic global banks in EMEs, is a mixed blessing to these economies: It allows the hot money flowing to EMEs to be more efficiently allocated, but may lead to less efficient allocation of domestic credit when hot money leaves.

Echoing the results of the first two essays, the empirical finding in these two essays illustrates a similar point: under certain environments, increasing the contingency in certain dimension of the contracting space could be a mixed blessing.

CHAPTER 1

OPTIMAL BANKING SYSTEM FOR PRIVATE MONEY CREATION

1.1. Introduction

A fundamental yet crucial role that banks play in an economy is as the creator of “money”. From its earliest form as record-keeping tokens to its modern form as demand deposits, these money-like assets created by banks lubricates transactions and activities in the economy by serving as a credible payment medium. Today 97% of the money circulating in the economy is created by banks, in the form of bank deposits, whilst just 3% is printed by the government.¹ The importance of bank-created safe assets as a store of value and medium of exchange has been well recognized in both the macro and the banking literature.² Yet less attention has been paid to the creation of these money-like assets. This paper studies the creation of private money by the banking sector.

A conventional wisdom of how banks create private money in an economy is the so called “fountain pen money” view. That is, banks can create money simply by making loans—loans made by one bank will immediately create matching deposits somewhere in the banking system and whichever banks receive them can keep making loans and so on so forth. While this notion of how banks create money seems logically appealing and is believed by many as an accurate depiction of the true picture, something fundamental is missing and flawed in it. First and most importantly, in the process of private money creation, banks maintain an illiquid capital structure and are thus subject to liquidity risks.³ Such an exposure to liquidity risks is problematic to banks’ money creation, as it poses a challenge to banks in

1. See *How Banks Create Money - Positive Money*, Bank of England quarterly bulletin 2014.

2. See Kiyotaki and Wright (1989); Gorton and Pennacchi (1990); Caballero (2006); Stein (2012); Hart and Zingales (2014); DeAngelo and Stulz (2015); Diamond (2017) etc..

3. The fact that banks, as the provider of liquidity insurance for individual households, are subject to risk of runs is pointed out by the canonical work by Diamond and Dybvig (1983a). The necessity of maintaining a fragile capital structure in financing illiquid projects that require special payment collection skills is further made clear in Diamond and Rajan (2001a).

guaranteeing the safety of the money they create. Second, loans do not generate deposits directly, but rather in an indirect way.⁴

My analysis starts with recognizing and fixing these two issues highlighted above in modeling banks' private money creation. A crucial linkage immediately emerges once we combine the two—loans made by one bank can generate fresh supply of liquidity to the banking sector before they pay off, since whoever receives these credit would have a demand for a safe store to place the credit they receive. Importantly, the enlarged liquidity pool for the banking sector helps to ensure the safety of bank deposits under the exposure to liquidity shocks, during the period before their loans pay off. In a world with one single bank, the bank will see that this liquidity pool, which is endogenously created by its loan making, be optimally produced ex-ante and properly utilized ex-post. However, in an environment with many banks, this endogenously created liquidity pool may not be optimally produced and utilized when markets and contracts are incomplete. The design of the banking system thus comes into the spotlight.

In this paper, I address the following question. In an environment where markets and contracts are incomplete, how should the private banking system be designed to most efficiently create money-like assets in the economy—the bank deposits, which need to be made both liquid and safe? Put differently, how should the banking system be designed to maximize the efficiency in its private safe assets creation under the exposure to liquidity risks?

In doing so, I first demonstrate that the combination of incomplete markets (and contracts) with a constraint imposed by safe asset creation under liquidity risks implies that several market failures of distinct natures could arise, in the process of private money creation in a decentralized economy. Having identified where the roots of inefficiencies are located, I then study the optimal design of the private banking system to alleviate the inefficiencies induced by these market failures and thus to maximize the efficiency of private

4. This point is first made clear by Tobin (1963) in his famous critique on the notion of bank money creation by saying "... It depends on whether somewhere in the chain of transactions initiated by the borrower's outlays are found depositors who wish to hold new deposits equal in the amount of the new loan...".

money creation in a decentralized economy.

In this paper I consider two commonly used policy instruments in the design of banking system. The first policy tool that a policy maker (who is not a social planner) can deploy is the regulation on banking market competition. In particular, I focus on the (de)regulation of bank funding markets, such as imposing/removing restrictions on banks' branching and deposit taking operations. The second policy tool could be deployed to achieve efficient private money creation is bank liquidity regulation. In particular, the only form of liquidity regulation considered in this paper is simply imposing certain uniform reserve requirements.⁵ As the main results of the analysis, I show that banking market competition has a mixed effect on efficiency and liquidity regulation becomes necessary for the private safe asset creation once banking market becomes sufficiently competitive. Let us now elaborate.

The economy in the model, which consists of three groups of agents— banks, households and entrepreneurs— is located on a circle as in Salop (1979) and Zentefis (2019). Each bank possesses a natural territory, within which it enjoys certain monopoly power in both lending and funding markets. Two basic assumptions are made. First, there is a demand for money-like safe assets to support economic activities in the economy.⁶ Second, entrepreneurs' projects are illiquid when external financing is needed.⁷ In such an environment, banks perform a dual role on either sides of their balance sheets: they create a payment medium by issuing money-like deposits and they finance illiquid projects as delegated monitors or relationship lenders.

The money creation process is initiated at the moment banks take deposits from local households, at which point an exchange medium is created. Thanks to the ex-ante creation of

5. In other words, it is assumed that the policy maker in this economy does not have access to more complicate policy tools such as the liquidity regulations proposed in Basel III (e.g., minimum requirement on LCR, NSFR, etc.)

6. The demand for money in the economy is not micro founded in this paper. A rationale for the necessity of money can be found in Kiyotaki and Moore (2002, 2018). An alternative assumption that does same the job for our modeling purpose could be that consumers have idiosyncratic liquidity needs so that bank deposits must be made both redeemable and safe, as in Diamond and Dybvig (1983a).

7. See Diamond (1984), Rajan (1992), Petersen and Rajan (1994, 1995). The illiquidity problem here is essentially the same as the limited pledgeability problem that plagues the private creation of liquidity in Holmström and Tirole (1998).

such money-like deposits, profitable projects are generated in the economy. Banks then invest part of the received deposits into illiquid lending to finance local entrepreneurs' projects.⁸ In an important novelty of this model, banks' loan making triggers a whole chain of subsequent transactions in the economy, which generates a fresh supply of liquidity to the banking sector. In the model, this "liquidity pool creation" effect of loan making is captured by assuming a constant labor payment per unit of production, which is distributed to local households. This loan-created liquidity pool in the economy helps to guarantee that deposits issued by banks are indeed safe assets.

A key assumption maintained throughout the analysis in this paper is that for bank deposits to be money-like, they need to be made both *liquid* and *safe*. A tension thus arises in banks' private money creation— safety of banks deposits needs to be guaranteed with a fragile bank capital structure being maintained.⁹ This fragility-safety conflict is modeled by assuming that some banks will be hit by "liquidity shocks" before their loans pay off, in which case these banks need to (be able to) raise enough short-term liquidity to avoid bankruptcy.¹⁰ Banks play a sequential game in this economy— they play an ex-ante game in loan making and play an ex-post game in liquidity raising after liquidity shocks hit the banking sector. Thus, an ex-post solvency constraint under liquidity shocks is at the core of the safe asset creation: the safety of the ex-ante issued deposits is ensured only if the ex-post solvency constraint under liquidity shocks is guaranteed to hold.¹¹

The first main result of the paper is that the combination of this safe asset creation constraint under liquidity risks with certain markets being missing implies that the private money creation in a decentralized economy could be constrained inefficient. In particular,

8. In the model, the illiquid feature of bank loans is captured by assuming that loans cannot be resold to their full value before maturity, but can only be borrowed against or liquidated to get a lower value.

9. Bank capital structure being fragile is due to the fact that bank deposits needs to be liquid and redeemable on demand, while banks' assets are illiquid.

10. This solvency constraint under liquidity shocks is essentially a panic-proof constraint. This constraint ensures each of the depositors to banks who get by "liquidity shocks" that running is not self-fulfilling.

11. The notion that only safe assets can perform the role as money in the economy is well recognized in the money and banking literature: see for instance Gorton and Pennacchi (1990)

under a practically and theoretically reasonable environment of contracting and market space, I identify three market failures that can potentially plague the private money creation in a market economy. Two of them can cause inefficiencies by making the safe asset creation constraint inefficiently tight and the other can result in a complete collapse of private money creation.

Let us be more specific. Banks' safe asset creation relies crucially on a commonly shared liquidity pool, which is endogenously generated by each individual bank's ex-ante loan making and provides liquidity to banks hit by ex-post liquidity shocks. As such, tightness of banks' safe asset creation constraint depends both on the ex-ante creation of this liquidity pool, as well as on the ex-post usage of the liquidity pool. In a social planner's solution, both the ex-ante creation and the ex-post usage of the liquidity pool are optimized, which may not hold once the economy is decentralized.

The first potential inefficiency in private safe asset creation is due to (ex-ante) underproduction of the liquidity pool, when not all banks will be hit by liquidity shocks. Each bank's ex-ante loan making enlarges the size of the common liquidity pool in the system, which generates a positive externality by lowering other banks' ex-post liquidity raising cost when themselves are not hit by liquidity shocks.¹² In the constrained efficient benchmark, this positive externality can be fully internalized by the social planner. This is because the planner can guarantee that surplus liquidity is always traded at its marginal costs from banks surplus in liquidity to those in need of liquidity. This ability to frictionlessly reallocate surplus liquidity within the banking sector allows the social planner to fully account for the loosening effect on the safe asset creation constraint, of the liquidity generated by each individual bank's ex-ante loan making.

However, this is unlikely to be true in a decentralized economy. Although a positive externality is generated when the loan-making bank is not hit by liquidity shocks, the cost is an increase in the bank's own demand for liquidity when it gets hit. An incentive issue thus

12. The nature of this positive externality is akin to that of the "collateral externality" discussed by Davila and Korinek (2016), in which individual decision maker's action can generate impact on certain aggregate state variables that affect the financial constraints faced by individual agents.

arises. Internalization of the positive externality requires sufficient incentives to be provided, which in turn depends on whether loan-making banks are properly compensated— in states where they do care about the compensation.¹³ As such, whenever banks are concerned that they cannot purchase surplus liquidity in the ex-post wholesale market at fair prices once in need of liquidity, the incentive provision for ex-ante creation of the liquidity pool would be inefficient. In such cases, a hold-up problem arises and the liquidity pool in the economy is under-produced, due to banks’ concern of being held up in ex-post wholesale liquidity trading.

The second inefficiency that potentially arises in private money creation is due to (ex-post) over-use of the liquidity pool, when more than one bank will be hit by liquidity shocks. Behind this over-use problem is a negative externality one bank generates when dipping into the liquidity pool on others who are also in need of liquidity.¹⁴ In the constrained efficient benchmark, the planner can fully internalize this “distributive externality” with her ability to dictate each shocked banks’ ex-post liquidity raising strategy— liquidating how much of their illiquid assets, as well as dipping how much into the liquidity pool. Importantly, the social planner can guarantee that the liquidity pool is always optimally used ex-post, contingent on any level of ex-ante production of the liquidity pool and any realization of liquidity shocks.

However, these conditions are likely to fail once the economy is decentralized. To achieve the time consistency in planner’s constrained efficient solution—that is, to ensure the optimality of ex-post liquidity pool usage contingent on ex-ante liquidity pool production, certain futures markets are needed in a decentralized system. The futures contracts required to implement the constrained efficient benchmark should allow each bank to purchase pre-specified quantities of ex-post retail liquidity at pre-specified prices, contingent only on their

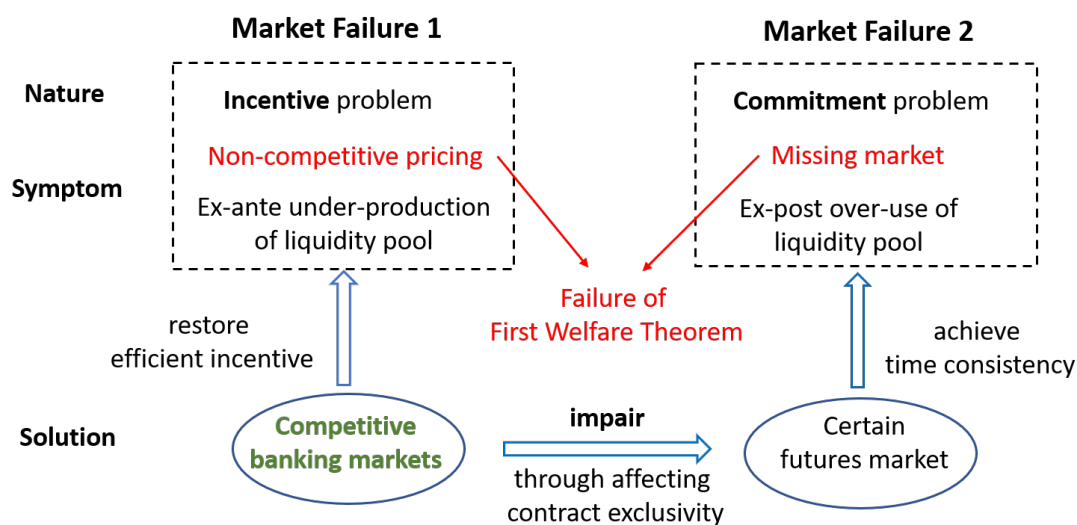
13. As the creator of safe assets, banks care more about the price at which they can purchase liquidity when they need it than about the price at which they can sell liquidity when it is in surplus.

14. The nature of this negative externality is akin to the “distributive externality” discussed by Davila and Korinek (2016), in which externalities are zero-sums across agents. Here one bank’s usage of the ex-post liquidity pool results in less available retail liquidity at given prices for other banks that also need liquidity, when the size of liquidity pool is held fixed.

ex-ante loan making choices while not affected by the ex-post behavior of other banks.¹⁵ Whenever this futures market is missing or is impaired, a commitment problem arises and banks hit by liquidity shocks end up being forced to over-use the liquidity pool in the ex-post equilibrium.¹⁶

As a brief summary of the analysis so far, two market failures can potentially lead to inefficiencies in private money creation by making the safe asset creation constraint inefficiently tight. The first is an *incentive* problem due to non-competitive pricing of ex-post wholesale liquidity, which can result in ex-ante under-production of the liquidity pool. The second is a *commitment* problem due to certain futures market being missing or impaired, which can result in ex-post over-use of the liquidity pool. These two market failures are exactly the manifestations of the two scenarios in which the first welfare theorem could fail and Pareto inefficiencies could arise, as illustrated in Figure 1.1.

Fig. 1.1. Mixed effect of banking market competition on efficiency



Based on the above normative analysis, I derive the key positive results of this paper.

15. Those banks who are not hit by liquidity shocks can then trade these ex-post retail liquidity to those in need of liquidity via the wholesale market.

16. Existence of such a futures market is desirable both collectively and also individually. This is because as the money creator, banks care about the worst case scenario, as captured by the safe asset creation constraint under the worst realization of ex-post liquidity shocks. This makes individual banks' interest aligned with all banks' collective interests, which is guaranteeing the safety of all banks' deposits under liquidity risks.

I demonstrate an interesting role played by banking market competition in affecting the efficiency of private money creation. In particular, I show that increased competition in banking market has a mixed effect on efficiency— it alleviates the incentive problem and hence the ex-ante under-production of liquidity pool, but it also exacerbates the commitment problem and the ex-post over-use of liquidity pool.¹⁷

The intuitions are as follows. With a more competitive retail liquidity market, banks hit by ex-post liquidity shocks are able to purchase wholesale liquidity at a price closer to its marginal cost. This is because a competitive retail liquidity market effectively improves the threat point of liquidity-needy banks, in their bargaining with banks surplus in liquidity. Therefore, banks are less concerned about being extracted in their ex-post wholesale liquidity trading once hit by liquidity shocks and thus are more incentivized to account for the liquidity creation effect of their ex-ante loan making. As such, the hold-up problem is alleviated and efficiency is improved.

A more competitive banking market, however, would have an undesirable effect on the futures markets that are necessary to get around the commitment problem in ex-post liquidity pool usage. With a highly competitive retail liquidity market, each individual bank's ability to write the future contracts on the ex-post retail liquidity usage and pricing would be impaired. This is because the quantity of retail liquidity a bank can obtain at certain price is likely to be affected by other banks' ex-post behavior, when a banking market is competitive. In other words, a competitive banking market impairs the contract exclusivity. This is problematic for the functioning of futures market because it means the liquidity pool usage specified in the futures contracts cannot be committed— because other banks' ex-post behavior could easily invalidate these ex-ante written contracts under a competitive market environment.¹⁸

In addition to the above two market failures that will lead to inefficient outcomes in

17. The banking market competition here refers to that in bank funding markets— the retail deposit market in particular.

18. The phenomenon described here shares some similar spirits to that illustrated in Petersen and Rajan (1995).

private money creation, there is a third market failure that can potentially result in a complete collapse of the whole private system in its safe asset creation. When banking markets become sufficiently competitive, an ex-ante *coordination* issue may arise in banks' safe asset creation. In an environment of competitive banking markets, the perceived cost of an ex-ante deviation to make more loans is relatively low for each individual bank. This is because after making such a deviation, the competitive ex-post liquidity market allows the bank to cover the increased demand for external liquidity without having to post a much higher rate.¹⁹ As such, when the banking market is too competitive, the safe asset creation equilibrium in which all banks can just stay solvent under ex-post liquidity shocks cannot be coordinated ex-ante. In such cases, no private safe assets can be created in the economy.²⁰

The results of the analysis in this paper have some powerful policy implications. Our main results, that banking market competition has a mixed effect on the efficiency in private money creation, have a clear policy implication on the optimal level of banking market competition in an economy. If an economy is subject to idiosyncratic risks (e.g. has a diversified industry structure and hence diversified risk factor loading), then a competitive banking market helps. This is because for such an economy, alleviating the incentive problem would be more economically important than curing the commitment problem, since the former is relevant when the economy is subject to idiosyncratic shocks whereas the latter is relevant for systemic shocks. In such cases, competitive banking markets play the role as an incentivizing tool and can achieve better risk-sharing when idiosyncratic shocks hit.

On the contrary, if an economy is exposed to systemic risks (e.g. has a concentrated industry structure and hence concentrated risk factor loading), then competitive banking markets can be harmful. In this case, competitive banking markets can actually trap the economy in a high interest rate equilibrium once systemic shocks hit the economy, in which all shocked banks aggressively dip into the liquidity pool until the liquidity price gets bid up

19. This is more likely to be true when the number of banks is large so that the impact of each individual bank's ex-ante deviation on ex-post liquidity price is not large enough for self-disciplining.

20. This system-wise collapse in safe asset creation is reminiscent of results in Jacklin (1987) and Farhi et al. (2009), which demonstrates that the existence certain ex-post markets can impair the ex-ante liquidity creation.

to an inefficiently high level. These predictions on how banking market competition would affect economy's resilience to unexpected shocks are supported by the empirical findings documented in Xu (2019). In that paper, through exploiting the 1986 oil price shock and the staggered intra-state banking deregulation in US during 1980s, I document the following facts: 1) for lightly hit areas, deregulation attenuates the shock; while 2) for heavily hit areas, deregulation amplifies the shock.

Finally, my analysis suggests that regulations on banks' liquid asset holding become essential for private safe asset creation when banking market becomes sufficiently competitive. In such cases, a properly designed ex-ante reserve requirement serves as a *coordinating* tool that commits all banks to choosing the (socially) desirable level of ex-ante loan making, which is the point that everyone can just stay solvent under ex-post liquidity shocks. The synchronized enforcement of nationally uniform reserve requirements with the banking deregulation in the "*Depository Institutions Deregulation And Monetary Control Act of 1980*" provides a real world example that is consistent with this implication.

Related literature This paper studies the creation by banks of private safe assets in the economy, with a threat of run being maintained on bank deposits. To the best of my knowledge, incorporating this fragility-safety conflict into private banks' money creation process is novel in the banking literature.

In my model, two components are crucial. First, the deposits that banks issue ex-ante must be guaranteed to be immune to panic under ex-post liquidity shocks. This safety requirement for bank deposits acknowledges the liquidity/ "money" creator role that banks play in the economy (e.g., Diamond and Dybvig (1983a); Gorton and Pennacchi (1990); Stein (2012); Hart and Zingales (2014); DeAngelo and Stulz (2015); Diamond (2017); Donaldson et al. (2018), etc.), and the intrinsic illiquidity of banking operations (e.g., Diamond and Dybvig (1983a); Diamond and Rajan (2000, 2001a, 2005), etc.).

Second, in the spirit of the Tobin (1963) critique, the model features an "endogenous money creation" notion in which banks generate a fresh supply of deposits by extending loans.

In my model, this deposits creation effect is reflected in the enlarged ex-post endowments of households that receive labor income generated by the loan-making activities of banks. The enlarged ex-post liquidity pool lowers the ex-post retail liquidity price and helps to back up the safety of deposits issued ex-ante.

The sources of risks that present difficulties in banks' safe asset creation that we identify in this paper differ from those presented in the previous literature on bank safe asset creation (e.g. Gorton and Pennacchi (1990); Stein (2012); DeAngelo and Stulz (2015); Diamond (2017), etc.) While in these papers the safety of bank deposits is impaired by the risks inherent in the payoff of projects financed by banks, in my paper the liquidity risks induced by runnable deposits cause the problem. Furthermore, different from DeAngelo and Stulz (2015) and Diamond (2017) in which capital structure management is considered as the solution for safe assets manufacturing, an endogenously created ex-post liquidity pool is the key in our model.

My results— that private safe asset creation in a decentralized economy is constrained inefficient— is related to a large literature, initiated by Geanakoplos and Polemarchakis (1985) and Greenwald and Stiglitz (1986), that studies pecuniary externalities in incomplete markets. More specifically, my model features two pecuniary externalities of distinct natures, as distinguished in Davila and Korinek (2016).

First is a positive externality associated with ex-ante creation of the common liquidity pool in the economy. The economics of this externality are such that an individual bank's ex-post panic-proof constraint is affected by an aggregate state variable: the size of the liquidity pool in the economy. Although associated with the opposite sign, this externality has a nature similar to that of the firesale externalities that usually work through the impact from the market value of collaterals on individual agents' collateral constraints (e.g. Kiyotaki and Moore (1997b); Gromb and Vayanos (2002); Jeanne and Korinek (2010); Bianchi and Mendoza (2011); Stein (2012); He and Krishnamurthy (2012); Hart and Zingales (2015), etc.). As a mirror image, while firesale externalities usually imply over-liquidation, in our model under-production of the liquidity pool is induced when this positive externality cannot

be fully internalized due to banks' concerns of being held up.

Second is a negative externality associated with ex-post usage of the common liquidity pool in the economy. As distinguished by Davila and Korinek (2016), this externality is a “distributive externality” because it is zero-sum across banks when the size of the liquidity pool is fixed.²¹ In our model, inefficiencies associated with this externality arise because the extra incentive compatibility constraint on liquidity pool usage introduces wedges to the equilibrium marginal rates of substitution in banks' ex-post liquidity raising, which distort them away from the optimal levels implied by the planner's solution. As such, the problem induced by this externality is reminiscent of those discussed by Allen and Gale (1994, 2000, 2004, 2005); Lorenzoni (2008b); Farhi et al. (2009); Gale and Yorulmazer (2011); He and Kondor (2016), etc., who note that in the decentralized economy, wedges in MRS drive inefficient outcomes.

In a key novel finding, I show that banking competitiveness plays a crucial role in determining the efficiency of private safe asset creation, by simultaneously affecting both externalities. In particular, a mixed effect is shown: a more competitive banking market alleviates the first inefficiency but exacerbates the second one.

Finally, I show that when the banking market is sufficiently competitive, regulation of banks' liquid asset holding becomes essential. The economics of this result recall those proposed by Jacklin (1987) and Farhi et al. (2009), who show that restrictions on private trading among consumers are crucial for intermediaries' liquidity creation.

The remainder of this chapter is organized as follows. Section 1.2 sketches the basic setup of the model, wherein private safe assets are created through a constrained “money multiplier”. Section 1.3 characterizes the equilibrium of bank safe asset creation. In Section 1.4, I analyze the equilibrium first by characterizing the planner's solution as a constrained efficient benchmark. Then I illustrate the problems that potentially arise when the economy is decentralized. Section 1.5 applies the model to study policy making by a regulator who

21. One bank using more of the liquidity pool results in the liquidity supply curve for another bank being shifted upward.

faces the same problems found in a decentralized economy. Conclusions follow.

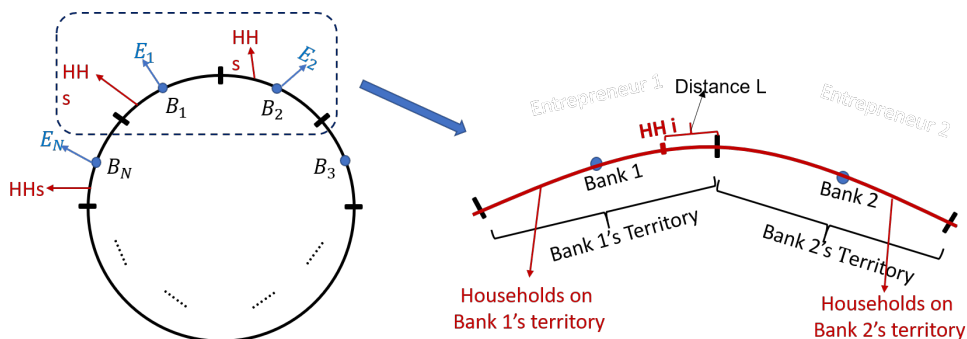
1.2. A Model of Private Safe Asset Creation

This section displays the model setup. I describe the model’s assumptions about the economy’s environment, endowments and technologies, as well as key frictions in the economy. In particular, a constrained “money multiplier” will be highlighted in banks’ private safe asset creation process.

A. The Economy

The economy considered in the model is located on a circle similar to those in Salop (1979) and Zentefis (2019); and it consists of three groups of agents: households, entrepreneurs, and banks, as displayed in Figure 1.2.²²

Fig. 1.2. Structure of the Economy



The banking sector is comprised of N identical banks, whose headquarters are evenly scattered over the circle.²³ Each bank possesses a natural territory centered around its headquarter, within which it may enjoy certain monopoly power in both the lending and funding markets. The territories of two adjacent banks exactly touch each other without overlapping.

22. Unlike Salop (1979) and Zentefis (2019) in which each bank is a single point on the circle, in our model each bank possesses an entire band around its headquarter as its natural territory. The competition in banking market essentially captures how integrated the retail deposit market is, similar to how financial integration is modeled in Gârleanu et al. (2015)

23. The number N of banks in the economy is treated in this paper as exogenously given.

Infinitesimal and ex-ante identical households are uniformly scattered over the entire circle. Each individual household HH consists of two members: A (consumer) and B (worker). To simplify the algebra, I normalize the total mass of households located on each bank's territory to be unity.

For the corporate sector, there is one single entrepreneur located in each bank's territory and all N entrepreneurs are identical except for their various locations.²⁴

To define bank territory, I assume that entrepreneurs can only borrow from their local banks.²⁵ In the model, competition in the deposit market is crucial, and it is captured by a parameter κ . A household would incur a traveling cost $\kappa \cdot L$ if it deposits with a bank from which the distance is L . The distance L is zero if the household resides within the bank's territory; if not, L is the minimum distance to the boundaries of the bank's territory.

As such, banking market competition in our model is captured by parameter $\tau \equiv \frac{1}{\kappa}$ with larger τ suggesting higher level of competition among banks. Two extreme cases will be frequently referred to in the following analysis: 1) $\tau = \infty$, in which case the banking market is perfectly competitive; 2) $\tau = 0$, in which case the banking market is completely segmented or non-competitive.

B. Endowments and Technologies

As in standard maturity mismatch models, there are three dates in the model: $t = 0, 1, 2$. In this subsection, I specify the model's assumptions regarding the endowments and technologies for each agents at relevant dates.

i) Households

At date 0, each household is endowed with one unit of (real) goods. I assume that these initial endowments are all owned by member A of each household, who has to rely on (local)

24. This single entrepreneur can be thought of as aggregating many infinitesimal entrepreneurs who reside in the same bank's territory.

25. This simplification of credit market competition can be rationalized by assuming that financing an entrepreneur's project requires frequent and intensive monitoring.

banks for value storage.²⁶

Between date 0 and date 1, member B of households located in each bank i 's territory receives endowment $e_i = \bar{e} + n_i$. Here \bar{e} represents the exogenous component of the endowment, while the endogenous part n_i will be determined by the production scale of local entrepreneurs.

On date 1, each member B is equipped with a storage technology $h(y)$ that allows him to transfer value from date 1 to date 2, where function $h(y)$ satisfies: $h'(y) > 0$, $h''(y) < 0$.

ii) Entrepreneurs

Investment opportunities only arrive on date 0, at which point entrepreneurs are endowed with a productive project that requires inputs to be invested on date 0 and pays off with a constant return $R > 1$ on date 2. Entrepreneurs do not have internal funds and must rely on external financing from banks. Under the assumption that each entrepreneur can only be financed by the local bank, banks have local monopoly power in the lending market and entrepreneurs elastically produce with whatever is lent to them. Projects are riskless if kept to date 2.

As a crucial component of the model, a constant labor cost $w \in (0, 1)$ is required per unit of production and is paid before date 1. To make the analysis simpler, I assume that these labor payments are evenly distributed to the member B of local households who reside in the same bank territory. As such, if the production scale in bank i 's territory is α_i , then the labor income that each household in its territory receives before date 1 is $n_i = w \cdot \alpha_i$.

This labor payment made before date 1 is intended to capture the fresh supply of deposits generated in the whole chain of transactions triggered by entrepreneurs' initial outlay of their received lending. Importantly, these labor payments distributed to local households contribute to the creation of the ex-post liquidity pool in the economy.

iii) Banks

To focus on the banking sector's creation of money-like safe assets in the economy, I

26. Competition for ex-ante deposits is abbreviated in the model. The key in our analysis is banks' competition for ex-post liquidity.

assume that banks are all debt financed.²⁷ At date 0, each bank raises 1 unit of liability from member A of households that reside in its territory, in the form of deposits demandable on both dates 1 and 2. In the model, these date-0 deposits issued by banks are the private safe assets that can function as money in the economy. To simplify the algebra, the deposit rates required on these date-0 deposits are assumed to be one for both dates 1 and 2.²⁸

After receiving 1 unit of deposits, each bank i makes its asset portfolio choice $(\alpha_i, 1 - \alpha_i)$, in which it invests α_i to finance local entrepreneur's project while it invests $1 - \alpha_i$ in a liquid but low return asset (cash). The illiquidity of loans made to entrepreneurs, from which banks can get a return R if kept to date 2, is reflected in their relatively low proceeds if liquidated at date 1.²⁹

While the liquid cash holding has a return of 1 on both date 1 and date 2, a liquidation technology $g(t, \alpha)$ governs the proceeds that banks can get when liquidating part of their illiquid loans on date 1. Specifically, if a bank made α illiquid loan on date 0, then by liquidating $t \in [0, \alpha]$ of these illiquid assets on date 1, a proceeds $g(t, \alpha)$ can be generated. To reflect the illiquidity, I assume that $g(t, \alpha) < t$, for $t \in [0, \alpha]$.³⁰ Furthermore, the following regulatory conditions are assumed on function $g(t, \alpha)$: i) $\frac{\partial g(t, \alpha)}{\partial t} > 0$; ii) $\frac{\partial^2 g(t, \alpha)}{\partial t^2} < 0$; iii) $\frac{\partial g(t, \alpha)}{\partial \alpha} < 0$. While condition i) is trivial, condition ii) can be explained as a "pecking order" in liquidation and condition iii) can be micro-founded by relating the asset sale price (liquidation proceeds) to seller's bargaining position.

C. Sources of Friction

Two sources of friction in this economy drive our analysis. The first is related to a lack

27. An implicit assumption made here is that equity issued by banks cannot function as money in the economy. However, while not explored in this paper, it is interesting to consider how bank equity can help make claims on bank debt more money-like. I leave this question for future research.

28. This simplifying assumption on date-0 deposit rates can be rationalized by the convenience yield on these money-like deposits, or by households' preference of holding safe assets (e.g. Stein (2012), Diamond (2017)).

29. Banks can get the full return from entrepreneurs' projects because credit market competition is shut down in the model—banks enjoy full monopoly power in local lending market.

30. The liquidation proceeds $g(t, \alpha)$ can be interpreted as the net revenue from liquidating t of the long-term assets, if a fixed cost in liquidation is required.

of double coincidence in consumer demand and limited pledgeability on consumers' future return from their specific human capital, as in Kiyotaki and Wright (1989) and Hart and Zingales (2014). Although not explicitly micro-founded in this paper, my model implicitly assumes (because of the issues described above) that there is a demand for safe asset to facilitate transactions.³¹

The second source of friction stems from entrepreneurs' special human capital in generating a payoff from their projects, which is costly to acquire. While this special human capital is needed to generate value, it also makes entrepreneurs' projects illiquid when they need an external funding source to finance their operation. As in Diamond and Rajan (2001a), this illiquidity is reflected as the entrepreneurs' inability to borrow from lenders who lack the skill to collect loan payments.

Banks arise to ameliorate these two fundamental frictions in the economy. Through deposit-taking activity in their liability-side operations, banks create a payment medium that facilitates otherwise restrained transactions. In their asset-side operations, by forming relationships (e.g., Rajan (1992); Petersen and Rajan (1994, 1995)) and behaving as delegated monitors (e.g., Diamond (1984)), banks enlarge the borrowing capacity of otherwise illiquid borrowers.

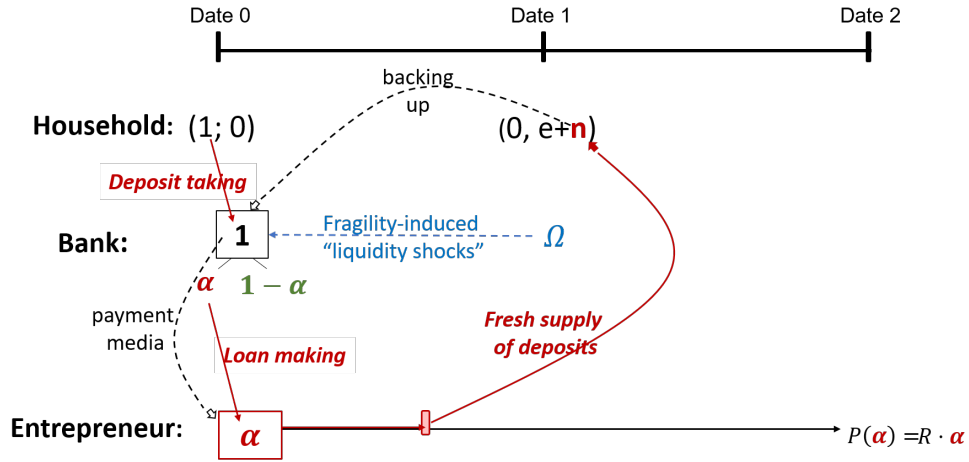
D. A Constrained “Money Multiplier”

In this economy, banks create money-like safe assets through the joint activities of deposit taking and loan making on either side of their balance sheets. As shown in Figure 1.3, a “money multiplier” drives this safe asset creation, at the core of which is an endogenously generated liquidity pool in the economy. However, a fragility-safety conflict implied by banks' illiquid capital structure imposes a natural bound on the size of this multiplier in private money creation. We now elaborate this constrained “money multiplier”.

i) Deposits Create Loans

31. Alternatively, such a demand for liquid and safe deposits in the economy can be rationalized if risk-averse consumer are subject to idiosyncratic liquidity shocks, as in Diamond and Dybvig (1983a).

Fig. 1.3. The constrained “money multiplier”



At date 0, through taking deposits on household member A’s endowments, banks create private safe assets in this economy that can be used as a payment medium in transactions between agents who otherwise have a limited ability to commit to paying and delivering. In the model, this demand of safe assets for value storing and credible wealth transferring (as in Kiyotaki and Wright (1989); Caballero (2006); Hart and Zingales (2014), etc.) is reflected in the requirement that these date-0 deposits must be made money-like. More specifically, only if deposits issued by banks on date 0 are guaranteed to be *liquid* and *safe* will investment opportunities with return R be generated in the economy.³²

Related to the transactional demand that these date-0 deposits can fulfill is the low interest rates required on them. As in Stein (2012), DeAngelo and Stulz (2015) and Diamond (2017), a convenience yield is assumed on these date-0 deposits, as long as they can be made money-like.

Thanks to the creation of these payment media, profitable real investment opportunities arise in the economy. Banks thus engage in their asset-side operations, in which they allocate part of the received deposits to finance local entrepreneurs’ production. In this sense, lending opportunities (and hence loans) are endogenously generated by the ex-ante creation of these

32. This assumption on the economy’s demand for perfectly safe assets does not affect the generality of the analysis that follows— the requirement for perfect safety is not essential for the results and is just a simplifying mathematical treatment.

money-like date-0 deposits.

ii) Loans Create Deposits

The second component of this “money multiplier” is based on the “endogenous deposit creation” notion pointed out in the [Tobin \(1963\)](#) critique of banks as money creator. The essence of this “endogenous deposit creation” is that when a banker signs a loan approval, a chain of subsequent transactions is triggered by the borrowing entrepreneurs’ initial outlay. Through this process, a fresh supply of deposits is created for both the bank that extends the original loan and for the entire banking system.

In our model, this deposit creation effect of bank’s loan-making activities is captured by assuming that for each unit of loans that bank i ($1 \leq i \leq N$) makes, w units of new labor income will be earned by households that reside in bank i ’s territory. More specifically, the date-1 endowment e_i in the hands of member B s of households that reside in bank i ’s territory will be $e_i = \bar{e} + w \cdot \alpha_i$, if bank i chooses an asset portfolio $(\alpha_i, 1 - \alpha_i)$ on date 0. The endogenous component $n_i = w \cdot \alpha_i$ in these date-1 endowments in the economy is generated by the loan-making activities of banks.

By enlarging the size of the (ex-post) liquidity pool in the economy, these loan-generated endowments can help back up the money-like feature of the deposits that banks issue on date 0. In our model, an enlarged ex-post pool of liquidity can be beneficial because it lowers the marginal cost of liquidity raising for banks, which is governed by member B ’s concave storage technology $h(y)$.

iii) A Fragility-Safety Conflict

To function as money in the economy, bank deposits must be made both *liquid* and *safe*. Being liquid requires deposits to be made runnable so that 1) depositors do not need to develop any specific payment collection skill to get paid (i.e., a threat of run needs to be maintained, as in [Diamond and Rajan \(2001a\)](#)); 2) or alternatively, depositors can be insured against idiosyncratic liquidity risks (i.e., deposits needs to be redeemable, as in [Diamond and Dybvig \(1983a\)](#)).

Although it ensures that deposits are liquid, making deposits runnable could impair their

safety. As pointed out in Diamond and Dybvig (1983a), runnable deposits expose banks to a risk of coordination failure among their depositors, unless running can be guaranteed to be not self-fulfilling. Thus, a fragility-safety conflict arises in the banking sector’s creation of deposits, which must be guaranteed to be both liquid and safe for reasons discussed before.

In the model, this fragility-safe conflict in banks’ safe asset creation is modeled by subjecting banks to ex-post liquidity shocks on date 1 (see elaboration in Section 3). The deposits that banks issue at date 0 can be made money-like only if their safety can be ensured under the exposure to ex-post liquidity shocks on date 1. The presence of such a conflict effectively sets a natural bound on the “money multiplier” during the safe asset creation process because it constrains the illiquid lending α that each bank can make on date 0.

1.3. Equilibrium Characterization

In this section, I characterize the equilibrium in which private safe assets are created in this economy. In particular, I define the condition for safe asset creation and characterize the game played by banks during this process.

A. Ex-post Liquidity Shocks and Panic-Proof Constraint

The fragility-safety conflict in private safe asset creation is modeled as exposing the banking sector to ex-post liquidity shocks on date 1. More specifically, I assume that on date 1, all depositors of k ($1 \leq k \leq N$) randomly-selected banks see a sunspot while all others do not. The scale of these ex-post liquidity shocks is parameterized by integer k , with larger k indicating that the liquidity shocks are more systemic. In the following analysis, I refer to shocks in which depositors of k banks seeing a sunspot as *level- k liquidity shocks*.

For notational convenience, let us denote the set of all level- k liquidity shocks as $\Omega_k = \{(i_1, \dots, i_k)\}$, where indices $1 \leq i_1 < \dots < i_k \leq N$. Also, denote each realization of an ex-post liquidity shock as $\omega \in \Omega_k$, where ω is a set that consists of the k banks that get hit by the shock. On date 0, all agents in the economy know that a level- k liquidity shock

$\omega \in \Omega_k$ will be hitting the system on date 1, but they do not know the exact realization of ω .³³

On date 1, given a realization of ω , depositors at each bank $i \in \omega$ see a sunspot and decide whether or not to run. In the model, I assume that the date-0 deposits can be made money-like only if the coordination failure risk among the depositors at these banks in ω can be eliminated. The following assumption formally specifies the condition for safe asset creation.

Assumption 1 *When a date-1 liquidity shock ω hits, the deposits each bank $i \in \omega$ issued on date 0 will be guaranteed to be safe if and only if running is not self-fulfilling for depositors at banks in ω .*

That is, on date 1, each bank $i \in \omega$ needs to assure each of its date-0 depositors that even if all other depositors (including those at other banks that get hit) immediately withdraw, choosing to stay is still a weakly dominating strategy. In this sense, this panic-proof constraint could be interpreted as a solvency constraint under *real* liquidity shocks, which force depositors (who get hit) to actually withdraw immediately on date 1.³⁴

Alternative Interpretation: Liquidity Stress Test with k Banks being Tested

While it seems somewhat obscure to imagine that depositors of k banks will miraculously see a sunspot at the same moment, this specification of ex-post liquidity shocks becomes more natural under an alternative interpretation. Stress tests are common practices that banking regulators adopt in designing policy tools that aim to enhance the stability of banking system and the whole economy. Prior to the 2008 financial crises, most of these stress tests run by policy makers are focusing attentions on bank *capital*. After the crises, stress tests on bank *liquidity* have gained more attentions and started to be considered in central bankers' policy

33. That is, at date 0, everyone in the economy knows that k banks will be hit by the liquidity shock on date 1, but they do not know which k banks will get hit.

34. Rigorously speaking, the “sunspot shock” ω is not exactly a liquidity shock, because banks in ω do not actually suffer immediate withdrawal from their depositors. But for our modeling purpose, it works exactly the same as a real liquidity shock. So in our following analysis, we refer to ω simply as liquidity shocks, and being hit by one means that all date-0 deposits will withdraw on date 1.

making.

These stress tests on bank liquidity normally work as follows: some banks are randomly picked and are asked to raise certain amount of short-term funding within a short duration of time. Such a liquidity stressful scenario for banks could be mapped onto real world events such as a sudden outflow (or withdrawal) of deposits, an increase in the short-term overdue ratio due to delayed loan payments, or a large drawdown in the credit line commitment, etc. Banks chosen to do the liquidity stress test can borrow against their long term assets to raise short-term liquidity, in order to pass the test.

In the concrete setting of this model, a liquidity stress test is run on date 1, in which k banks are randomly picked and each of these k banks needs to raise 1 unit of liquidity to pass the test. It's easy to see that for each individual bank under test, the condition of passing the liquidity stress test is mathematically equivalent to the run-proof condition elaborated above.

Under this alternative interpretation, the variable k – the number of banks that will be hit by liquidity shocks on date 1 has a very natural economic meaning. If an economy has a relatively concentrated industry structure and risk factor loading, then the relevant liquidity stress test for the policy maker in this economy should be associated with a larger value of k . On the contrary, for an economy with relatively diversified industry structure and risk factor loading, the relevant liquidity stress test to be run for such an economy should be associated with smaller value of k .

In the next subsection we ask: How can banks make themselves safe (immune to panic) under liquidity shocks at date 1, thus rendering their date-0 deposits money-like?

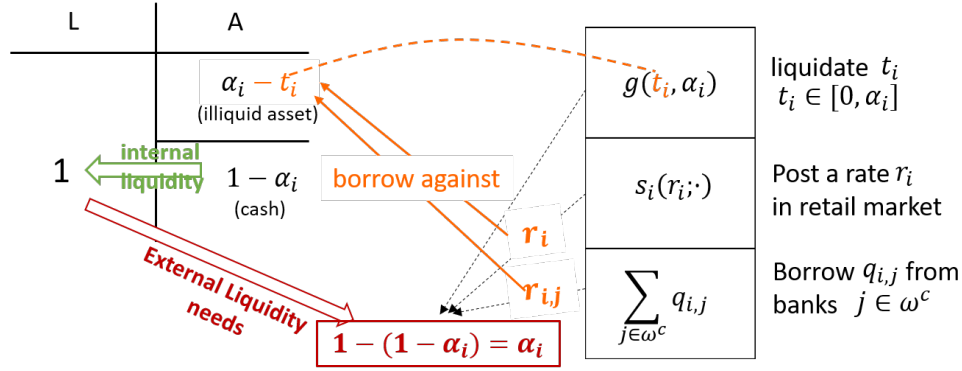
B. Coverage of Ex-post Liquidity Needs for Bank $i \in \omega$

On date 1, after a liquidity shock ω hits, each bank $i \in \omega$ needs to be able to cover potential liquidity demand so that panic among its date-0 depositors can be deterred. In this subsection, I discuss the ex-post liquidity coverage for each bank gets hit by liquidity shocks on date 1.

i) **Ex-post Solvency of Bank $i \in \omega$**

As discussed above, the ex-post panic-proof constraint can be constructed as the solvency constraint on date 1 under *real* liquidity shocks that depositors of all banks get hit require immediate payment. Figure 1.4 illustrates the ex-post liquidity coverage for a bank $i \in \omega$ that chooses α_i in ex-ante loan making.

Fig. 1.4. Ex-post liquidity coverage for bank $i \in \omega$



With α_i being invested in illiquid loans on date 0, the remaining $1 - \alpha_i$ liquid cash holding can be used as internal liquidity to cover bank i 's liquidity needs on date 1. To ensure that the liquidity shortage can be made up, the demand for liquidity to be raised externally on date 1 is $1 - (1 - \alpha_i) = \alpha_i$.

In the model, each bank $i \in \omega$ can employ three exhaustive methods to raise liquidity apart from its cash holding. First, it can deploy its liquidation technology $g(t, \alpha)$ and liquidate a certain amount $t_i \in [0, \alpha_i]$ of its long term assets (illiquid loans). In this manner, bank i can immediately raise ex-post liquidity $g(t_i, \alpha_i)$ on date 1, while the remaining long term assets kept on date 2 become $\alpha_i - t_i$.

Second, a bank $i \in \omega$ can post a rate on the retail market to raise liquidity from household member B 's date-1 endowments. I assume that banks cannot price discriminate in the retail market and thus that they can only post a single rate in date-1 liquidity raising.³⁵ The proceeds from posting a rate r_i are governed by a liquidity supply function $s_i(r_i; \cdot)$ for bank

³⁵. No price discrimination in the retail liquidity market can be implied by assuming that banks cannot tell the identity of each household.

i , in which “ \cdot ” indicates that this supply function is parameterized by certain variables. The determination of this ex-post liquidity supply function $s_i(r_i; \cdot)$ will be elaborated in part ii) of this subsection.

Third, a bank $i \in \omega$ can raise liquidity by borrowing in the wholesale market from banks in surplus of liquidity. After a liquidity shock ω hits on date 1, each bank $i \in \omega$ that needs liquidity would borrow from each bank $j \in \omega^c$ that has a surplus of liquidity. In the model, these pairwise ex-post wholesale liquidity trades are determined as bilateral bargaining. The bargaining outcome specifies the quantity $q_{i,j}$ of date-1 liquidity to be delivered to the borrower as well as the price $r_{i,j}$ at which date-2 repayment is made. The determination of the bargaining outcome $(q_{i,j}, r_{i,j})$ between bank $i \in \omega$ and bank $j \in \omega^c$ will be elaborated in part iii) of this subsection.

On date 1, each bank $i \in \omega$ optimally determines its liquidity raising strategy (t_i, r_i) while the wholesale liquidity trading $\{(q_{i,j}, r_{i,j})\}_{j \in \omega^c}$ is determined as bargaining outcomes. Coverage of liquidity shortage on date 1 requires

$$g(t_i, \alpha_i) + s_i(r_i; \cdot) + \sum_{j \in \omega^c} q_{i,j} = \alpha_i$$

That is, the total proceeds of date-1 liquidity that come from adopting strategy (t_i, r_i) coupled with interbank trading $\{(q_{i,j}, r_{i,j})\}_{j \in \omega^c}$, should be just enough to cover bank i 's demand for external liquidity.

However, the ex-post liquidity raising strategy (t_i, r_i) is bounded by a feasibility constraint that is determined by bank i 's solvency on date 2. That is, the date-2 payoff from bank i 's unliquidated long-term assets must be sufficient to make the promised payments to the date-1 creditors in both retail and wholesale liquidity markets. The ex-post solvency condition for bank i can then be formulated as

$$S_i(\cdot, \omega) = R(\alpha_i - t_i) - r_i \cdot s_i(r_i; \cdot) - \sum_{j \in \omega^c} r_{i,j} \cdot q_{i,j}$$

where “.” indicates that the ex-post solvency of bank i is a function of certain variables. Bank i can stay solvent under liquidity shock ω with an ex-post liquidity raising profile $\left\{ (t_i, r_i), \{ (q_{i,j}, r_{i,j}) \}_{j \in \omega^c} \right\}$ only if

$$S_i(\cdot, \omega) \geq 0$$

ii) Pricing of Retail Liquidity: Households' Problem

Household member B 's endowments on date 1 serve as the ex-post liquidity pool in the economy, and banks may dip into the pool once hit by liquidity shocks. Under the assumption that banks cannot price discriminate against households, a retail liquidity supply function $s_i(r_i; \cdot)$ governs the proceeds each bank i can raise at date 1 by posting a rate r_i .

This ex-post liquidity supply function is obtained by solving individual household's problem, in which each HH member B optimally determines the amount to deposit at the rate posted by banks on date 1 and the amount to deploy his storage technology $h(y)$. The following lemma describes the liquidity supply from each individual household.

Lemma 1 *On date 1, for a household member B with endowment $e + w \cdot \alpha$, its (individual) inverse supply of deposits is $r(d; \alpha) \equiv h'(e + w \cdot \alpha - d)$. Accordingly, its (individual) deposit supply function is $d(r; \alpha) = r^{-1}(d; \alpha)$.*

Depending on the competitiveness τ of the banking market, the ex-post liquidity supply function $s_i(r_i; \cdot)$ for each bank i can be formulated based on the individual liquidity supply. Two extreme cases are useful for illustration and will be frequently referred to in our following analysis.

When banking market is completely segmented (i.e., $\tau = 0$), each bank can only raise deposits from its own territory. In this case, for a bank i that chooses α_i on date 0, the ex-post liquidity supply curve it faces on date 1 is

$$s_i(r_i; \alpha_i) = d(r_i; \alpha_i)$$

which is parameterized by its own date-0 lending α_i .

In contrast, when the banking market is perfectly competitive (i.e., $\tau = \infty$), banks can

freely compete for households that reside in the territories of other banks. In this case, if all other banks $n \neq i$ are posting a rate \bar{r} , the ex-post liquidity supply curve for an individual bank i on date 1 is

$$s_i(r_i; \bar{r}) = \begin{cases} 0 & r_i < \bar{r} \\ \text{anything} & r_i \geq \bar{r} \end{cases}$$

which is parameterized by other banks' choice \bar{r} .

For general cases, both banks' ex-ante choice of α and others banks' ex-post action \bar{r} will impact each individual bank's liquidity supply curve. The following lemma describes the ex-post liquidity supply for general cases.

Lemma 2 *For general cases in which $0 < \tau < \infty$, if all banks chose α on date 0 and all other banks $n \neq i$ are posting a rate \bar{r} on date 1, then the ex-post liquidity supply curve faced by bank i is*

$$s_i(r_i; \alpha, \bar{r}) = d(r_i; \alpha) \cdot [1 + 2\tau \cdot (V_H(r_i; \alpha) - V_H(\bar{r}; \alpha))]$$

where $V_H(r; \alpha) \equiv \max_d r \cdot d + h(e + s \cdot \alpha - d)$ is the optimized value for a HH with endowment $e + s \cdot \alpha$ and being offered a rate r .

Parameter τ (i.e. $\frac{1}{\kappa}$) affects households' traveling cost, through which it determines the competitiveness of the banking market.³⁶ With higher values of τ indicating higher competitiveness, lemma 2 suggests that the ex-post liquidity supply is more elastic when the banking market is more competitive. Detailed analysis and algebra of retail liquidity supply are provided in Appendix [Section A1](#).

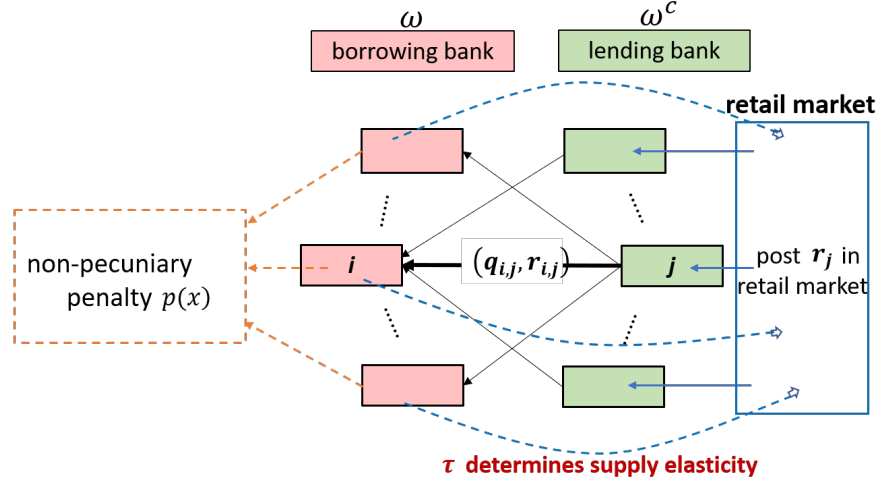
iii) Pricing of Wholesale Liquidity: Interbank Bargaining

In addition to raising liquidity by directly posting rates in the retail market, banks hit by liquidity shocks can also borrow in an ex-post wholesale liquidity market. Figure 1.5

36. A natural interpretation of the central banker's power to affect parameter τ is her ability to control the degree of competition in the retail markets by stipulating appropriate regulatory restrictions on the branching operations of banks.

illustrates ex-post interbank transactions in the wholesale liquidity market.

Fig. 1.5. Interbank bargaining



After the realization of a liquidity shock ω on date 1, each bank $i \in \omega$ establishes a trading deal $(q_{i,j}, r_{i,j})$ with each bank $j \in \omega^c$. The trading deal $(q_{i,j}, r_{i,j})$ specifies the quantity $q_{i,j}$ of liquidity to be delivered on date 1 by bank j to bank i and the rate $r_{i,j}$ at which repayment is made on date 2. To deliver the date-1 liquidity as specified in equilibrium trading deals, each bank $j \in \omega^c$ posts a rate r_j in the retail market and lends the proceeds to borrowing banks accordingly.³⁷

These interbank transactions on date 1 between liquidity-needy banks and liquidity-surplus banks are modeled as non-cooperative bilateral bargaining. The equilibrium trading deal $(q_{i,j}, r_{i,j})$ between bank $i \in \omega$ and bank $j \in \omega^c$ is determined as the Nash bargaining solution that maximizes the joint surplus from trading for the two banks. That is, given other equilibrium outcomes and the equilibrium strategies others, the ex-post trading deal between bank $i \in \omega$ and bank $j \in \omega^c$ is determined as

$$(q_{i,j}, r_{i,j}) = \arg \max_{(q,r)} \left[V_i(q, r) - V_i^R \right]^\beta \cdot \left[V_j(q, r) - V_j^R \right]^{1-\beta}$$

37. To simplify analysis, I assume that banks in ω^c will only lend the proceeds from ex-post retail market, but not their ex-ante liquid cash holding. In the next section, I will argue that this simplifying assumption is innocuous for our efficiency analysis of private safe asset creation.

in which exogenous parameter β is the relative bargaining power, $V(q, r)$ is the valuation of an arbitrary deal (q, r) and V^R is the reservation value to each party.

Reservation value V_j^R of the liquidity-surplus bank j is simply the extra profit bank j can make from date-1 trading, under the restriction that no deal with bank i is reached.³⁸ The reservation value V_i^R of the liquidity-needy bank i is determined by bank i 's alternative liquidity raising capacity and the penalty it will suffer once liquidity needs cannot be fully covered on date 1.

The elasticity of the retail liquidity supply curve that bank i faces plays a crucial role in determining its bargaining position in interbank trading: a more elastic retail liquidity supply allows bank i to raise more liquidity without having to offer a much higher rate once the deal breaks down. Finally, to pin down the reservation value of borrowing banks, we assume that a non-pecuniary penalty $p(x)$ will be imposed if a bank fails to meet the liquidity needs on date 1 with a margin $x > 0$, where function $p(\cdot)$ is exogenously given.³⁹ Detailed analysis and algebra for interbank bargaining in wholesale market are provided in [Appendix Section A2](#).

C. Equilibrium of Private Safe Asset Creation

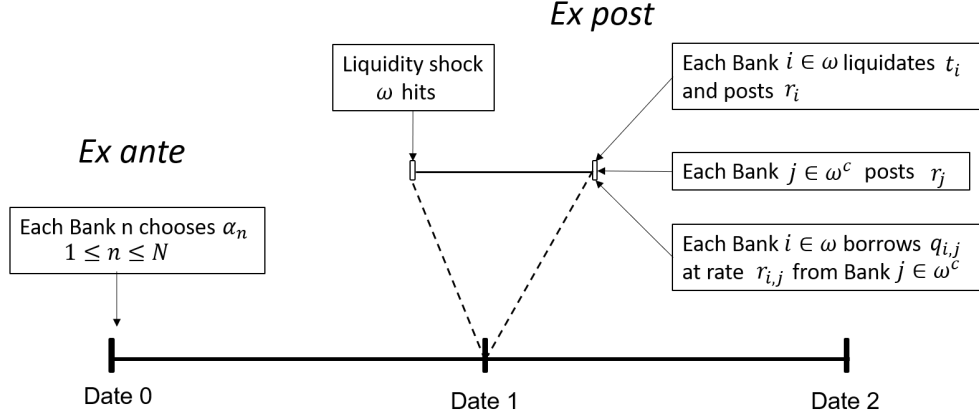
Banks play a sequential game in the safe assets creation process, as shown in Figure 1.6. On date 0, banks play an *on equilibrium* game of money creation in which each bank i chooses its loan making α_i . On date 1, banks play an *off equilibrium* game of liquidity raising, in which a liquidity shock ω hits and banks in ω must meet the liquidity needs so that their ex-ante deposits can be made safe.⁴⁰ We now examine this game.

38. For instance, if bank i and j are the only banks in the economy, then $V_j^R = 0$.

39. This margin-contingent non-pecuniary penalty on a bank's failure to meet its liquidity needs can be interpreted as the reputation loss banks would incur in such events. It may also be viewed as a stigma associated with discount window facility usage, which a bank will have to resort to if exhausting all other liquidity sources is not sufficient to cover its liquidity needs. In this paper, I do not explicitly model the central bank's intervention policy. Similar treatments of central bank's intervention with an attached non-pecuniary penalty can be found in [Diamond and Rajan \(2012\)](#).

40. The game played on date 1 is *off equilibrium* because the liquidity shock ω is essentially a "sunspot shock" and running does not actually materialize on date 1, as long as banks can make their deposits panic-proof.

Fig. 1.6. Time line of gameplay



i) Subgame of Ex-post Liquidity Raising

We characterize this sequential game backward. Thus, we first describe the ex-post subgame played on date 1, given the ex-ante loan making profile $\{\alpha_n\}_{n=1}^N \in \mathcal{A}$ chosen on date 0.

On date 1, after a liquidity shock $\omega \in \Omega_k$ hits, a subgame of liquidity raising is played in the economy. In this ex-post game, banks in ω have to raise sufficient date-1 liquidity to cover their liquidity needs, while banks in ω^c trade surplus liquidity to maximize their date-2 profits.

Upon a liquidity shock ω hits at date 1, an interbank trading deal $(q_{i,j}, r_{i,j})$ is established between each bank $i \in \omega$ and each bank $j \in \omega^c$. As discussed above, the equilibrium trading deals are determined as the non-cooperative bargaining solution that maximizes the joint surplus of both parties. Each party's reservation value and value gained from trading are perfectly known by the other. That is, for each pair $(i \in \omega, j \in \omega^c)$, the interbank deal $(q_{i,j}, r_{i,j})$ is determined as the Nash bargaining solution, given the equilibrium rates $\{r_n\}_{n \neq i,j}$ posted by others and all other interbank deals established in equilibrium.

Given the interbank trading deals established with banks in ω^c , each bank $i \in \omega$ optimally chooses its own liquidity raising strategy (t_i, r_i) to cover the remaining shortage of liquidity. That is, taking as given the rates $\{r_n\}_{-i}$ posted by others and the interbank deals

$\{(q_{i,j}, r_{i,j})\}_{j \in \omega^c}$ established with banks in ω^c , each bank i chooses (t_i, r_i) to solve

$$\max_{t_i, r_i} R(\alpha_i - t_i) - r_i \cdot s_i(r_i; \cdot) - \sum_{j \in \omega^c} r_{i,j} \cdot q_{i,j}$$

subject to the liquidity coverage constraint

$$g(t_i, \alpha_i) + s_i(r_i; \cdot) + \sum_{j \in \omega^c} q_{i,j} = \alpha_i$$

That is, each bank $i \in \omega$ maximizes its solvency under the constraint that liquidity needs must be covered. If the optimized solvency can be made non-negative, then it means that bank i can stay solvent under liquidity shock ω .⁴¹

The ex-post game playing of banks not hit by liquidity shocks is simpler. In equilibrium, each bank $j \in \omega^c$ posts rate r_j so as to deliver the quantity of date-1 liquidity specified in established interbank deals:

$$s_j(r_j; \cdot) = \sum_{i \in \omega} q_{i,j}$$

taking as given the equilibrium rates $\{r_n\}_{-j}$ posted by others.

For notational convenience, we define the following mappings Φ_N , Φ_S and Φ_I that map ex-ante loan making profile $\{\alpha_n\} \in \mathcal{A}$ and realization of ex-post liquidity shock $\omega \in \Omega_k$ into equilibrium outcomes of the ex-post subgame in liquidity raising. Specifically, for each pair of $\{\alpha_n\} \in \mathcal{A}$ and $\omega \in \Omega_k$,

- 1) a mapping $\Phi_N : \mathcal{A} \times \Omega_k \rightarrow \{\{(t_i, r_i)\}_{i \in \omega}\}$ dictates the ex-post liquidity raising strategy (t_i, r_i) that each bank $i \in \omega$ adopts in equilibrium;
- 2) a mapping $\Phi_S : \mathcal{A} \times \Omega_k \rightarrow \{\{r_j\}_{j \in \Omega/\omega}\}$ dictates the ex-post rate posting policy r_j for each bank $j \in \omega^c$;

41. The constrained optimization problem for each bank hit by liquidity shocks can be equivalently formulated as maximizing liquidity raising on date 1 under the constraint that the bank must stay solvent on date 2.

3) a mapping $\Phi_I : \mathcal{A} \times \Omega_k \rightarrow \left\{ \{(q_{i,j}, r_{i,j})\}_{i \in \omega, j \in \Omega/\omega} \right\}$ specifies the ex-post interbank trading deal $(q_{i,j}, r_{i,j})$ between each bank $i \in \omega$ and each bank $j \in \omega^c$ in equilibrium.

ii) Game of Ex-ante “Money” Creation

Having characterized the ex-post subgame in liquidity raising, we are now ready to describe banks’ ex-ante decision in money creation/loan making. On date 0, banks play a “money creation” game in which each bank acts independently in choosing its loan making volume. On the premise that it is ensuring the money-like feature of its date-0 deposits, each bank i in this game chooses its asset portfolio $(\alpha_i, 1 - \alpha_i)$ to maximize the payoff on date 2.

To facilitate analysis, let us define the ex-post solvency function $S(i; \{\alpha_n\}, \omega)$ for each bank i , given any arbitrary ex-ante money creation profile $\{\alpha_n\} \in \mathcal{A}$ and ex-post realization of liquidity shock $\omega \in \Omega_k$. For banks $i \in \omega$, the ex-post solvency in the equilibrium of subgame played on date 1 is

$$S(i; \{\alpha_n\}, \omega) = R(\alpha_i - t_i) - r_i \cdot s_i(r_i; \cdot) - \sum_{j \in \Omega/\omega} r_{i,j} \cdot q_{i,j}$$

in which t_i , $\{r_n\}$ and $\{(q_{i,j}, r_{i,j})\}$ are evaluated as the subgame equilibrium outcomes implied by mappings Φ_N , Φ_S and Φ_I given $(\{\alpha_n\}, \omega)$. For banks $i' \notin \omega$, solvency under liquidity shock (or panic-proofness) is not a concern on date 1 and the solvency constraint would be slack. Consequently, given the choice of $\{\alpha_n\}$ on date 0, the ex-post solvency of bank i on date 1 under a liquidity shock ω can be formulated as

$$S(i; \{\alpha_n\}, \omega) \equiv \begin{cases} \epsilon > 0 & \text{if } i \notin \omega \\ R(\alpha_i - t_i) - r_i \cdot s_i(r_i; \cdot) - \sum_{j \in \omega^c} r_{i,j} \cdot q_{i,j} & \text{if } i \in \omega \end{cases}$$

Given the choice of $\{\alpha_n\}$ on date 0, bank i can stay solvent (or immune to panic) under liquidity shock ω if and only if

$$S(i; \{\alpha_n\}, \omega) \geq 0$$

In the loan-making game played on date 0, all banks simultaneously make their asset portfolio choice. In choosing its loan making volume α_i , each bank i takes the action profile $\{\alpha_n\}_{-i}$ of others as given and solves

$$\max_{\alpha_i \in [0,1]} R\alpha_i + (1 - \alpha_i)$$

subject to the **money/safe asset creation constraint**:

$$\min_{\omega \in \Omega_k} S(i; \{\alpha_i, \{\alpha_n\}_{-i}\}, \omega) \geq 0$$

That is, to ensure that the ex-ante deposits banks issued on date 0 are money-like, banks must guarantee that panic among their depositors is always prevented. This solvency constraint under the most unfavorable liquidity shocks guarantees that runnable deposits issued ex-ante will be safe assets.

iii) A Private Safe Asset Creation Equilibrium

The equilibrium of private safe asset creation in this economy takes the form of a subgame perfect Nash equilibrium, in which simultaneous games are sequentially played on date 0 and date 1. The private safe asset creation equilibrium associated with level- k liquidity shocks is defined as follows.

Equilibrium Definition

In this economy, a subgame perfect Nash equilibrium of bank money creation associated with level- k liquidity shocks consists of:

I) a loan-making strategy profile $\{\alpha_n^E\} \in \mathcal{A}$ and

II) mappings Φ_N , Φ_S and Φ_I as defined in part ii) of this subsection

such that

I) On date 1, for any arbitrary $\{\alpha_n\} \in \mathcal{A}$ and $\omega \in \Omega_k$,

- 1. the strategy profile $\{(t_i, r_i)\}_{i \in \omega}$ for liquidity-needy banks implied by mapping Φ_N solves the constrained optimization problem in liquidity raising for each bank $i \in \omega$;*
- 2. the strategy profile $\{r_j\}_{j \in \omega^c}$ for liquidity-surplus banks implied by mapping Φ_S guarantees interbank liquidity delivery for each bank $j \in \omega^c$;*

3. the interbank trading deals $\{(q_{i,j}, r_{i,j})\}_{i \in \omega, j \in \omega^c}$ implied by mapping Φ_I maximize the joint surplus from trading between each bank $i \in \omega$ and each bank $j \in \omega^c$;

given others' equilibrium actions.

II) On date 0, given the (perceived) ex-post solvency implied by mappings Φ_N , Φ_S and Φ_I , α_i^E solves the constrained optimization problem in money creation for each bank i , given others choosing $\{\alpha_n^E\}_{-i}$.

In the rest part of the paper, I analyze the properties of private safe asset creation in the economy, based on the subgame perfect Nash equilibrium $\{\alpha_n^E\}$ characterized above.

1.4. Analysis: Efficiency and Implementability

In this section I study properties of the private safe asset creation in the economy. As a benchmark, I first solve the constrained efficient solution in private safe asset creation that a planner can achieve. I then show that three commitment problems arise when the economy is decentralized: two of them can render the equilibrium outcomes inefficient while the third can cause the complete collapse of safe asset creation in the economy. Let us now elaborate.

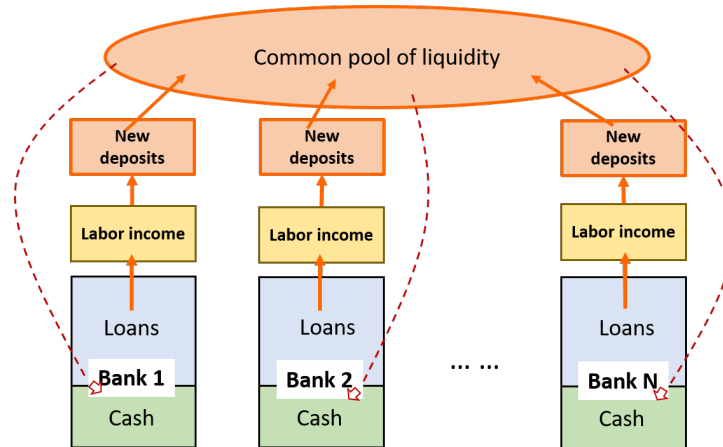
A. The Constrained Efficient Benchmark: Planner's Solution

The creation of money-like liquid and safe deposits is performed not by any single bank but by the entire banking system. Interactions among banks during the process of safe asset creation can be crucial for equilibrium outcomes. The limited ability of individual banks to commit to not engaging in certain socially undesirable behavior can induce inefficiency or implementability issues in a decentralized economy. To highlight these potential problems, we first characterize the planner's solution as a constrained efficient benchmark that eliminates limited commitment problems.

The banking sector shares a common liquidity pool in its safe asset creation process. As illustrated in Figure 1.7, a liquidity pool is endogenously generated in the economy by banks' ex-ante loan making activities, and it provides liquidity to banks hit by ex-post

liquidity shocks. As such, in the social planner’s allocation for maximizing safe asset creation in the economy, both the ex-ante creation and the ex-post usage of this liquidity pool must be optimized.

Fig. 1.7. Liquidity pool in private safe asset creation



In the analysis that follows, we shut down the ex-post trading of the liquid cash banks hoarded ex-ante in order to focus on the ex-ante creation and ex-post usage of this commonly shared liquidity pool. That is, we assume that the liquid cash holding $1 - \alpha_i$ of each bank i will only be used to cover its own ex-post liquidity needs. The purpose of this assumption is to focus on the potential under-production of the commonly shared liquidity pool in the economy. In the Appendix [Section B1](#), we relax this assumption and show that all the results are qualitatively unaffected or even strengthened.⁴²

Facing the same panic-proof constraint induced by the fragility-safety conflict as in the decentralized economy, the planner solves the optimal allocation in private safe asset creation.⁴³ In making her allocation decisions, the planner has to respect each household’s

42. Each bank has natural monopoly power on their liquid asset holding, so the purpose of making this assumption is to tease out the contribution to the under-production of the commonly shared liquidity pool from this source. In fact, as we show in the Appendix [Section B1](#), the existence of the commonly shared liquidity pool can weaken the market power induced by privately held liquidity. Furthermore, we show that our efficiency analysis for both the ex-ante under-production and ex-post over-use of the commonly shared liquidity pool remains the same after the trading of ex-ante cash holding is introduced back to our model.

43. Here we are essentially assuming that the planner cannot resolve the limited commitment problem associated with banks’ special loan collection skills, and so that the threat of run must also be maintained in planner’s problem.

outside option implied by its storage technology $h(y)$ and the illiquidity of loans implied by liquidation technology $g(t, \alpha)$.

The planner's objective is to maximize the amount of economic activities that the banking sector can finance in the economy while ensuring that the deposits issued on date 0 are guaranteed safe under exposure to date-1 liquidity shocks. That is, on date 0 the planner chooses banks' ex-ante loan making profile $\{\alpha_n\}$ to maximize the total volume of loan making $\max_{\{\alpha_n\}} \sum_{n=1}^N \alpha_n$, subject to the constraint that all banks' date-0 deposits can be (simultaneously) ensured safe under any ex-post liquidity shock $\omega \in \Omega_k$ that could hit on date 1.

Given the ex-ante loan-making profile $\{\alpha_n\}$, a liquidity pool is generated in the economy into which banks can dip for ex-post liquidity needs. Specifically, the date-1 endowments in the hands of households that reside in bank n 's territory will be $\bar{e} + w \cdot \alpha_n$ ($1 \leq n \leq N$). On date 1, with k banks getting hit by a liquidity shock $\omega \in \Omega_k$, the planner can optimally raise liquidity by dipping into the liquidity pool and liquidating the loans of banks in ω .⁴⁴ That is, on date 1 planner solves

$$L(\{\alpha_n\}, \omega) = \max_{\{t_i\}_{i \in \omega}, \{r_n\}} \sum_{i \in \omega} g(t_i, \alpha_i) + \sum_{n=1}^N d(r_n; \alpha_n)$$

subject to the feasibility constraint

$$\sum_{i \in \omega} R \cdot (\alpha_i - t_i) \geq \sum_{n=1}^N r_n \cdot d(r_n; \alpha_n)$$

That is, the date-2 payoff from the unliquidated loans of banks in ω must be sufficient to cover the promised payments to the date-1 creditors.

The ex-ante loan-making profile $\{\alpha_n^P\}$ that solves the planner's allocation problem on

44. It is assumed that the planner cannot liquidate the long term assets of banks that are not hit by liquidity shocks. Only the loans of banks in ω can be liquidated or borrow against on date 1.

date 0 is then determined by

$$\{\alpha_n^P\} = \arg \max_{\{\alpha_n\}} \sum_{n=1}^N \alpha_n$$

subject to the **safe asset creation constraint**:

$$\min_{\omega \in \Omega_k} L(\{\alpha_n\}, \omega) - \sum_{i \in \omega} \alpha_i \geq 0$$

That is, the amount of liquidity the planner can raise by adopting the optimal feasible strategy must be sufficient to cover the total demand for external liquidity from banks in ω . For safe asset creation, this condition must hold even for the most unfavorable liquidity shock $\omega \in \Omega_k$.

In this paper I focus on symmetric equilibrium in which all banks adopt the same ex-ante loan-making strategy. The following proposition characterizes the symmetric constrained efficient equilibrium α_P that can be achieved in the planner's allocation.

Proposition 1 *The symmetric constrained efficient equilibrium α_P of safe asset creation associated with level- k liquidity shocks in a planner's solution is determined by*

$$k \cdot g(t^*, \alpha_P) + N \cdot d(r^*; \alpha_P) = k \cdot \alpha_P$$

where the optimal liquidity raising strategy (t^*, r^*) satisfies

$$\frac{d(r^*; \alpha_P)}{d'(r^*; \alpha_P)} + r^* = R / \frac{\partial g(t^*, \alpha_P)}{\partial t}$$

$$k \cdot R(\alpha_P - t^*) = N \cdot r^* \cdot d(r^*; \alpha_P)$$

The constrained efficient benchmark defined above is featured with two crucial trade-offs that are optimized in the planner's solution.

i) Trade-off 1: Optimal ex-ante creation of the liquidity pool

The first key trade-off in the planner's solution is related to the ex-ante creation of liquidity pool through banks' loan making activities. By increasing the ex-ante loan making

α , the ex-post liquidity pool that the planner can deploy is enlarged. However, the demand for ex-post liquidity that the planner needs to cover on date 1 also increases.

The planner's solution α^P optimally balances these two opposing effects. For $\alpha < \alpha^P$, the ex-ante safe asset creation constraint is slack because the demand for ex-post liquidity is too small relative to what the planner is able to raise:

$$\min_{\omega \in \Omega_k} S^P(\{\alpha\}, \omega) > 0$$

where $S^P(\{\alpha_n\}, \omega) = L(\{\alpha_n\}, \omega) - \sum_{i \in \omega} \alpha_i$ is the planner's solvency function under liquidity shock ω . Similarly, for $\alpha > \alpha^P$, the ex-ante safe asset creation constraint cannot hold because the enlargement of the ex-post liquidity pool cannot keep up with the increased demand for liquidity:

$$\min_{\omega \in \Omega_k} S^P(\{\alpha\}, \omega) < 0$$

ii) Trade-off 2: Optimal ex-post usage of the liquidity pool

The second key trade-off regards the ex-post of usage of the liquidity pool. The liquidity raised on date 1 by dipping into the liquidity pool needs to be repaid on date 2, which is accomplished by banks' payoff from their unliquidated loans. As such, an optimal marginal rate of substitution in the planner's ex-post liquidity raising (t, r) governs how much loans should be liquidated and what rate should be posted in the retail market. Specifically,

$$\frac{d(r^*; \alpha_P)}{d'(r^*; \alpha_P)} + r^* = R / \frac{\partial g(t^*, \alpha_P)}{\partial t}$$

pins down this optimal marginal substitution. Liquidating too many long term assets or dipping too much into the ex-post liquidity pool would create wedges that distort the MRS in ex-post liquidity raising away from that characterized in the preceding equation.

Detailed analysis and calculations of planner's optimal allocation in safe asset creation are provided in Appendix [Section A3](#).

As a brief summary of our analysis of the planner's solution, the implementation of the constrained efficient benchmark hinges on three conditions that a social planner can guarantee to hold. In particular, the planner can ensure that

on date 1:

1) surplus liquidity in the economy can be frictionlessly reallocated within the banking system—that is, it can be guaranteed to be traded at a **competitive** price that equals its marginal cost;

2) the optimal liquidity raising strategy $\{t_i^{SP}, d_i^{SP}\}_{i \in \omega}$ and $\{d_j^{SP}\}_{j \in \omega^c}$ in planner’s solution can be **committed**;

on date 0:

3) the lending profile $\{\alpha_i^{SP}\}_{i=1}^N$ can be **coordinated**.

While these conditions for implement the constrained efficient benchmark can guarantee to hold when there is a social planner, they are likely to fail in a decentralized economy where certain markets (and contracts) are missing. In the remainder of this section, I identify three market failures, which correspond to the three conditions outlined above, that could arise under a practically and theoretically reasonable environment of contracting and market space.

B. Inefficiency I: Ex-ante Under-production of Liquidity Pool

Once the economy is decentralized, the first inefficiency that can arise in the private safe asset creation is the ex-ante under-production of the liquidity pool in the economy. The key economics of this inefficiency is an incentive problem that originates from the non-competitive pricing of the liquidity traded in ex-post inter-bank markets.

Insurance Markets for Incentive Provision when $k < N$

On date 0, by increasing its loan making α_i , each bank i enlarges the size of the ex-post liquidity pool in the economy.⁴⁵ However, this makes each bank’s own balance sheet more illiquid and increases its own demand for external liquidity on date 1, when it is hit by liquidity shocks. Proper compensation thus needs to be provided to incentivize banks to engage in ex-ante liquidity creation activities. Whenever not all banks will be hit by

45. This enlarging effect on the ex-post liquidity pool is reflected as the lowered marginal costs in retail liquidity raising in bank i ’s territory on date 1.

ex-post liquidity shocks on date, i.e., $k < N$, the incentive provision for ex-ante liquidity pool creation would be relevant.

As the creator of “money” in the economy, banks’ valuation of the ex-post liquidity price will be state-contingent. Specifically, banks care more about the price of purchasing liquidity at when they need liquidity than the price for selling liquidity when there is a surplus.⁴⁶ This state-contingent valuation of the ex-post liquidity price implies that an insurance market generally would be needed for incentive provision.⁴⁷ An insurance market in which banks can insure against unfavorable liquidity states can restore potential incentive distortion because banks can use the profits they make in good states to purchase insurance to insure themselves against bad states.

However, such an insurance market usually does not exist in reality. Multiple reasons can contribute to this particular incompleteness in the space of marketable claims. For example, an exogenous reason could be that ex-post idiosyncratic liquidity shocks are observable but not verifiable. This would create a technical difficulty in writing contracts contingent on banks’ ex-post liquidity status. Endogenous reasons, too, can prevent such a market from being opened. Although not micro-founded in this paper, opening a market that allows banks to insure against ex-post liquidity shocks can induce ex-ante moral hazard issues that may render the entire system worse off.⁴⁸

Without such an insurance market, the incentive provision for individual bank’s ex-ante liquidity pool creation would then hinge on the pricing of ex-post liquidity.

Non-competitive Liquidity Pricing and a Hold-up Problem

The absence of the aforementioned insurance market itself does not cause the problem; it

46. In the model, such a state-contingent valuation of ex-post liquidity price is reflected as the safe asset creation constraint being binding when hit by liquidity shocks and being slack when not hit.

47. In our concrete setting, the insurance market for incentive provision is a market in which contracts can be written such that banks can purchase ex-post liquidity at pre-committed prices. These pre-committed prices are set according to each banks’ ex-ante loan-making activities. In other words, the social value of liquidity creation is properly reflected in ex-post liquidity prices.

48. See Diamond and Rajan (2012) and Farhi and Tirole (2012) for detailed discussions of how ex-post intervention can cause ex-ante problems.

simply implies that ex-post rent distribution will distort ex-ante incentives. It must be certain socially inefficient behavior banks engage in that makes it problematic. In our model, this market incompleteness become relevant because of the rent extraction behavior by lending banks' in ex-post interbank trading.

Whenever the ex-post interbank market is not perfectly competitive (as reflected in the lending banks' ability to charging a positive markup in liquidity price), the ex-ante incentive provision for liquidity creation will be inefficient. This is so for the following reason: the incentive provided by the profit that a bank makes (by charging mark-ups) from interbank trading when surplus in liquidity is not enough to offset the disincentivization of the high liquidity price (caused by the same mark-up) when itself is in need of liquidity.⁴⁹ As such, the ex-ante incentive for liquidity creation would be under-provided and, thus, in a decentralized system, the liquidity pool would be under-produced .

The following simple case illustrates this first inefficiency, the nature of which is a hold-up problem, in private safe asset creation in a decentralized economy.

Special Case Analysis: $k = 1, N = 2, \tau = 0$

This first market failure, which results in ex-ante under-production of the liquidity pool in the economy, is relevant whenever not all banks will be hit by ex-post liquidity shocks; i.e., $k \leq N - 1$. Here I analyze the simplest case that satisfies this condition, in which $k = 1, N = 2$. Furthermore, to highlight the potential hold-up in interbank trading, I assume $\tau = 0$. That is, the banking market is completely segmented.

Let us focus on symmetric equilibrium. That is, both banks choose α on date 0 in their ex-ante loan making. WLOG, suppose on date 1 bank 1 is hit by an ex-post liquidity shock while bank 2 is not. To cover its liquidity needs, bank 1 then

- i) liquidates $t_1 \in [0, \alpha]$ of its long term asset;
- ii) posts a rate r_1 in the retail liquidity market to raise liquidity from households;
- iii) borrows liquidity from bank 2 for quantity $q_{1,2}$ at rate $r_{1,2}$.

49. Because the insurance market is absent, banks are not able to purchase insurance against unfavorable liquidity states with the profits they make in good states.

With the banking market being completely segmented (i.e. $\tau = 0$), the retail liquidity supply function on date 1 for each bank i ($i = 1, 2$) is

$$s(r_i; \alpha) = d(r_i; \alpha)$$

That is, each bank can only raise deposits from its own territory, regardless of the rate being offered by the other bank.

The interbank deal $(q_{1,2}, r_{1,2})$ is determined as the Nash bargaining solution that solves

$$(q_{1,2}, r_{1,2}) = \arg \max_{\hat{q}_{1,2}, \hat{r}_{1,2}} \left[V_1(\hat{q}_{1,2}, \hat{r}_{1,2}) - V_1^R \right]^\beta \left[V_2(\hat{q}_{1,2}, \hat{r}_{1,2}) - V_2^R \right]^{1-\beta}$$

in which V_i^R is each bank i 's reservation value and $V_i(\hat{q}_{1,2}, \hat{r}_{1,2})$ is each bank i 's valuation of any arbitrary deal $(\hat{q}_{1,2}, \hat{r}_{1,2})$. The detailed expressions of V_i^R and $V_i(\hat{q}_{1,2}, \hat{r}_{1,2})$ are displayed in the Appendix [Section A4](#).

In this example with $\tau = 0$, we can show the following property of the equilibrium interbank deal $(q_{1,2}, r_{1,2})$.

Lemma 3 *With $\tau = 0$, the interbank deal $(q_{1,2}, r_{1,2})$ established in equilibrium satisfies $q_{1,2} < s(r_{1,2}; \alpha)$.*

That is, a positive mark-up is being charged in the liquidity that bank 1 purchases from the wholesale market. By posting rate $r_{1,2}$ in bank 2's territory, the price at which bank 1 purchases liquidity from bank 2, an amount of $s(r_{1,2}; \alpha)$ retail liquidity could be raised. However, from its wholesale market trading with bank 2, bank 1 receives only $q_{1,2}$ liquidity, delivered at the same price $r_{1,2}$. In this sense, bank 1 is being held up in the ex-post interbank liquidity trading.

Coverage of ex-post liquidity shortage for bank 1 requires that in equilibrium

$$g(t_1, \alpha) + \underbrace{s(r_1; \alpha)}_{\text{retail liquidity}} + \underbrace{q_{1,2}}_{\text{wholesale liquidity}} = \alpha$$

while the solvency on date 2 (or panic-proofness at date 1) requires

$$R(\alpha - t_1) - \underbrace{r_1 \cdot s(r_1; \alpha)}_{\text{retail liquidity payment}} - \underbrace{r_{1,2} \cdot q_{1,2}}_{\text{wholesale liquidity payment}} \geq 0$$

As displayed in Table 1, the private safe asset creation outcome achieved in the decentralized economy α_E is compared with that achieved in the planner's solution α_P .

Table 1: Efficiency analysis: $k = 1$, $N = 2$, $\tau = 0$

	Equilibrium	Planner's problem
Liquidity coverage:	α_E is the maximum α such that $\exists t_1, r_1 :$ $g(t, \alpha) + s(r_1; \alpha) + q_{1,2} = \alpha$	α_P is the maximum α such that $\exists t_1, r_1, q_{1,2}, r_{1,2} :$ $g(t, \alpha) + s(r_1; \alpha) + q_{1,2} = \alpha$
Inter-bank liquidity pricing:	$(q_{1,2}, r_{1,2}) = \text{argmax}_{\hat{q}_{1,2}, \hat{r}_{1,2}} [V_1(\hat{q}_{1,2}, \hat{r}_{1,2}) - V_1^R]^\beta [V_2(\hat{q}_{1,2}, \hat{r}_{1,2}) - V_2^R]^{1-\beta}$	$q_{1,2} = s(r_{1,2}, \alpha)$
Solvency:	$R(\alpha - t_1) - [r_1 s(r_1; \alpha) + r_{1,2} q_{1,2}] \geq 0$	$R(\alpha - t_1) - [r_1 s(r_1; \alpha) + r_{1,2} q_{1,2}] \geq 0$

A banks' ex-ante incentive of liquidity creation is determined by the tightness of the ex-post solvency constraint under liquidity shocks. This tightness, in turn, depends on the price at which banks can purchase liquidity when hit by ex-post liquidity shocks. In the planner's solution, it is guaranteed that banks can purchase extra liquidity at prices that properly reflect the social value of their ex-ante loan making.⁵⁰

However, the wholesale liquidity price in the decentralized economy is determined by ex-post bargaining, during which lending banks are able to charge a positive mark-up above the marginal cost. Concerned that it could be held up in ex-post interbank trading if it is hit by liquidity shocks, each bank is thus less incentivized to engage in ex-ante liquidity creation activities. Consequently, in contrast to the planner's allocation, the ex-ante liquidity creation

50. In the symmetric equilibrium that all banks choose α on date 0, the retail liquidity supply $s(r; \alpha)$ in the territory of banks not hit by liquidity shocks can be deployed by the planner to cover the liquidity needs of those that are hit. The pricing of these extra liquidity reflects the social value of ex-ante loan making by those who get hit, as all banks choose the same α ex-ante.

in the decentralized economy is not optimized; indeed, liquidity pool in the economy is under produced. As a result, the safe asset creation constraint in the decentralized economy would be inefficiently tight. More generally, we have the following proposition.

Proposition 2 *When the retail market competitiveness is sufficiently low, the laissez-faire outcomes of private safe asset creation associated with level- k ($k \leq N - 1$) liquidity shocks are inefficient. That is, there exists a threshold $\hat{\tau} \in [0, \infty]$ ($\hat{\tau}$ could be ∞), such that*

$$\alpha_E < \alpha_P$$

whenever $\tau < \hat{\tau}$ (or $\kappa > \frac{1}{\hat{\kappa}}$).

In our model, the panic-proof constraint faced by each individual bank is affected by an aggregate state variable– the size of the commonly shared liquidity pool in the economy– through its impact on ex-post retail liquidity price. Because this aggregate state variable is affected by each individual bank’s ex-ante loan-making decision, inefficiencies arise when individual banks do not fully internalize such effects. Imperfect interbank market raises concerns of being extracted in ex-post interbank trading and thus results in the ex-ante under-production of the liquidity pool– a hold-up problem arises. The following corollary shows that a perfectly competitive banking market can restore efficiency.

Corollary 1 *The laissez-faire equilibrium of bank money creation associated with level-1 liquidity shock is efficient; i.e.,*

$$\alpha_E = \alpha_P$$

if $\tau = \infty$ or ($\kappa = 0$).

When $k = 1$, only this first efficiency will be present in the private safe asset creation.⁵¹ In this case, making the retail banking market perfectly competitive can dispel individual bank’s concern of being extracted in ex-post interbank trading and thus eliminates the hold-up problem in banks’ ex-ante liquidity pool creation. This helps restore constrained efficient safe asset creation in the decentralized economy. We discuss the impact of the banking

51. In the next subsection, it becomes clear why the second inefficiency is absent when $k = 1$.

market structure in more details in section 5.

C. Inefficiency II: Ex-post Over-use of Liquidity Pool

The second potential inefficiency in the decentralized economy's private safe asset creation is the ex-post over-use of the liquidity pool. The key economics of this inefficiency are reminiscent of the phenomenon demonstrated by Hart (1975)– that under certain market settings, adding certain spot markets can be counter-productive. As will be shown below, in our concrete setting the existence of a particular ex-post spot market can reduce welfare by impairing the functioning of certain futures markets, which are necessary for achieving the time consistency in banks' optimal sequential game play.

Necessity of Futures Markets for Time Consistency

In the process of private money creation, banks play a sequential game– they play an ex-ante game in loan making (or liquidity pool creation) on date 0 and play an ex-post game in liquidity raising after liquidity shocks on date 1. Implementing the constrained efficient benchmark requires both the incentive provision for ex-ante liquidity pool creation to be efficient, as well as a time consistency to be achieved in banks' ex-post usage of the liquidity pool created in the economy. That is, contingent on the level of ex-ante production of the liquidity pool, the ex-post utilization of the liquidity pool in the decentralized economy needs to be guaranteed optimized.

The second inefficiency that can potentially arise in private money creation when more than one bank will be hit by liquidity shocks, i.e., $k > 1$, is due to (ex-post) over-use of the liquidity pool. A negative externality, generated by one bank when it dip into the liquidity pool to others who are also in need of liquidity, is behind this over-use problem. The planner can fully internalize this “distributive externality” with her ability to dictate each bank's ex-post liquidity raising strategy and, thus, the liquidity pool usage can always guaranteed to be optimized contingent on any level of ex-ante production of the liquidity pool and any realization of liquidity shocks.

These conditions, however, are likely to fail once the economy is decentralized. To achieve the time consistency in planner's constrained efficient solution— that ex-post liquidity pool usage can be guaranteed optimized contingent on ex-ante liquidity pool creation, certain futures markets are needed in a decentralized system. The futures contracts required to implement the constrained efficient solution should allow each bank to purchase pre-specified quantities of ex-post retail liquidity at pre-specified prices, contingent only on their ex-ante loan making choices. Whenever such a futures market is absent or impaired, the time consistency that is needed for achieving constrained efficient outcomes is likely to fail.

Ex-post Spot Market and Impaired Contract Exclusivity when $k > 1$

In this model, the spot market that can cause welfare loss is the ex-post retail liquidity market that allows (or makes it easier for) banks to raise liquidity in the territories of other banks, which is made possible by a competitive banking market. When such an ex-post spot market is introduced on date 1, an incentive compatibility constraint is placed on the ex-post liquidity raising strategy of banks that are hit by liquidity shocks. We now explain how.

Without the futures market as described above, an ex-post commitment problem could arise. Whenever a disciplining tool on ex-post competition is absent or not fully imposed, banks cannot commit to not competing for ex-post liquidity in each others' territories. Consequently, the equilibrium ex-post retail liquidity price in the territories of each bank hit by liquidity shocks must rise to a sufficiently high level. If it does not, other banks may be tempted to engage in liquidity stealing, which they achieve by offering slightly higher rates than those offered by native banks.

In this sense, a competitive banking market can generate an undesirable effect on the futures market that is needed to achieve the time consistency in efficient private money creation. With a highly competitive retail liquidity market, each individual bank's ability to write the futures contracts that specify ex-post retail liquidity usage and pricing would be impaired. This is because the quantity of retail liquidity a bank can obtain at certain price is likely to be affected by other banks' ex-post behavior, when a banking market is competitive. In other words, a competitive banking market impairs the contract exclusivity.

This is problematic for the functioning of futures market because it means the liquidity pool usage specified in the futures contracts cannot be committed— because other banks’ ex-post behavior could easily invalidate these ex-ante written contracts under a competitive market environment.

Due to the introduction of this ex-post spot market, banks are likely to become trapped in a dilemma: if they do not dip much enough into the liquidity pool they will not get anything from it. As a result, wedges are generated and distort banks’ equilibrium marginal rates of substitution in ex-post liquidity raising away from the socially optimal levels. In this manner, banks hit by liquidity shocks would be forced to adopt ex-post liquidity raising strategies that are sub-optimal in the planner’s solution. Specifically, in the decentralized economy, banks would use the liquidity pool too much yet liquidate their long-term assets too little.

Special Case Analysis: $k = 2, N = 2, \tau = \infty$

This second market failure, which results in an ex-post over-use of the liquidity pool, will be relevant whenever more than one bank is receiving ex-post liquidity shocks; i.e., $k \geq 2$. Here I analyze the simplest case that satisfies this condition, in which $k = 1, N = 2$. Furthermore, to highlight the welfare loss associated with introducing the ex-post spot market described above, I assume $\tau = \infty$. In other words, the banking market is perfectly competitive.

Again we focus on symmetric equilibrium, in which both banks choose α on date 0 in ex-ante loan making. Thus on date 1, the endowments of households in both banks’ territories are $\bar{e} + w \cdot \alpha$. When the retail liquidity market is perfectly competitive, each bank can freely compete for liquidity in others’ territory without having to offer extra higher rates. Therefore, on date 1, if the other bank posts a rate r_{-i} , then the retail liquidity supply for each bank i is

$$s(r; \alpha) = \begin{cases} 0 & \text{for } r < r_{-i} \\ \text{anything in certain range} & \text{for } r \geq r_{-i} \end{cases}$$

That is, bank i can raise nothing by posting any rate $r < r_{-i}$ or it can raise as much as it wants (bounded by certain limits) by posting a rate slightly higher than r_{-i} . Therefore, in the equilibrium on date 1, both banks must post the same rate \hat{r} in the retail liquidity market.

In equilibrium, when the ex-post retail liquidity price is \hat{r} , each bank i on date 1 finds optimal to also post the same rate in the retail market and optimally determines liquidation volume t by solving

$$\max_{t \in [0, \alpha]} R(\alpha - t) - \hat{r} \cdot [\alpha - g(t, \alpha)]$$

Here $\alpha - g(t, \alpha)$ is the liquidity shortage after liquidating t of the illiquid assets, which can be raised from the retail liquidity market at price \hat{r} .⁵²

The first order condition regarding t implies that in equilibrium

$$-R + \hat{r} \cdot \frac{\partial g(t, \alpha)}{\partial t} \geq 0$$

This is the incentive compatibility constraint on bank's ex-post usage of the liquidity pool that ensures no banks have incentive to deviate in equilibrium.⁵³

With the equilibrium ex-post retail liquidity price being \hat{r} , the aggregate supply of liquidity from the retail market is $2 \cdot d(\hat{r}; \alpha)$. The aggregate demand for retail liquidity from the banking sector is $2 \cdot [\alpha - g(t, \alpha)]$, in which t is the optimal liquidation volume implied by the above first order condition. The equilibrium rate \hat{r} equates supply with demand:

$$2 \cdot d(\hat{r}; \alpha) = 2 \cdot [\alpha - g(t, \alpha)]$$

Table 2 compares the private safe asset creation outcome achieved in the decentralized economy α_E and that achieved in the planner's solution α_P .

Here the inefficiency in the decentralized economy's private safe asset creation is driven entirely by this extra incentive compatibility constraint on banks' ex-post usage of the liq-

52. Since both banks choose the same α ex-ante, they would liquidate the same amount t in equilibrium. Hence the subscript in t is suppressed.

53. The deviation here is to steal liquidity in others' territory that are originally raised by those native banks, by posting a slightly higher rate.

Table 2: Efficiency analysis: $k = 2, N = 2, \tau = \infty$

	Equilibrium	Planner's problem
Market clearing/ Liquidity coverage:	α_E is the maximum α such that $\exists t, \hat{r} :$ $d(\hat{r}; \alpha) = \alpha - g(t, \alpha)$	α_P is the maximum α such that $\exists t, \hat{r} :$ $g(t, \alpha) + d(\hat{r}; \alpha) = \alpha$
Incentive constraint:	$-R + \hat{r} \cdot \frac{\partial g(t, \alpha)}{\partial t} \geq 0$	N/A
Solvency:	$R(\alpha - t) - r \cdot d(\hat{r}; \alpha) \geq 0$	$R(\alpha - t) - r \cdot d(\hat{r}; \alpha) \geq 0$

liquidity pool. The existence of an ex-post spot market, implied by $\tau = \infty$, forces each bank hit by liquidity shocks to adopt a liquidity raising strategy that satisfies this extra IC constraint. However, the marginal rates of substitution in liquidity raising implied by this IC constraint generally differ from the optimal ones implied in the planner's solution.

As a result, the ex-post usage of liquidity pool in the decentralized economy is not optimized as it is in the planner's allocation. In particular, the liquidity pool in the economy is over-used. Because banks hit by ex-post liquidity shocks are forced to adopt strategies that are (socially) sub-optimal, the safe asset creation constraint that governs banks' ex-ante loan making will be inefficiently tight and it will result in inefficient safe asset creation. More generally, we have the following proposition.

Proposition 3 *The laissez-faire equilibrium of bank money creation associated with level- k ($k \geq 2$) liquidity shocks is inefficient; i.e.,*

$$\alpha_E < \alpha_P$$

whenever $\tau > 0$ (or $\kappa < \infty$).

In the model, the key component that makes this second inefficiency relevant is the assumption that banks' date-0 deposits must be made panic-proof when exposed to ex-post liquidity shocks on date 1. This panic-proof constraint implies an optimal marginal rate of substitution in ex-post liquidity raising that the planner would adopt. A competitive banking market introduces a commitment problem, as a consequence of which the socially

optimal ex-post liquidity-raising policy cannot be implemented in the decentralized system. The following corollary shows that efficiency can be restored with complete segmentation in the retail liquidity market.

Corollary 2 *The laissez-faire equilibrium of bank money creation associated with level- N liquidity shocks is efficient; i.e.,*

$$\alpha_E = \alpha_P$$

if $\tau = 0$ (or $\kappa = \infty$).

When $k = N$, only this second inefficiency will be present in the private safe asset creation because there is no spare liquidity in the ex-post liquidity market. In this case, making the banking market completely segmented restores efficient safe asset creation in the decentralized economy. Detailed calculations for this inefficiency are provided in [Appendix Section A5](#).

D. Ex-ante Coordination in Safe Asset Creation

The two potential inefficiencies in private safe asset creation are essentially caused by ex-post commitment problems in the decentralized economy.⁵⁴ In addition to these two ex-post commitment issues, which can cause the laissez-faire solution of safe asset creation to be inefficient, an ex-ante commitment problem can also arise that impedes the private safe asset creation in the economy.

Equilibrium Implementability

In the ex-ante money creation/loan making on date 0, banks play a simultaneous game in which each bank chooses its own loan-making volume α and no banks know what choices the other banks have made. Consequently, banks cannot commit to an ex-ante loan-making

54. The commitment problem relevant for the first inefficiency is that when the banking market is imperfect, lending banks cannot commit to not extracting rents from ex-post interbank trading. In the case of the second inefficiency, the problem is that once an ex-post spot market is opened, banks cannot commit to not stealing liquidity from each others' territories.

strategy unless it is incentive compatible. Relatedly, we define the *automatic implementability* of an arbitrary ex-ante loan-making profile $\{\alpha_n\}$ as follows.

Definition *An ex-ante loan-making profile $\{\alpha_n\}$ is automatically implementable (AI) if and only if for each individual bank i , given the other banks choose $\{\alpha_n\}_{-i}$, it can commit to choosing α_i ; i.e., it optimizes by choosing α_i .*

The symmetric equilibrium α_E of private safe asset creation in this economy must satisfy $S(\alpha_E) = 0$, where function $S(\alpha)$ represents banks' ex-post solvency with everyone choosing α ex-ante. That is, when all banks choose α_E on date 0, everyone (who gets hit) can stay just solvent under ex-post liquidity shock at date 1.

To study whether or not the symmetric equilibrium $\{\alpha_E\}$ can be implemented, we define the following individual deviation function $S_D(\alpha; \alpha_E)$. This function $S_D(\alpha; \alpha_E)$ calculates the (perceived) ex-post solvency of an individual bank after it makes an arbitrary deviation α in its ex-ante loan making, while all other banks still choose α_E . Given this individual deviation function, the following lemma defines the conditions that ensure a safe asset creation equilibrium $\{\alpha_E\}$ to be *automatically implementable*.

Lemma 4 *A safe asset creation equilibrium $\{\alpha_E\}$ is automatically implementable if and only if*

$$\left. \frac{\partial S_D(\alpha; \alpha_E)}{\partial \alpha} \right|_{\alpha \rightarrow \alpha_E^+} \leq 0$$

That is, with all others choosing α_E at date 0, each individual bank can commit to choosing α_E in its ex-ante loan making.

The private safe asset creation equilibrium in which the banking sector can just stay solvent under ex-post liquidity shocks may not be automatically implementable. This is so because if the associated ex-ante loan making profile does not satisfy the necessary ex-ante incentive compatibility constraint, each individual bank cannot commit to choosing the loan making amount as specified in the profile. As illustrated in the special case analysis that follows, this ex-ante commitment problem will be acute when the banking market is competitive.

Special Case Analysis: $k = N = 10^6$

To highlight this ex-ante commitment problem in safe asset creation, we consider a case in which the number of banks in the economy is very large and the ex-post liquidity shock is systemic.

In this case with many banks in the economy, a perfectly competitive banking market ($\tau = \infty$) is likely to be problematic. Suppose in the equilibrium at date 1, the market clearing retail liquidity price \hat{r} satisfies $\hat{r} < R$.⁵⁵ Then by making the following ex-ante deviation $\alpha = \alpha_E + \epsilon$ where $\epsilon > 0$ is infinitesimally small, an individual bank can be strictly better off. This is so because after making such an ex-ante upward deviation, this individual bank can adopt the following strategy in ex-post liquidity raising: it liquidates the same amount of long term assets as in old equilibrium and it raises additional ϵ liquidity from the retail market. As such, we have

$$S(\alpha_E + \epsilon; \alpha_E) \geq \epsilon \cdot R - \epsilon \cdot \hat{r} > 0$$

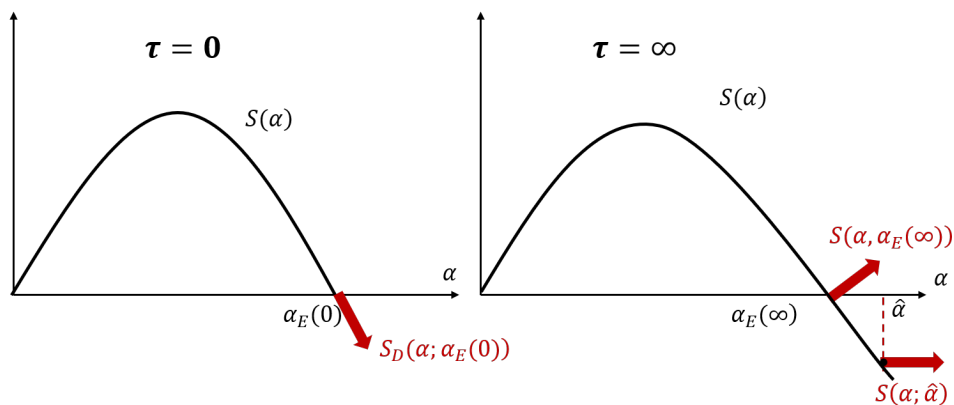
in which the retail liquidity price in the new ex-post equilibrium is still \hat{r} , thanks to the competitive retail market and the large number of banks in the economy.

Yet this commitment problem disappears when the banking market is completely segmented; i.e., $\tau = 0$. Now each individual bank only raises retail liquidity from its own territory, which makes the individual deviation function $S_D(\alpha; \alpha_E)$ perfectly aligned with the aggregate solvency function $S(\alpha_E)$. Figure 7 illustrates the comparison between $\tau = \infty$ and $\tau = 0$.

In the left panel of Figure 1.8, where the banking market is completely segmented ($\tau = 0$), the safe asset creation equilibrium $\{\alpha_E(0)\}$ is both solvent and committed. In the right panel where the banking market is perfectly competitive ($\tau = \infty$), the equilibrium $\{\alpha_E(\infty)\}$ in which banks can just stay solvent ex-post cannot be committed ex-ante. In the equilibrium $\{\hat{\alpha}\}$ where ex-ante commitment can be guaranteed, everyone would however become insolvent once ex-post liquidity shocks hit.

55. Conditions of exogenous parameters that ensure this inequality are provided in the appendix.

Fig. 1.8. Equilibrium implementability



In this sense, without a proper ex-ante commitment device, no safe asset can be created in the decentralized economy when the banking market is perfectly competitive! More generally, we have the following proposition.

Proposition 4 *For each (N, k) , there exists a threshold τ_{AI} in retail market competitiveness τ , such that the symmetric bank money creation equilibrium $\{\alpha_E\}$ that satisfies $S(\alpha_E; \tau) = 0$ is automatically implementable if and only if $\tau \leq \tau_{AI}$.*

The key intuition is that more competitive ex-post retail market makes ex-ante individual deviation less expensive. When the cost of making ex-ante deviation becomes low enough for individual banks such that everyone has incentive to make deviations at the equilibrium loan-making profile α_E that satisfies $S(\alpha_E) = 0$, an ex-ante commitment problem arises. This is because if every bank deviates ex-ante, no one bank can stay solvent ex-post. Detailed analysis and calculations are provided in Appendix [Section A6](#).

1.5. Policy Making for Safe Asset Creation

In this section, we conduct a policy analysis to study a regulator's optimal policy making for private safe asset creation in the economy.

A. The Regulator's Problem and Policy Instruments

The regulator seeks to maximize the safe asset creation in the economy. That is, the regulator's objective is to maximize the number of economic activities being financed by the banking sector while ensuring that the bank deposits are money-like.

However, unlike the planner, the regulator is constrained by several limited commitment problems. The following commitment issues impede the regulator's maximization of private safe asset creation:

- i) bank deposits cannot be made renegotiation-proof unless a threat of run is maintained;
- ii) banks cannot commit to not engaging in certain ex-post behavior (i.e., rent extraction, competition) unless proper commitment devices are imposed;
- iii) banks cannot commit to adopting an ex-ante loan making strategy α unless it is incentive compatible.

As discussed in Section 2.2, the commitment issue i) implies that the safety of deposits must be guaranteed under exposure to ex-post liquidity shocks that are endogenously implied by the fragile bank capital structure. Commitment issue ii) suggests that the two inefficiencies examined in Section 4 lie at the center of the regulator's optimization problem. Finally, commitment issue iii) reminds the regulator that the equilibrium in which the efficiency of private safe asset creation is maximized may not be automatically implementable unless proper regulatory policies is stipulated.

In this paper, I consider two policy instruments that the regulator can deploy in solving her problem:

- i) regulation of banking market competitiveness τ ;
- ii) regulation of banks' liquid asset holding.

Through banking market regulation (or deregulation), such as stipulating rules on the geographic scope of banks' branching operations, the regulator can manipulate competitiveness τ in the banking market. By stipulating a uniform requirement regarding banks' ex-ante liquid asset holding, the regulator is able to commit banks to adopting ex-ante loan-making strategies that might not be incentive compatible.⁵⁶

56. For instance, banks who are discovered failed to abide the liquid asset holding requirement will be

We now examine the effectiveness and efficacy of these two policy instruments.

B. Mixed Effects of Banking Market Competitiveness τ

In this subsection, we show that banking market competitiveness τ is a “double-edged sword” because it has mixed impacts on the two inefficiencies identified in Section 2.4.

High Competitiveness τ as (Ex-ante) Incentivizing Tool

In a highly competitive banking market, the ex-post retail liquidity supply for banks hit by liquidity shocks is relatively elastic. Given this elastic retail liquidity supply, when interbank deals in the wholesale market break down, banks in need of liquidity will not have to increase much the rates posted in the retail market to raise extra liquidity. As a result, the ability of lending banks to extract rents from ex-post interbank trading is weakened, due to the improved outside options of banks that need liquidity.

When banks are less concerned about getting held up in ex-post wholesale liquidity trading when liquidity shocks hit, they are more incentivized to engage in ex-ante liquidity creation activities. Through more efficient incentive provision, the first inefficiency in safe asset creation associated with ex-ante under-production of liquidity pool can be alleviated. In the extreme case illustrated in Corollary 1, when the banking market is perfectly competitive (i.e., $\tau = \infty$), inefficiencies caused by under-produced liquidity pool can be completely eliminated. More generally, we have the following proposition.

Proposition 5 *The laissez-faire equilibrium outcome of private safe asset creation associated with level-1 liquidity shocks $\alpha_E(\tau)$ is an increasing function in banking competitiveness τ .*

When $k = 1$, only the first inefficiency is present. As it dispels banks’ concern about being held up in ex-post wholesale trading, more competitive banking market alleviates this ex-ante under-production inefficiency and monotonically improves welfare.

Low Competitiveness τ as (Ex-post) Disciplining Tool

penalized.

As demonstrated in Section 4(C), the competitive retail liquidity market might be counter-productive when more than one bank is receiving ex-post liquidity shocks. In such cases, making the banking market more competitive works equivalently as introducing an ex-post spot market, which imposes an extra incentive compatibility constraint on banks' ex-post usage of the liquidity pool. Thus, unlike the optimal marginal rate of substitution guaranteed in planner's allocation, decentralized equilibrium forces banks to over-use the liquidity pool.

Making the banking market more segmented (less competitive)— i.e., reducing τ — can alleviate this second inefficiency associated with ex-post over-use of the liquidity pool. The economics here recall those of Jacklin (1987), who demonstrates that restricting ex-post trading among consumers is essential for financial intermediaries' ex-ante liquidity creation. In our problem, a less competitive banking market makes the extra IC constraint on banks' ex-post usage of liquidity pool more aligned with the optimal MRS in liquidity raising that the planner's solution implies. In effect, a lower τ functions as a disciplining tool on banks' ex-post competing behavior, and thus more effectively commits banks to using the ex-post liquidity pool at the socially desired level.

In the extreme case illustrated in Corollary 2, when the banking market is completely segmented ($\tau = 0$), inefficiency induced by the ex-post liquidity pool being over-used can be completely eliminated. More generally, we have the following proposition.

Proposition 6 *The laissez-faire equilibrium outcome of private safe asset creation associated with level- N liquidity shocks $\alpha_E(\tau)$ is a decreasing function in banking competitiveness τ .*

When $k = N$, only the second inefficiency is present. By better committing banks to using the liquidity pool at the socially desired level, a less competitive banking market alleviates this ex-post over-use inefficiency and strictly improves welfare.

Special Case Illustration: $k = 2, N = 3$

When the number of banks subject to ex-post liquidity shocks satisfies $2 \leq k \leq N - 1$, both inefficiencies will actively affect the private safe asset creation in the decentralized

economy. In this part, we analyze a simplest case that satisfies this condition, in which $k = 2, N = 3$.

Consider an symmetric equilibrium in which all three banks choose α on date 0 and WLOG assume that bank 1 and bank 2 are hit by liquidity shocks on date 1 while bank 3 is not. In the equilibrium on date 1, both bank 1 and bank 2 will be:

- i) liquidating t_1 ($t_1 \in [0, \alpha]$) of their long term assets;
- ii) posting rate r_1 in the retail market to raise liquidity in the amount $s(r_1; \cdot, \tau)$;
- iii) borrowing from bank 3 for quantity $q_{1,3}$ at rate $r_{1,3}$.

where the retail liquidity supply $s(r_i; \cdot, \tau)$ for each bank i is parameterized by banking competitiveness τ . The detailed expression of $s(r_i; \cdot, \tau)$ is presented in the appendix.

Combining the efficiency analysis carried out for the previous two special cases, Table 3 compares the decentralized equilibrium outcome α_E and planner's solution α_P of private safe asset creation. Detailed calculations are presented in the Appendix [Section A7](#).

Table 3: Efficiency analysis: $k = 2, N = 3$

	Equilibrium	Planner's problem
Market clearing/ Liquidity coverage:	α_E is the maximum α such that $\exists t_1, r_1 :$ $g(t_1, \alpha) + s(r_1; \cdot, \tau) + q_{1,3} = \alpha$	α_P is the maximum α such that $\exists t_1, r_1, q_{1,3}, r_{1,3} :$ $g(t_1, \alpha) + s(r_1; \cdot, \tau) + q_{1,3} = \alpha$
Inter-bank liquidity pricing:	$(q_{1,3}, r_{1,3}) =$ $\operatorname{argmax}_{\hat{q}_{1,3}, \hat{r}_{1,3}} [V_1(\hat{q}_{1,3}, \hat{r}_{1,3}; \tau) -$ $V_1^R(\tau)]^\beta [V_2(\hat{q}_{1,3}, \hat{r}_{1,3}; \tau) - V_2^R(\tau)]^{1-\beta}$	$2q_{1,3} = s(r_{1,3}; \cdot, \tau)$
Incentive constraint:	$R \frac{\partial g(t_1, \alpha)}{\partial t} - r_1 = \frac{s(r_1; \cdot, \tau)}{s'(r_1; \cdot, \tau)}$	N/A
Solvency:	$R(\alpha - t_1) - [r_1 s(r_1; \alpha) + r_{1,3} q_{1,3}] \geq 0$	$R(\alpha - t_1) - [r_1 s(r_1; \alpha) + r_{1,3} q_{1,3}] \geq 0$

As shown in table 3, both inefficiencies are actively affecting the equilibrium tightness of the safe asset creation constraint in the decentralized economy. Higher banking market competitiveness improves the borrowing banks' bargaining position and, hence, it reduces the mark-up charged in the equilibrium interbank trading deal $(q_{1,3}, r_{1,3})$. As such, higher bank-

ing competitiveness τ can loosen the solvency constraint by making the wholesale liquidity price closer to the marginal cost.

In contrast, lower banking competitiveness brings the IC constraint on banks' ex-post usage of the liquidity pool more into alignment with the optimal MRS in liquidity raising that the planner's solution implies. Therefore, a lower banking market competitiveness τ can loosen the solvency constraint by reducing the sub-optimality of the equilibrium liquidity-raising strategy that banks adopt in the decentralized economy.

The level τ^* of the banking market competitiveness that maximizes private safe asset creation must optimally balance the two opposing effects, as described above.

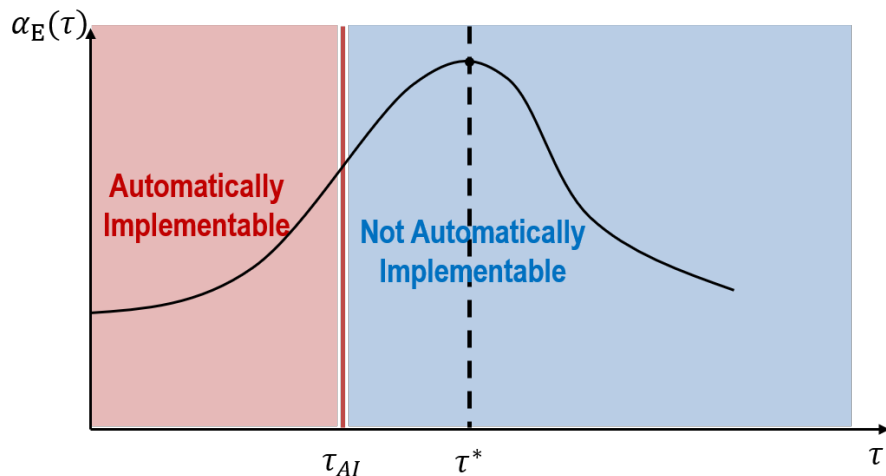
C. Liquidity Regulation for Equilibrium Implementation

Finally, we discuss the role played by bank liquidity regulation in maximizing the economy's private safe asset creation.

Reserve Requirement as (Ex-ante) Coordinating Tool

The private safe asset creation equilibrium associated with the optimal level of banking competitiveness τ^* may not be automatically implementable, as illustrated in Figure 1.9.

Fig. 1.9. Policy making for optimal safe asset creation



If the level of banking competitiveness that optimally balances the two ex-post commitment problems is higher than the threshold defined in proposition 4 that governs equilibrium implementability, i.e. $\tau^* > \tau_{AI}$, then the optimal equilibrium $\{\alpha_E(\tau^*)\}$ cannot be ex-ante committed. In such cases, to implement the desired private safe asset creation in the economy, the regulator needs to pair the banking market regulation that set $\tau = \tau^*$ with a liquidity regulation. Specifically, a reserve requirement on banks' ex-ante liquid asset holding $1 - \alpha$ needs to be imposed:

$$1 - \alpha \geq 1 - \alpha_E(\tau^*)$$

such that banks that fail to abide to this requirement will be penalized. Absent such a liquidity regulation, a coordination failure may arise in banks' safe asset creation because everyone has an incentive to make an upward deviation against $\alpha_E(\tau^*)$; thus, no one stay solvent ex-post. In this sense, the liquidity regulation on banks' liquid asset holding functions as a coordinating tool in the respect that it coordinates all banks in the economy to choose the right amount of illiquid lending ex-ante.

A Real World Example

The banking sector reform in the U.S. during the 1980s provides a concrete real world example for the theory developed in this paper. In the 1980s, the banking sector in the U.S. experienced significant regulatory reforms. The *Depository Institutions Deregulation and Monetary Control Act of 1980* is one of the most important pieces of legislation to affect the Federal Reserve during the last century.

This Act has two major titles. First, the Act deregulates financial institutions that accept deposits. Prior to 1980, commercial banks in the U.S. were subject to rigorous geographic restrictions on their branching operations and ceilings on the deposit rate they could offer. The *Depository Institutions Deregulation* removes these restrictions on branching operation and deposit raising. In our model, this banking market deregulation corresponds to an increase in banking market competitiveness τ .

However, the Act also strengthens the Fed's control on the liquidity of non-member

banks; this is reflected in a set of reserve requirements that uniformly apply to all banks in the economy. Before 1980, the reserve requirements of nonmember institutions varied from state to state, and most state regulatory agencies imposed statutory requirements that were lower than Fed-mandated requirements.⁵⁷ The *Monetary Control* title imposes a set of requirements on the minimum liquid asset holding that all banks must follow.

The theory developed in this paper offers a novel rationale for the synchronized enforcement of a uniform reserve requirement with the banking deregulation as stipulated in the Act. The reserve requirement on banks' ex-ante liquid asset holding becomes essential for safe asset creation when the banking market is sufficiently competitive.

1.6. Conclusions

This paper develops a general equilibrium model of private safe asset creation in which banks create money-like deposits through a joint behavior of deposit taking and loan making. Liquid and safe deposits are manufactured through a “money multiplier”, at the core of which is a common liquidity pool. This liquidity pool is endogenously generated by banks' loan-making activities, and it helps back up the money-like feature of the deposits that banks issued. In this process, a fragile bank capital structure imposes a constraint on the “money multiplier”.

The first main result of the paper is that the combination of this safe asset creation constraint under liquidity risks with certain markets being missing implies that the private money creation in a decentralized economy could be constrained inefficient. In particular, under a practically and theoretically reasonable environment of contracting and market space, I identify three market failures that can potentially plague the private money creation in a market economy. Two of them can cause inefficiencies by making the safe asset creation constraint inefficiently tight and the other can result in a complete collapse of private money creation.

57. See Gilbert and Lovati (1978).

Two market failures can potentially lead to inefficiencies in private money creation by making the safe asset creation constraint inefficiently tight. The first is an *incentive* problem induced by non-competitive pricing of ex-post wholesale liquidity, which can result in ex-ante under-production of the liquidity pool. The second is a *commitment* problem due to certain futures market being missing or impaired, which can result in ex-post over-use of the liquidity pool. These two market failures are exactly the manifestations of the two scenarios in which the first welfare theorem could fail and Pareto inefficiencies could arise.

Banking market competition plays an interesting role in affecting the efficiency of private money creation. In particular, I show that increased competition in banking market has a mixed effect on efficiency— it alleviates the incentive problem and hence the ex-ante under-production of liquidity pool, but it also exacerbates the commitment problem and the ex-post over-use of liquidity pool. These results have a clear policy implication on the optimal level of banking market competition in an economy. If an economy is subject to idiosyncratic risks, then a competitive banking market is beneficial— by playing the role as an incentivizing tool and help achieve better risk-sharing when idiosyncratic shocks hit. If an economy is exposed to systemic risks, then competitive banking markets can be harmful. In this case, competitive banking markets can trap the economy in a high interest rate equilibrium once systemic shocks hit the economy, in which all shocked banks aggressively dip into the liquidity pool until the liquidity price gets bid up to an inefficiently high level.

In addition to the above two market failures that will lead to inefficient outcomes in private money creation, a third market failure can potentially result in a complete collapse of the whole private system in its safe asset creation. When banking markets become sufficiently competitive, an ex-ante *coordination* problem may arise in banks' safe asset creation, at which point no private safe assets can be created in the economy without a proper reserve requirement being imposed. The analysis has implications for regulations of banking markets and bank liquidity.

1.7. Appendix

A. Proofs and Derivations

A1. Retail liquidity Pricing: Proofs of Lemma 1 and 2

In Section A1, we elaborate in detail the pricing of retail liquidity at date 1. The price of retail liquidity at date 1 is determined by household member B's problem.

Lemma 1 *On date 1, for a household member B with endowment $e + w \cdot \alpha$, its (individual) inverse supply of deposits is $r(d; \alpha) \equiv h'(e + w \cdot \alpha - d)$. Accordingly, its (individual) deposit supply function is $d(r; \alpha) = r^{-1}(d; \alpha)$.*

Proof For an individual HH member B with endowment $e + w \cdot \alpha$ (that is, his local bank makes α amount of lending at date 0), facing an interest rate r that pays off at date 2, this risk neutral decision maker solves

$$\max_d h(e + w \cdot \alpha - d) + r \cdot d$$

in which the HH member B deploys his storage technology $h(\cdot)$ to carry the remaining endowments into date 2. Under our regulatory assumptions on function $h(\cdot)$, the optimal choice of d to deposit at rate r is determined by the first order condition regarding d :

$$r = h'(e + w \cdot \alpha - d)$$

which immediately gives us the individual inverse supply of deposits $r(d; \alpha) \equiv h'(e + w \cdot \alpha - d)$ of this HH member B with endowment $e + w \cdot \alpha$, as a function of d . The inverse function of $r(d; \alpha)$ gives us the individual supply function of deposits from this HH member B: $d(r; \alpha) = r^{-1}(d; \alpha)$. ■

From the above individual deposit supply function, we can thus characterize the (aggregate) retail liquidity supply function $s_i(r; \cdot)$ faced by each individual bank i .

Lemma 2 *For general cases in which $0 < \tau < \infty$, if all banks chose α on date 0 and all*

other banks $n \neq i$ are posting a rate \bar{r} on date 1, then the ex-post liquidity supply curve faced by bank i is

$$s_i(r_i; \alpha, \bar{r}) = d(r_i; \alpha) \cdot [1 + 2\tau \cdot (V_H(r_i; \alpha) - V_H(\bar{r}; \alpha))]$$

where $V_H(r; \alpha) \equiv \max_d r \cdot d + h(e + s \cdot \alpha - d)$ is the optimized value for a HH with endowment $e + s \cdot \alpha$ and being offered a rate r .

Proof To prove Lemma 2, we proceed in two steps.

Step 1

First, we prove that each individual HH member B would never deposit in more than one bank. Suppose not, let us assume that a HH member B simultaneously deposits with two banks, i and j . Suppose the rates offered by each bank are r_i and r_j , while this HH's distance to each bank are L_i and L_j respectively. Furthermore, suppose that the HH deposits d_i with bank i and deposits d_j with bank j , where both d_i and d_j are strictly positive.

WOLG, let us assume $0 \leq L_i \leq L_j$, then it must be that $r_i < r_j$, because otherwise this HH can strict be made better by deviating to just deposit with bank i . This is because when $r_i \geq r_j$, by making the proposed deviation, the households can get weakly increased payoff at date 2 (since $r_i \geq r_j$) while the traveling cost $L_j \cdot \tau > 0$ ($L_i \leq L_j$ implies $L_j > 0$) is saved.

However, if $r_i < r_j$, then the following profitable deviation exists. That is, the HH can choose the following depositing profile: $\hat{d}_i = d_i - \epsilon$ and $\hat{d}_j = d_j + \epsilon$, where $\epsilon > 0$ is an arbitrary small positive number such that $\hat{d}_i > 0$. Then following the proposed deviation strategy, the HH can be made strictly better off:

$$\begin{aligned} r_i \cdot \hat{d}_i + r_j \cdot \hat{d}_j &= r_i \cdot (d_i - \epsilon) + r_j \cdot (d_j + \epsilon) \\ &= r_i \cdot d_i + r_j \cdot d_j + (r_j - r_i) \cdot \epsilon \\ &> r_i \cdot d_i + r_j \cdot d_j \end{aligned}$$

where the inequality is because $(r_j - r_i) \cdot \epsilon > 0$. As such, each individual bank would only

deposit in one single bank.

Step 2

We are now ready to characterize the retail liquidity supply function for each individual bank i . For a HH member B with endowments $\bar{e} + w \cdot \alpha$ who chooses to deposit with a bank offering rate r , define function

$$V_H(r; \alpha) \equiv \max_d r \cdot d + h(e + s \cdot \alpha - d)$$

This function $V_H(r; \alpha)$ gives us the optimal payoff this HH can gain from depositing with this bank (before subtracting traveling costs from doing so).

Now consider an individual bank i . If all banks choose α at date 0, then the date-1 endowments of all HH member B on the entire circle is $\bar{e} + w \cdot \alpha$. Suppose all other banks are posting rate \bar{r} in the retail market for liquidity raising. Then if bank i posts a rate $r < \bar{r}$, some HH that reside in bank i 's territory will be attracted by adjacent banks. Specifically, the HH who resides within a distance L to the boundaries of bank $i - 1$ and bank $i + 1$ would be attracted away, where the distance L is given by

$$\begin{aligned} L &= \frac{1}{\kappa} \cdot (V_H(\bar{r}; \alpha) - V_H(r_i; \alpha)) \\ &\equiv \tau \cdot (V_H(\bar{r}; \alpha) - V_H(r_i; \alpha)) \end{aligned}$$

As such, by offer a rate $r_i < \bar{r}$, bank i will only be able to raise liquidity from $1 - 2 \cdot L$ HH, each of whom would deposit an amount of $d(r_i; \alpha)$. Here we are making use of the results we established in step 1, that each individual HH would choose to deposit in one single bank. Therefore, the total amount of retail liquidity bank i can raise by posting a rate $r_i < \bar{r}$ is

$$s_i(r_i; \alpha, \bar{r}) = d(r_i; \alpha) \cdot [1 - 2\tau \cdot (V_H(\bar{r}; \alpha) - V_H(r_i; \alpha))]$$

Similarly, we can show that by posting a rate $r_i \geq \bar{r}$, the amount of retail liquidity can be

raised by bank i is

$$s_i(r_i; \alpha, \bar{r}) = d(r_i; \alpha) \cdot [1 + 2\tau \cdot (V_H(r_i; \alpha) - V_H(\bar{r}; \alpha))]$$

Combine both cases, Lemma 2 is proved. ■

A2. Wholesale Liquidity Pricing

In Section A2, we provide details for interbank trading in the wholesale liquidity market at date 1.

After a liquidity shock ω hits, each bank $i \in \omega$ trades with each bank $j \in \omega^c$ for date-1 liquidity. The trading deal $(q_{i,j}, r_{i,j})$ is determined as the bargaining outcome in the bilateral negotiation between bank i and bank j . Mathematically, $(q_{i,j}, r_{i,j})$ maximizes the joint surplus from trading for both parties:

$$(q_{i,j}, r_{i,j}) = \arg \max_{(q,r)} [V_i(q, r) - V_i^R]^\beta \cdot [V_j(q, r) - V_j^R]^{1-\beta}$$

In the above equation, reservation values V_i^R and V_j^R are determined as the outside options for each bank given that a deal between the two cannot be reached. Since the interbank trading in the wholesale market at date 1 is modeled as non-cooperative bargaining, in doing our calculations for V_i^R and V_j^R , the following are held as fixed: the equilibrium deposit rates posted by banks n , where $n \neq i, j$; and all other interbank deals established in the equilibrium at date 1.

Under this model specification of the interbank bargaining between each pair of bank $i \in \omega$ and bank $j \in \omega^c$, reservation values V_i^R and V_j^R are determined as follows. Under the restriction that no deal between the two banks could be established, these two banks play will play a “hypothetical game”, in which

- i) bank i tries to minimize the margin at which (could be zero) it fails to meet its liquidity obligation; and
- ii) bank j has to raise enough liquidity in order to deliver what are specified in its established

interbank trading deals with other banks in ω .

Therefore, taking as given the old equilibrium rate posted by banks $n \neq i, j$ and the rate \hat{r}_j posted by bank j in the new hypothetical equilibrium, bank i chooses its new strategy (\hat{t}_i, \hat{r}_i) to solve

$$\min_{(\hat{t}_i, \hat{r}_i)} \alpha_i - g(\hat{t}_i, \alpha_i) - s_i(\hat{r}_i; \cdot, \hat{r}_j) - \sum_{j' \in \omega^c \setminus \{j\}} q_{i,j'}$$

subject to feasibility constraint

$$R \cdot (\alpha_i - \hat{t}_i) \geq r_i \cdot s_i(\hat{r}_i; \cdot, \hat{r}_j) + \sum_{j' \in \omega^c \setminus \{j\}} r_{i,j'} \cdot q_{i,j'}$$

Here the retail liquidity supply function $s_i(r_i; \cdot, \hat{r}_j)$ for bank i is affected by banks' date-0 loan making profile $\{\alpha_n\}$, the equilibrium date-1 rates r_n posted by banks $n \neq i, j$, and the new rate \hat{r}_j posted by bank j .

For bank j , taking as given the old equilibrium rate posted by banks $n \neq i, j$ and the rate \hat{r}_i posted by bank i in the new hypothetical equilibrium, it posts a rate \hat{r}_j to ensure wholesale liquidity delivery:

$$s_j(\hat{r}_j; \cdot, \hat{r}_i) = \sum_{i' \in \omega \setminus \{i\}} q_{i',j}$$

Likewise, the retail liquidity supply function $s_i(r_i; \cdot, \hat{r}_j)$ that bank j faces would be affected by rate \hat{r}_i posted by bank i in the new equilibrium.

Suppose the equilibrium outcome of this “hypothetical game” after interbank deal breaks is that bank i adopts $(\hat{t}_i^H, \hat{r}_i^H)$ while bank j posts rate \hat{r}_j^H . Then the reservation value of bank j can be calculated as

$$V_j^R = \sum_{i' \in \omega \setminus \{i\}} r_{i',j} \cdot q_{i',j} - \hat{r}_j^H \cdot s_j(\hat{r}_j^H; \cdot, \hat{r}_i^H)$$

which is the total profits bank j could make from its established trading deals with other banks in ω .

For bank i 's reservation value \hat{r}_i^H , we first calculate the margin m^H at which bank i will be failing to meet its liquidity obligation in the ‘‘hypothetic equilibrium’’:

$$m^H = \left\{ \alpha_i - g(\hat{t}_i^H, \alpha_i) - s_i(\hat{r}_i^H; \cdot, \hat{r}_j^H) - \sum_{j' \in \omega^c \setminus \{j\}} q_{i,j'} \right\}^+$$

Then the reservation value of bank i is

$$V_i^R = p(m^H)$$

where a non-pecuniary penalty of size $p(m^H)$ will be imposed on bank i for its failure in meeting the liquidity obligation.

The valuation of an arbitrary trading deal $V_i(q, r)$ and $V_j(q, r)$ to both parties can be obtained following the same procedure. Now with a deal (q, r) being established between the two banks, bank i chooses (\hat{t}_i, \hat{r}_i) to solve

$$\min_{(\hat{t}_i, \hat{r}_i)} \alpha_i - g(\hat{t}_i, \alpha_i) - s_i(\hat{r}_i; \cdot, \hat{r}_j) - \sum_{j' \in \omega^c \setminus \{j\}} q_{i,j'} - q$$

subject to feasibility constraint

$$R \cdot (\alpha_i - \hat{t}_i) \geq r_i \cdot s_i(\hat{r}_i; \cdot, \hat{r}_j) + \sum_{j' \in \omega^c \setminus \{j\}} r_{i,j'} \cdot q_{i,j'} + r \cdot q$$

and bank j posts a rate \hat{r}_j to ensure wholesale liquidity delivery:

$$s_j(\hat{r}_j; \cdot, \hat{r}_i) = \sum_{i' \in \omega \setminus \{i\}} q_{i',j} + q$$

A3. Constrained Efficient Benchmark: Proof of Proposition 1

In Section A3, we provide details for the characterization of the planner's solution in maximizing private safe asset creation in the economy. Planner's authority in liquidity raising at date 1 is what ensures that the optimal private safe creation can be achieved. In particular, the planner's ability of credibly committing to implementing the following two behavior is crucial:

- 1) In the planner's allocation, each individual bank i only raises deposits from its own territory at date 1, at a rate r_i dictated by the planner;
- 2) The planner can ensure that the wholesale liquidity traded in the interbank market is always priced at lending banks' marginal cost in deposit raising.

We now prove Proposition 1, which characterizes the symmetric constrained efficient equilibrium of safe asset creation that can be achieved in the planner's solution.

Proposition 1 *The symmetric constrained efficient equilibrium α_P of safe asset creation associated with level- k liquidity shocks in a planner's solution is determined by*

$$k \cdot g(t^*, \alpha_P) + N \cdot d(r^*; \alpha_P) = k \cdot \alpha_P$$

where the optimal liquidity raising strategy (t^*, r^*) satisfies

$$\frac{d(r^*; \alpha_P)}{d'(r^*; \alpha_P)} + r^* = R / \frac{\partial g(t^*, \alpha_P)}{\partial t}$$

$$k \cdot R(\alpha_P - t^*) = N \cdot r^* \cdot d(r^*; \alpha_P)$$

Proof We proceed in three steps.

Step 1

First we show that with all banks choosing the same α on date 0 (since we are focusing on symmetric equilibrium), in the planner's optimal allocation on date 1, all banks are posting the same rate r in the retail market.

Suppose all banks choose α on date 0, then the date-1 endowments of all households over the circle are $\bar{e} + w \cdot \alpha$. After a liquidity shock ω hits on date 1, which makes k banks in the economy in need of liquidity, the planner optimally raises liquidity in the economy to cover such needs. Specifically, the planner dictates the rate r_n each bank n to post in the retail

market and the liquidation amount t_i for each bank $i \in \omega$ to solve

$$L(\alpha, \omega) \equiv \max_{\{t_i\}_{i \in \omega}, \{r_n\}} \sum_{i \in \omega} g(t_i, \alpha) + \sum_{n=1}^N d(r_n; \alpha)$$

subject to the feasibility constraint:

$$\sum_{i \in \omega} R \cdot (\alpha - t_i) \geq \sum_{n=1}^N r_n \cdot d(r_n; \alpha)$$

Form the Lagrangian

$$\mathcal{L} = \sum_{i \in \omega} g(t_i, \alpha) + \sum_{n=1}^N d(r_n; \alpha) + \lambda \left[\sum_{i \in \omega} R \cdot (\alpha - t_i) - \sum_{n=1}^N r_n \cdot d(r_n; \alpha) \right]$$

Take the first order conditions:

$$\begin{aligned} [r_n] : d'(r_n; \alpha) - \lambda \cdot [d(r_n; \alpha) + r_n \cdot d'(r_n; \alpha)] &= 0 \\ [t_i] : \frac{\partial g(t_i, \alpha)}{\partial t} - \lambda R &= 0 \end{aligned}$$

The FOC regarding t_i ($i \in \omega$) immediately implies that in planner's allocation, all banks in ω will liquidate the same amount of their long term asset. The FOC regarding r_n ($1 \leq n \leq N$) implies that

$$\begin{aligned} \lambda &= \left[\frac{d(r_n; \alpha)}{d'(r_n; \alpha)} + r_n \right]^{-1} \\ &\equiv [F(r_n)]^{-1} \end{aligned}$$

Given our assumption that HH's date-1 storage technology $h(\cdot)$ is concave, we can easily show that $d''(r_n; \alpha) < 0$. Therefore, we have

$$\begin{aligned} F'(r_n) &= 1 + \frac{d'(r_n; \alpha)}{d'(r_n; \alpha)} + \frac{-d(r_n; \alpha) \cdot d''(r_n; \alpha)}{[d'(r_n; \alpha)]^2} \\ &> 0 \end{aligned}$$

As such, all banks must be posting the same retail rate for liquidity raising in the planner's optimal allocation on date 1.

Finally, it's easy to observe that in the planner's allocation problem, the exact realization of $\omega \in \Omega_k$ does not matter. Given this fact, we can write function $L(\alpha, \omega)$ simply as $L(\alpha)$, which is a function only of the date-0 loan making choice α .

Step 2

In the next step of our proof, we show that the date-0 loan making α^P in the planner's optimal allocation must satisfy

$$L(\alpha_P) = k \cdot \alpha^P$$

Obviously we must have $L(\alpha_P) \geq k \cdot \alpha_P$. Otherwise if the planner chooses an α such that $L(\alpha) < k \cdot \alpha_P$, then after a liquidity shock hits the banking sector on date 1, even with the optimal liquidity raising strategy the planner will not be able to meet the aggregate demand for liquidity from banks that get hit. As a result, the deposits issued by banks in the economy on date 0 cannot be guaranteed to be safe assets.

On the other hand, if the date-0 loan making α_P in the planner's allocation satisfies $L(\alpha_P) > k \cdot \alpha_P$, the safe asset creation is then not optimized. This is because the continuity of function $L(\alpha)$ implies that there exists a positive $\epsilon > 0$ such that $L(\alpha_P + \epsilon) > k \cdot \alpha_P$. Therefore, by increasing the date-0 loan making from α_P to $\alpha_P + \epsilon$, the planner can increase the amount of economic activities financed by banks in the economy while ensuring that the safety of deposits issued by banks on date 0 are still maintained. In other words, the planner's allocation of safe asset creation cannot be optimized by choosing α_P at which $L(\alpha_P) > k \cdot \alpha_P$

Therefore, in the planner's optimal allocation for safe asset creation, we must have $L(\alpha_P) = k \cdot \alpha_P$.

Step 3

Based on the results established in Step 1 and Step 2, we are now ready to prove this

proposition. In planner's optimal allocation, with the k banks receiving liquidity shocks adopting the same strategy (t^*, r^*) and all other banks posting the same rate r^* , we have

$$L(\alpha_P) = k \cdot g(t^*, \alpha_P) + N \cdot d(r^*; \alpha_P)$$

Combined with the results from Step 2, we immediately have

$$k \cdot g(t^*, \alpha_P) + N \cdot d(r^*; \alpha_P) = k \cdot \alpha_P$$

To derive the conditions that t^* and r^* satisfy, combine the FOCs regarding r_n and t_i derived in Step 1, we get

$$\frac{d(r^*; \alpha_P)}{d'(r^*; \alpha_P)} + r^* = R / \frac{\partial g(t^*, \alpha_P)}{\partial t}$$

which gives us the optimal marginal rate of substitution between liquidation and retail liquidity raising implied by planner's solution.

Finally, at retail deposit rate r^* , the total supply of retail liquidity must equal the demand for them, when banks in ω are liquidating t^* of their long-term assets. That is,

$$k \cdot R(\alpha_P - t^*) = N \cdot r^* \cdot d(r^*; \alpha_P)$$

which finishes the proof. ■

A4. Inefficiency I: Proofs of Lemma 3, Proposition 2 and Corollary 1

In Section A4, we provide details of calculations in our analysis for efficiency I: the ex-ante under-production of the liquidity pool.

In our special case where $k = 1, N = 2, \tau = 0$, bank 1 is hit by the liquidity shock on date 1 while bank 2 is not. In the wholesale market for date-1 liquidity, bank 1 reaches a

deal $(q_{1,2}, r_{1,2})$ with bank 2, which is determined by

$$(q_{1,2}, r_{1,2}) = \arg \max_{\hat{q}_{1,2}, \hat{r}_{1,2}} \left[V_1(\hat{q}_{1,2}, \hat{r}_{1,2}) - V_1^R \right]^\beta \left[V_2(\hat{q}_{1,2}, \hat{r}_{1,2}) - V_2^R \right]^{1-\beta}$$

In this Nash bargaining, bank 2's reservation value from outside option is simply

$$V_2^R = 0$$

This is because when no deals could be made with bank 1, the liquidity-surplus bank 2 cannot make any extra profits from date-1 liquidity trading: no one else would be purchasing wholesale liquidity from it. We now calculate the other terms in the above equation.

Suppose both banks make α illiquid lending on date 0. With an arbitrary deal $(\hat{q}_{1,2}, \hat{r}_{1,2})$ established with bank 1, the extra profit from wholesale liquidity trading that bank 2 can make on date 1 is

$$V_2(\hat{q}_{1,2}, \hat{r}_{1,2}) = \hat{q}_{1,2} \cdot (\hat{r}_{1,2} - r_2)$$

where r_2 is the rate bank 2 posts in the retail market in order to deliver the wholesale liquidity trading specified in the interbank deal $(\hat{q}_{1,2}, \hat{r}_{1,2})$.

With the banking market being completely segmented (i.e. $\tau = 0$), each bank can only raise deposits from its own territory. The retail liquidity supply function on date 1 for each bank i ($i = 1, 2$) is $s(r_i; \alpha) = d(r_i; \alpha)$, regardless of the rate being offered by the other bank. Therefore, the rate r_2 that bank 2 posts in the retail liquidity market satisfies

$$d(r_2; \alpha) = \hat{q}_{1,2}$$

For bank 1, its reservation value is determined by the outcomes of its re-optimization after the deal with bank 2 breaks down. That is, facing the new feasibility constraint after the

deal with bank 1 breaks down, bank 2 re-optimizes its liquidity raising to solve

$$\max_{(t_1, r_1)} g(t_1, \alpha) + s(r_1; \alpha)$$

subject to the new feasibility constraint

$$R \cdot (\alpha - t_1) \geq r_1 \cdot s(r_1; \alpha)$$

Denote the solution by (t_1^R, r_1^R) and the optimized objective by $L^R(\alpha) \equiv g(t_1^R, \alpha) + s(r_1^R; \alpha)$. The reservation value of bank 1 is then

$$V_1^R = -p(m^R(\alpha))$$

where $m^R(\alpha) \equiv (\alpha - L^R(\alpha))^+$ is the margin at which bank 1 fails to meet its liquidity obligation after adopting strategy (t_1^R, r_1^R) .

Similarly, for any arbitrary trading deal $(\hat{q}_{1,2}, \hat{r}_{1,2})$, bank 1's valuation $V_1(\hat{q}_{1,2}, \hat{r}_{1,2})$ can be calculated as

$$V_1(\hat{q}_{1,2}, \hat{r}_{1,2}) = -p(m(\alpha; \hat{q}_{1,2}, \hat{r}_{1,2}))$$

The failure margin $m(\alpha; \hat{q}_{1,2}, \hat{r}_{1,2})$ is formulated as $m(\alpha; \hat{q}_{1,2}, \hat{r}_{1,2}) = (\alpha - L^R(\alpha; \hat{q}_{1,2}, \hat{r}_{1,2}))^+$, in which

$$L^R(\alpha; \hat{q}_{1,2}, \hat{r}_{1,2}) = g(\hat{t}_1, \alpha) + s(\hat{r}_1; \alpha)$$

where (\hat{t}_1, \hat{r}_1) is the optimal liquidity raising strategy bank 1 should adopt given a wholesale liquidity trading deal $(\hat{q}_{1,2}, \hat{r}_{1,2})$ being established.

Having provided the details for interbank bargaining, we are now ready to prove the results regarding the first inefficiency in private safe asset creation.

Lemma 3 *With $\tau = 0$, the interbank deal $(q_{1,2}, r_{1,2})$ established in equilibrium satisfies $q_{1,2} < s(r_{1,2}; \alpha)$.*

Proof Suppose instead $q_{1,2} \geq s(r_{1,2}; \alpha)$. Then by the strict monotonicity of function $s(r; \alpha) \equiv d(r; \alpha)$, we know that

$$r_{1,2} \leq s^{-1}(q_{1,2}; \alpha) = r_2$$

Therefore, this implies that in equilibrium $V_2(\hat{q}_{1,2}, \hat{r}_{1,2}) = \hat{q}_{1,2} \cdot (\hat{r}_{1,2} - r_2) \leq 0$. But $V_2^R = 0$, thus the value gained from trading for bank 2 is non-positive, i.e., $V_2(\hat{q}_{1,2}, \hat{r}_{1,2}) - V_2^R \leq 0$.

However, when $\tau = 0$, it's easy to show that the set of trading deals $(\hat{q}_{1,2}, \hat{r}_{1,2})$ such that $V_1(\hat{q}_{1,2}, \hat{r}_{1,2}) - V_1^R > 0$ and $q_{1,2} = s(r_{1,2}; \alpha)$ is non-empty. Therefore, whenever the bargaining parameter $\beta < 1$, the Nash bargaining solution must satisfy that $V_2(\hat{q}_{1,2}, \hat{r}_{1,2}) - V_2^R > 0$. Hence $q_{1,2} \geq s(r_{1,2}; \alpha)$ is impossible to hold in equilibrium. ■

Proposition 2 *When the retail market competitiveness is sufficiently low, the laissez-faire outcomes of private safe asset creation associated with level- k ($k \leq N - 1$) liquidity shocks are inefficient. That is, there exists a threshold $\hat{\tau} \in [0, \infty]$ ($\hat{\tau}$ could be ∞), such that*

$$\alpha_E < \alpha_P$$

whenever $\tau < \hat{\tau}$ (or $\kappa > \frac{1}{\hat{\tau}}$).

Proof We proceed in two steps.

Step 1

First we show that when the retail market competitiveness τ is sufficiently, a positive mark-up will be charged in the liquidity that banks hit by liquidity shocks purchase from the wholesale market. For simplicity we show this result for the case $k = 1, N = 2$, proofs for the general cases follow the same arguments.

The trading deal established in equilibrium will be featuring a positive mark-up in liq-

uidity price whenever the following is true: there exists a trading deal $(\hat{q}_{1,2}, \hat{r}_{1,2})$ such that

$$\begin{aligned} V_1(\hat{q}_{1,2}, \hat{r}_{1,2}) - V_1^R &> 0 \\ V_2(\hat{q}_{1,2}, \hat{r}_{1,2}) - V_2^R &\geq 0 \end{aligned}$$

This is because if such a trading deal exists, then $\beta < 1$ implies that at the $(q_{1,2}, r_{1,2})$ that maximizes the joint surplus, we must have $V_2(\hat{q}_{1,2}, \hat{r}_{1,2}) - V_2^R > 0$.

We now show that when the retail market competitiveness τ is sufficiently low, such a trading deal $(\hat{q}_{1,2}, \hat{r}_{1,2})$ would always exist. Denote by (t_1^*, r_1^*) the optimal solution to

$$\max_{(t_1, r_1)} g(t_1, \alpha) + 2s(r_1; \alpha)$$

subject to the feasibility constraint

$$R \cdot (\alpha - t_1) \geq 2r_1 \cdot s(r_1; \alpha)$$

Then trading deal $(q_{1,2}^*, r_{1,2}^*)$ constructed as follows satisfies the above conditions: $r_{1,2}^* = r_1^*$ and $q_{1,2}^* = d(r_1^*; \alpha)$. Let us now verify.

With the established interbank trading deal being $(q_{1,2}^*, r_{1,2}^*)$, by construction, in equilibrium bank 1's optimal liquidity raising strategy will be (t_1^*, r_1^*) . Therefore, the equilibrium rate bank 2 needs to post in order to deliver $q_{1,2}^*$ wholesale liquidity is $r_2 = r_1^*$. As such,

$$\begin{aligned} V_2(q_{1,2}^*, r_{1,2}^*) - V_2^R &= q_{1,2}^* \cdot (r_{1,2}^* - r_2) - 0 \\ &= 0 \end{aligned}$$

Finally, we need to show that when retail market competitiveness τ is sufficiently low, $V_1(q_{1,2}^*, r_{1,2}^*) - V_1^R > 0$. Suppose now the deal between the two banks breaks down and bank 2 will not be posting rates in the retail market anymore. In this case, if bank 1 can freely raise retail liquidity over the entire circle, then by construction the optimal strategy it

should adopt is (t_1^*, r_1^*) . This gives us the upper bound of bank 1's reservation value from its outside option. However, when retail market competitiveness τ becomes low enough, bank 1 will not be able to raise $q_{1,2}^* = d(r_1^*; \alpha)$ amount of retail liquidity from bank 2's territory by posting rate r_1^* . This is because the traveling cost (implied by the low τ) could be large enough to discourage some households that reside in bank 2's territory to deposit with bank 1 at rate r_1^* . When this happens, the reservation value of bank 1 would be strictly worse than its valuation of a deal $(q_{1,2}^*, r_{1,2}^*)$ with bank 2, i.e.,

$$V_1(q_{1,2}^*, r_{1,2}^*) - V_1^R > 0$$

Therefore, whenever the bargaining parameter $\beta < 1$, the wholesale liquidity would be traded with a positive mark-up if the retail market competitiveness is sufficiently low.

Step 2

This part of the proof is simple. When the retail market competitiveness is low so that in the decentralized economy wholesale liquidity trading are featured with positive mark-up, the panic-proof constraint that binds banks' ex-ante choice of α is inefficiently tight. This is because if such positive mark-up in the liquidity that banks purchase from the wholesale market can be eliminated, as can be guaranteed in the planner's solution, the constraint could be loosened and banks are able to make more illiquid lending on date 0 while staying immune to panic on date 1. In other words, when private safe asset creation in the decentralized economy is constrained inefficient when the retail market competitiveness τ is sufficiently low. ■

Corollary 1 *The laissez-faire equilibrium of bank money creation associated with level-1 liquidity shock is efficient; i.e.,*

$$\alpha_E = \alpha_P$$

if $\tau = \infty$ or $(\kappa = 0)$.

Proof When $k = 1$, only one bank will be receiving liquidity shocks on date 1. In this case, only the first inefficiency is active in affecting the private safe asset creation. Therefore,

constrained efficiency (second best) can be achieved if this first inefficiency can be eliminated.

Again, we prove this result for case $k = 1, N = 2$ and the argument for general cases follows similarly. WLOG, suppose bank 1 is hit while bank 2 is not. From the analysis in our proof of Proposition 2, it suffices to show that when $\tau = \infty$, the liquidity traded in the wholesale market will always be priced at its marginal cost. To show this, we need to show that the following is true: there does not exist any $(\hat{q}_{1,2}, \hat{r}_{1,2})$, such that

$$\begin{aligned} V_2(\hat{q}_{1,2}, \hat{r}_{1,2}) - V_2^R &> 0 \\ V_1(\hat{q}_{1,2}, \hat{r}_{1,2}) - V_1^R &\geq 0 \end{aligned}$$

By way of contradiction, suppose there exists a $(\hat{q}_{1,2}, \hat{r}_{1,2})$ satisfying the above conditions. Because $\tau = \infty$, the rates \hat{r}_i both banks post in the retail market must be equalized, i.e., $\hat{r}_1 = \hat{r}_2$. Suppose in equilibrium the mass of households depositing with bank 2 is \hat{n}_2 , then $\hat{q}_{1,2} = \hat{n}_2 \cdot d(\hat{r}_2; \alpha)$. Bank 2's valuation of deal $(\hat{q}_{1,2}, \hat{r}_{1,2})$ is $V_2(\hat{q}_{1,2}, \hat{r}_{1,2}) = \hat{q}_{1,2} \cdot (\hat{r}_{1,2} - \hat{r}_2)$, therefore $V_2(\hat{q}_{1,2}, \hat{r}_{1,2}) - V_2^R > 0$ implies that $\hat{r}_{1,2} > \hat{r}_2$.

To calculate bank 1's reservation value from its outside option, suppose the deal between the two banks breaks down. In this case, a feasible option for bank 1 is to post the same rate \hat{r}_1 as it did in the original equilibrium. By doing so, bank 1 will be able to raise the same amount of retail liquidity from those households that deposited with them in the original equilibrium. Furthermore, it can raise $d(\hat{r}_2; \alpha)$ from each of the \hat{n}_2 households that used to deposit with bank 2.

Therefore, following this strategy bank 1 can raise the same amount of retail liquidity as it did in the original equilibrium, but the required date-2 payment is reduced. This is because $\hat{r}_{1,2} > \hat{r}_2 = \hat{r}_1$. As such, bank 1's reservation value from its outside option must be strictly higher than its valuation of the so-constructed trading deal $(\hat{q}_{1,2}, \hat{r}_{1,2})$, which is a contradiction. ■

A5. Inefficiency II: Proofs of Proposition 3 and Corollary 2

In Section A5, we provide detailed calculations for our analysis of the second efficiency

in private safe asset creation: the ex-post over-use of the liquidity pool.

Proposition 3 *The laissez-faire equilibrium of bank money creation associated with level- k ($k \geq 2$) liquidity shocks is inefficient; i.e.,*

$$\alpha_E < \alpha_P$$

whenever $\tau > 0$ (or $\kappa < \infty$).

Proof We prove this result for case $k = 2, N = 2$, the argument for general cases follows similarly. Again, we proceed in two steps.

Step 1

The first step of our proof is to show that for any loan-making profile α chosen on date 0, the date-1 liquidity raising strategy (t^*, r^*) that solves the planner's constrained optimization problem cannot be committed in the decentralized economy, whenever retail market competitiveness $\tau > 0$.

From Proposition 1, we know that the optimal date-1 liquidity raising (t^*, r^*) in the planner's allocation satisfies

$$\frac{d(r^*; \alpha)}{d'(r^*; \alpha)} + r^* = R / \frac{\partial g(t^*, \alpha)}{\partial t}$$

Let us now check whether (t^*, r^*) can be committed when the economy is decentralized. WOLG, we consider the incentive compatibility problem for bank 1. With bank 2 posting rate r^* , the retail liquidity supply function faced by bank 1 is

$$\begin{aligned} s_1(r; \alpha, r^*) &= d(r; \alpha) \cdot [1 + 2\tau \cdot (V_H(r; \alpha) - V_H(r^*; \alpha))] \\ &\equiv d(r; \alpha) \cdot [1 + 2\tau \cdot F(r; \alpha)] \end{aligned}$$

where function $F(r; \alpha) \equiv V_H(r; \alpha) - V_H(r^*; \alpha)$. It's easy to show that this function F satisfies $F(r^*; \alpha) = 0$ and $\frac{\partial F(r^*; \alpha)}{\partial r} > 0$.

Facing this retail liquidity supply function, bank 1 solves

$$\max_{(t_1, r_1)} R(\alpha - t_1) - r_1 \cdot s_1(r_1; \alpha, r^*)$$

subject to the liquidity coverage constraint

$$g(t_1, \alpha) + s_1(r_1; \alpha, r^*) = \alpha$$

Form the Lagrangian:

$$\mathcal{L}(t_1, r_1) = R(\alpha - t_1) - r_1 \cdot s_1(r; \alpha, r^*) + \lambda \cdot [g(t_1, \alpha) + s_1(r; \alpha, r^*) - \alpha]$$

From the first order condition regarding t ,

$$-R + \lambda \cdot \frac{\partial g(t^*, \alpha)}{\partial t} = 0$$

we know that at (t^*, r^*) , the shadow value of relaxing the liquidity coverage constraint is

$$\lambda = R / \frac{\partial g(t^*, \alpha)}{\partial t}$$

For (t^*, r^*) to be committed, bank 1 must have no incentive to make the following deviation: posting a slightly higher rate $r^* + \epsilon$ and reduces the liquidation volume accordingly. For this to be true, the following needs to be true:

$$\frac{\partial \mathcal{L}(t^*, r^*)}{\partial r_1} \leq 0$$

However, whenever $\tau > 0$ this cannot be true. This is because

$$\begin{aligned}
\frac{\partial \mathcal{L}(t^*, r^*)}{\partial r_1} &= -s_1(r^*; \alpha, r^*) - r^* \cdot s'_1(r^*; \alpha, r^*) + \lambda \cdot s'_1(r^*; \alpha, r^*) \\
&= s'_1(r^*; \alpha, r^*) \cdot \left[\lambda - r^* - \frac{s_1(r^*; \alpha, r^*)}{s'_1(r^*; \alpha, r^*)} \right] \\
&= s'_1(r^*; \alpha, r^*) \cdot \left[R \frac{\partial g(t^*, \alpha)}{\partial t} - r^* - \frac{s_1(r^*; \alpha, r^*)}{s'_1(r^*; \alpha, r^*)} \right] \\
&= s'_1(r^*; \alpha, r^*) \cdot \left[\frac{d(r^*; \alpha)}{d'(r^*; \alpha)} - \frac{s_1(r^*; \alpha, r^*)}{s'_1(r^*; \alpha, r^*)} \right]
\end{aligned}$$

where the last line of derivation makes use of the property that planner's optimal allocation (t^*, r^*) satisfies. When the retail market competitiveness $\tau > 0$,

$$\begin{aligned}
s'_1(r^*; \alpha, r^*) &= d'(r^*; \alpha) \cdot [1 + 2\tau F(r^*; \alpha)] + d(r^*; \alpha) \cdot 2\tau \cdot \frac{\partial F(r^*; \alpha)}{\partial r} \\
&= d'(r^*; \alpha) + d(r^*; \alpha) \cdot 2\tau \cdot \frac{\partial F(r^*; \alpha)}{\partial r}
\end{aligned}$$

where the second line of derivation makes use of the fact that $F(r^*; \alpha) = 0$. Therefore,

$$\begin{aligned}
\frac{s_1(r^*; \alpha, r^*)}{s'_1(r^*; \alpha, r^*)} &= \frac{d(r^*; \alpha)}{d'(r^*; \alpha) + d(r^*; \alpha) \cdot 2\tau \cdot \frac{\partial F(r^*; \alpha)}{\partial r}} \\
&< \frac{d(r^*; \alpha)}{d'(r^*; \alpha)}
\end{aligned}$$

where the second line of derivation is based on the fact that $\frac{\partial F(r^*; \alpha)}{\partial r} > 0$.

As such, whenever the retail market competitiveness $\tau > 0$, $\frac{\partial \mathcal{L}(t^*, r^*)}{\partial r_1} > 0$. This implies that the optimal liquidity raising strategy (t^*, r^*) implied in the planner's allocation cannot be committed in the decentralized economy. Specifically, at (t^*, r^*) each bank has incentive to reduce the liquidation of its long-term assets by posting a slightly higher rate in the retail market.

Step 2

Having established the result that banks in the decentralized economy cannot commit to adopting the socially optimal liquidity raising strategy on date 1, we now argue that the

safe asset creation on date 0 would be inefficient when the economy is decentralized.

Suppose $\alpha_E = \alpha_P$ and denote by (t_E, r_E) the strategy each bank adopts at date 1. Since both banks must stay immune to panic under liquidity shocks on date 1, we have

$$\begin{aligned} g(t_E, \alpha_E) + d(r_E; \alpha_E) &\geq \alpha_E \\ R \cdot (\alpha_E - t_E) &\geq r_E \cdot d(r_E; \alpha_E) \end{aligned}$$

As such the date-1 liquidity raising profile $\{(t_E, r_E)\}$ is in the feasibility set of planner's allocation. Furthermore, following this feasible liquidity raising profile, the total amount of date-1 liquidity that the planner can raise satisfies

$$\sum_{i=1,2} g(t_E, \alpha_E) + d(r_E; \alpha_E) \geq 2\alpha_E$$

However, based on the results from Step 1, when the retail market competitiveness $\tau > 0$, the strategy (t_E, r_E) each individual bank adopts is strictly sub-optimal as solution to the planner's allocation problem. Therefore, the optimal amount of liquidity the planner can raise must satisfy

$$L(\alpha_E) > \sum_{i=1,2} g(t_E, \alpha_E) + d(r_E; \alpha_E) \geq 2\alpha_E$$

If $\alpha_E = \alpha_P$, then it implies that $L(\alpha_P) > 2\alpha_P$. This is a contradiction to Proposition 1. Therefore, whenever $\tau > 0$, the private safe asset creation in the decentralized economy must be inefficient; i.e., $\alpha_E < \alpha_P$. ■

Corollary 2 *The laissez-faire equilibrium of bank money creation associated with level- N liquidity shocks is efficient; i.e.,*

$$\alpha_E = \alpha_P$$

if $\tau = 0$ (or $\kappa = \infty$).

Proof From our proof of Proposition 3, we have

$$\frac{s_1(r^*; \alpha, r^*)}{s'_1(r^*; \alpha, r^*)} = \frac{d(r^*; \alpha)}{d'(r^*; \alpha)}$$

when the retail liquidity market is completely segmented; i.e., $\tau = 0$. Therefore, the socially optimal liquidity raising strategy (t^*, r^*) can be fully committed by each individual bank when the economy is decentralized, since $\frac{\partial \mathcal{L}(t^*, r^*)}{\partial r_1} = 0$. As such, the inefficiency induced by banks adopting sub-optimal liquidity raising strategy in the decentralized economy is completely eliminated.

In this case where the ex-post liquidity shock is systemic (i.e., $k = N$), only this second inefficiency will be relevant for private safe asset creation. Therefore, the equilibrium of safe asset creation achieved in the decentralized economy will be efficient if the retail market is completely segmented; i.e., $\tau = 0$. ■

A6. Implementability: Proofs of Lemma 4 and Proposition 4

In Section A6, we provide detailed calculations for our analysis of the equilibrium implementability.

Lemma 4 *A safe asset creation equilibrium $\{\alpha_E\}$ is automatically implementable if and only if*

$$\frac{\partial S_D(\alpha; \alpha_E)}{\partial \alpha} \Big|_{\alpha \rightarrow \alpha_E^+} \leq 0$$

That is, with all others choosing α_E at date 0, each individual bank can commit to choosing α_E in its ex-ante loan making.

Proof By definition, the symmetric equilibrium α_E of private safe asset creation must satisfy $S(\alpha_E) = 0$. In other words, if all banks choose α_E on date 0, then following the game played on date 1 after the liquidity shocks hit, banks receiving the liquidity shocks can just stay solvent.

On date 0, with all other banks choosing α_E , an individual bank i will not have incentive to make downward deviations; i.e., choosing any level of α that is below α_E . This is because

doing so would result in strictly lowered date-2 profits.

On the other hand, an individual bank may have incentives to make upward deviations. This is because if it can still guarantee its safety under liquidity shocks on date 1 after making such upward deviations on date 0, strictly increased profits can be earned on date 2.

Therefore, a safe asset creation equilibrium $\{\alpha_E\}$ can be implemented in the decentralized economy if and only if the following is true: given all other banks choosing α_E on date 0, an individual bank would become insolvent under liquidity shocks on date 1 if it makes any arbitrary upward deviation $\alpha_E + \epsilon$. As such, this is equivalent to the following condition

$$\frac{\partial S_D(\alpha; \alpha_E)}{\partial \alpha} \Big|_{\alpha \rightarrow \alpha_E^+} \leq 0$$

That is, at equilibrium α_E , any upward deviation made on date 0 would render the bank's solvency function $S_D(\alpha; \alpha_E)$ liquidity shocks on date 1 negative. ■

Proposition 4 *For each (N, k) , there exists a threshold τ_{AI} in retail market competitiveness τ , such that the symmetric safe asset creation equilibrium $\{\alpha_E\}$ that satisfies $S(\alpha_E; \tau) = 0$ is automatically implementable if and only if $\tau \leq \tau_{AI}$.*

Proof We prove this result for the case where $k = N = \infty$. The argument for general cases follows similarly. Let us construct the solvency function after deviation $S_D(\alpha; \alpha_E, \tau)$ first.

Given all other banks choosing α_E on date 0, for an individual bank that makes a deviation to choose any arbitrarily higher α , it solves the following problem on date 1:

$$S_D(\alpha; \alpha_E, \tau) = \max_{t, r} R(\alpha - t) - r \cdot s(r; \cdot)$$

subject to the feasibility constraint

$$g(t, \alpha) + s(r; \cdot) = \alpha$$

After making such a deviation in its date-0 loan making, the retail liquidity supply function

$s(r; \cdot)$ for this bank is

$$s(r; \cdot) = d(r; \alpha) + d(r; \alpha_E) \cdot 2\tau \cdot F(r; \alpha_E)$$

where function $F(r; \alpha_E) \equiv V_H(r; \alpha_E) - V_H(r_E; \alpha_E)$ satisfies $F(r_E; \alpha_E) = 0$ and $F'(r_E; \alpha_E) > 0$. Here r_E is the rate each bank will be posting on date 1 in (old) equilibrium. In this case where $k = N = \infty$, after one bank makes a deviation in choosing α on date 0, the rate posted by other banks in the new equilibrium on date 1 would still be r_E .

Let us now form the Lagrangian

$$\mathcal{L}(\alpha; \alpha_E, \tau) = R(\alpha - t) - r \cdot s(r; \cdot) + \lambda \cdot [g(t, \alpha) + s(r; \cdot) - \alpha]$$

Following the same procedure as in our analysis of Proposition 4, we can show that at the optimal solution, the following must hold

$$\lambda^* = r^* + \frac{s(r^*; \cdot)}{s'(r^*; \cdot)}$$

To study how the solvency on date 1 changes after an individual bank makes a arbitrarily small rightward deviation, let us examine the local property of function $S_D(\alpha; \alpha_E, \tau)$ at point $\alpha = \alpha_E$. Specifically, take the right derivative and by the envelope theorem we have

$$\frac{\partial S_D(\alpha; \alpha_E, \tau)}{\partial \alpha} = \frac{\partial \mathcal{L}(\alpha; \alpha_E, \tau)}{\partial \alpha}$$

and furthermore,

$$\frac{\partial \mathcal{L}(\alpha; \alpha_E, \tau)}{\partial \alpha} = R - r^* \cdot \frac{\partial d(r^*; \alpha)}{\partial \alpha} + \lambda^* \cdot \left[\frac{\partial g(t^*, \alpha)}{\partial \alpha} + \frac{\partial d(r^*; \alpha)}{\partial \alpha} - 1 \right]$$

in which we use the fact that $\frac{\partial s(r; \cdot)}{\partial \alpha} = \frac{\partial d(r; \alpha)}{\partial \alpha}$.

Based on Lemma 1, we can show that $\frac{\partial d(r; \alpha)}{\partial \alpha} = w$. We can thus further simplify the

above equation to

$$\frac{\partial \mathcal{L}(\alpha; \alpha_E, \tau)}{\partial \alpha} = R - w \cdot r^* + \lambda^* \cdot \left[\frac{\partial g(t^*, \alpha)}{\partial \alpha} + w - 1 \right]$$

Evaluating the above partial derivative at $\alpha \rightarrow \alpha_E^+$, we have

$$\begin{aligned} \frac{\partial S_D(\alpha; \alpha_E, \tau)}{\partial \alpha} \Big|_{\alpha \rightarrow \alpha_E^+} &= R - w \cdot r_E + \lambda^* \cdot \left[\frac{\partial g(t_E, \alpha_E)}{\partial \alpha_E} + w - 1 \right] \\ &= R - w \cdot r_E + \left(r_E + \frac{s(r_E; \cdot)}{s'(r_E; \cdot)} \right) \cdot \left[\frac{\partial g(t_E, \alpha_E)}{\partial \alpha_E} + w - 1 \right] \end{aligned}$$

where we make use the fact that when $\alpha \rightarrow \alpha_E$, the optimal liquidity raising strategy (t^*, r^*) that the deviating bank will adopt on date 1 converges to (t_E, r_E) .

Similar to our analysis for Proposition 4, we can show that

$$\frac{s(r_E; \cdot)}{s'(r_E; \cdot)} = \frac{d(r_E; \alpha_E)}{d'(r_E; \alpha_E) + d(r_E; \alpha_E) \cdot 2\tau \cdot \frac{\partial F(r_E; \alpha_E)}{\partial r}}$$

Therefore, as long as $\frac{\partial g(t^*, \alpha)}{\partial \alpha} + w - 1 < 0$, which can be guaranteed by regulatory conditions on model parameters, $\frac{\partial S_D(\alpha; \alpha_E, \tau)}{\partial \alpha} \Big|_{\alpha \rightarrow \alpha_E^+}$ will be increasing in the retail market competitiveness τ for any given level of α_E . This monotonicity of the local deviation at equilibrium level of loan making $\frac{\partial S_D(\alpha; \alpha_E, \tau)}{\partial \alpha} \Big|_{\alpha \rightarrow \alpha_E^+}$ regarding retail market competitiveness implies that there would be a threshold τ_{AI} that governs whether or not the ex-ante loan making α_E satisfying $S(\alpha_E)$ can be implemented in the decentralized economy.

It would be interesting to examine the two extreme cases. When the retail liquidity market is perfectly competitive, i.e., $\tau = \infty$, we have $\frac{s(r_E; \cdot)}{s'(r_E; \cdot)} = 0$. Therefore in this case

$$\begin{aligned} \frac{\partial S_D(\alpha; \alpha_E, \tau)}{\partial \alpha} \Big|_{\alpha \rightarrow \alpha_E^+} &= R - w \cdot r_E + r_E \cdot \left[\frac{\partial g(t_E, \alpha_E)}{\partial \alpha_E} + w - 1 \right] \\ &= R - r_E \cdot \left[1 - \frac{\partial g(t_E, \alpha_E)}{\partial \alpha_E} \right] \end{aligned}$$

Therefore, whenever in the date-1 equilibrium $R > r_E \cdot \left[1 - \frac{\partial g(t_E, \alpha_E)}{\partial \alpha_E} \right]$, which can be

guaranteed by certain conditions on model parameters, the safe asset creation equilibrium associated with perfectly competitive retail market cannot be automatically implemented in the decentralized economy.

On the other hand, when the retail market is completely segmented, i.e., $\tau = 0$, we have $\frac{s(r_E; \cdot)}{s'(r_E; \cdot)} = \frac{d(r_E; \alpha_E)}{d'(r_E; \alpha_E)}$. Applying the envelope theorem to the planner's allocation problem on date 1 as in Section A3, it's easy to see that the individual deviation $\left. \frac{\partial S_D(\alpha; \alpha_E, \tau)}{\partial \alpha} \right|_{\alpha \rightarrow \alpha_E^+}$ when $\tau = 0$ is perfectly aligned with the local deviation in planner's problem $\left. \frac{\partial \mathcal{L}^P(\alpha)}{\partial \alpha} \right|_{\alpha \rightarrow \alpha_P^+}$. As such, completely segmented retail market $\tau = 0$ guarantees that ex-ante loan making α_E satisfying $S(\alpha_E)$ can be fully committed in the decentralized economy. ■

A7. Mixed Effect of Competitiveness τ : Proofs of Proposition 5 and 6

In Section A7, we provide detailed calculations for our analysis of how the banking market competitiveness τ affects the efficiency of private safe asset creation in the decentralized economy.

Proposition 5 *The laissez-faire equilibrium outcome of private safe asset creation associated with level-1 liquidity shocks $\alpha_E(\tau)$ is an increasing function in banking competitiveness τ .*

Proof We prove this result for the case $k = 1, N = 2$. The argument for general cases follows similarly. WOLOG, suppose bank 1 is hit by the liquidity shock while bank 2 is not. For any level of α both banks choose on date 0, in the equilibrium on date 1, the interbank trading deal $(q_{1,2}, r_{1,2})$ is determined as

$$\left(q_{1,2}^*, r_{1,2}^* \right) = \arg \max_{(q_{1,2}, r_{1,2})} \left[V_1(q_{1,2}, r_{1,2}; \alpha, \tau) - V_1^R(\alpha, \tau) \right]^\beta \cdot \left[V_2(q_{1,2}, r_{1,2}; \alpha, \tau) - V_2^R(\alpha, \tau) \right]$$

Functions $V_i(q_{1,2}, r_{1,2}; \alpha, \tau)$ and $V_i^R(\alpha, \tau)$ are formulated as in our analysis in Section A2. The retail market competitiveness τ affects the elasticity of the retail liquidity supply, through which it affects the valuation functions in bargaining. Importantly, for any given α , we can show the following properties of functions $V_i(q_{1,2}, r_{1,2}; \alpha, \tau)$ and $V_i^R(\alpha, \tau)$:

- 1) higher τ improves bank 1's reservation value, i.e., $\frac{\partial V_1^R(\alpha, \tau)}{\partial \tau} \geq 0$;

2) for any arbitrary $(q_{1,2}, r_{1,2})$ (in the equilibrium-relevant set), higher τ improves payoff for bank 1, i.e., $\frac{\partial V_1(q_{1,2}, r_{1,2}; \alpha, \tau)}{\partial \tau} > 0$;

In other words, increased retail market competitiveness τ improves bank 1's reservation value from its outside option when no deal could be made, as well as improves bank 1's valuation from any trading deal that may arise in equilibrium. Following the analysis in Thomson (1987) about monotonicity of bargaining solutions regarding disagreement point, these properties we established above implies that holding fixed the α chosen at date 0, increased τ improves the equilibrium payoff of bank 1. That is, for any $\tau > \tau'$, we have

$$V_1 \left(q_{1,2}^*(\tau), r_{1,2}^*(\tau); \alpha, \tau \right) \geq V_1 \left(q_{1,2}^*(\tau'), r_{1,2}^*(\tau'); \alpha, \tau' \right)$$

Finally, since in equilibrium banks' ex-ante choice of α must satisfy $V_1 \left(q_{1,2}^*(\tau), r_{1,2}^*(\tau); \alpha_E, \tau \right) = 0$, it follows that $\alpha_E(\tau)$ is increasing in τ . This is because holding τ fixed, $V_1 \left(q_{1,2}^*(\tau), r_{1,2}^*(\tau); \alpha, \tau \right)$ as a function of α is downward sloping at point $\alpha_E(\tau)$. The above inequality suggests that for any $\tau > \tau'$, function $V_1 \left(q_{1,2}^*(\tau), r_{1,2}^*(\tau); \alpha, \tau \right)$ is above function $V_1 \left(q_{1,2}^*(\tau'), r_{1,2}^*(\tau'); \alpha, \tau' \right)$. Therefore, the intercept of the former must locate to the right of the latter. ■

Proposition 6 *The laissez-faire equilibrium outcome of private safe asset creation associated with level- N liquidity shocks $\alpha_E(\tau)$ is a decreasing function in banking competitiveness τ .*

Proof We prove this result for the case $k = 2, N = 2$. The argument for general cases follows similarly.

Let us first hold fixed the choice of α made by both banks on date 0. On date 1, taking as given the rate r_E posted by the other bank, each bank chooses its liquidity raising strategy (t, r) to maximize the date-2 solvency

$$S(\alpha, \tau) \equiv \max_{(t,r)} R(\alpha - t) - r \cdot s(r; \alpha, r_E)$$

subject to liquidity coverage constraint

$$g(t, \alpha) + s(r; \alpha, r_E) = \alpha$$

Here the retail liquidity supply function each bank faces is

$$s(r; \alpha, r_E) = d(r; \alpha) [1 + 2\tau \cdot F(r; \alpha, r_E)]$$

where $F(r; \alpha, r_E) \equiv V_H(r; \alpha) - V_H(r_E; \alpha)$ satisfies $F(r_E; \alpha, r_E) = 0$ and $\frac{\partial F(r_E; \alpha, r_E)}{\partial r} > 0$.

Form the Lagrangian

$$\mathcal{L}(\alpha, \tau) = R(\alpha - t) - r \cdot s(r; \cdot) + \lambda [g(t, \alpha) + s(r; \cdot) - \alpha]$$

Then we have

$$\lambda^* = r^* + \frac{s(r^*; \cdot)}{s'(r^*; \cdot)}$$

where

$$\frac{s(r; \cdot)}{s'(r; \cdot)} = \frac{d(r; \alpha)}{d'(r; \alpha) + d(r; \alpha) \cdot 2\tau \cdot \frac{\partial F(r; \alpha, r_E)}{\partial r}}$$

Apply the envelope theorem, we have

$$\frac{\partial \mathcal{L}(\alpha, \tau)}{\partial \tau} = -r^* \cdot \frac{\partial s(r^*; \cdot)}{\partial \tau} + \frac{\partial}{\partial \tau} \left[\left(r^* + \frac{s(r^*; \alpha)}{s'(r^*; \alpha)} \right) \cdot s(r^*; \cdot) \right]$$

In the above equation, we have

$$\frac{\partial s(r^*; \cdot)}{\partial \tau} = 2d(r^*; \alpha) \cdot F(r^*; \alpha, r_E)$$

But since in equilibrium $r^* = r_E$, thus we have

$$\frac{\partial s(r^*; \cdot)}{\partial \tau} = 0$$

where we use the fact that $F(r_E; \alpha, r_E) = 0$. Based on this result, we can simplify the above

equation as follows:

$$\begin{aligned}\frac{\partial \mathcal{L}(\alpha, \tau)}{\partial \tau} &= s(r^*; \alpha, r_E) \cdot \frac{\partial}{\partial \tau} \left(r^* + \frac{s(r^*; \alpha)}{s'(r^*; \alpha)} \right) \\ &= s(r^*; \alpha, r_E) \cdot \frac{\partial}{\partial \tau} \left(\frac{d(r^*; \alpha)}{d'(r^*; \alpha) + d(r^*; \alpha) \cdot 2\tau \cdot \frac{\partial F(r^*; \alpha, r_E)}{\partial r}} \right)\end{aligned}$$

Furthermore, we have

$$\begin{aligned}\frac{\partial}{\partial \tau} \left(\frac{d}{d' + d \cdot 2\tau \cdot \frac{\partial F(r^*; \alpha, r_E)}{\partial r}} \right) &= \frac{-d^2 \cdot \frac{\partial F(r_E; \alpha, r_E)}{\partial r}}{\left(d' + d \cdot 2\tau \cdot \frac{\partial F(r^*; \alpha, r_E)}{\partial r} \right)^2} \\ &< 0\end{aligned}$$

where we use the fact that $\frac{\partial F(r_E; \alpha, r_E)}{\partial r} > 0$. As such, we prove the following important result: for any fixed α chosen on date 0,

$$\frac{\partial S(\alpha, \tau)}{\partial \tau} < 0$$

Based on this result, it immediately follows that the private safe asset creation equilibrium $\alpha_E(\tau)$ in the decentralized economy is decreasing in the retail market competitiveness τ .

B. Model Extensions and Alternative Specifications

B1. Relaxing Assumptions on Wholesale Liquidity Trading

In our model, to focus on the ex-ante creation and the associated under-production problem of the commonly shared liquidity pool in the economy, we make a simplifying assumption that each bank i 's date-0 liquid asset hoarding $1 - \alpha_i$ can only be used to cover its own liquidity needs on date 1. In other words, the ex-post wholesale liquidity trading on date 1 does not involve these liquid cash banks hoarded on date 0.

In this section, we show that this simplifying assumption on ex-post interbank trading is innocuous to our analysis of the efficiency of private safe asset creation. Specifically, we

relax this assumption by allowing banks' ex-ante liquid cash hoarding to be traded in ex-post wholesale market and show that the main results of the paper still hold (or even get strengthened). Let us first start with the planner's problem.

The Planner's Problem

In the planner's optimal allocation for safe asset creation in the economy, because more liquidity resources can be deployed on date 1, it's natural to expect that more ex-ante loan making on date 0 could be supported. Specifically, for any loan-making profile $\{\alpha_n\}$ chosen on date 0, after a liquidity shock ω hits on date 1, the planner solves the following problem

$$L(\{\alpha_n\}, \omega) \equiv \max_{\{t_i\}_{i \in \omega}, \{r_n\}} \sum_{i \in \omega} g(t_i, \alpha_i) + \sum_{n=1}^N d(r_n; \alpha_n) + \sum_{j \in \omega^c} (1 - \alpha_j)$$

subject to the feasibility constraint:

$$\sum_{i \in \omega} R \cdot (\alpha_i - t_i) \geq \sum_{n=1}^N r_n \cdot d(r_n; \alpha_n) + \sum_{j \in \omega^c} 1 \cdot (1 - \alpha_j)$$

In solving this date-1 liquidity raising problem, the planner can optimally choose the liquidation profile $\{t_i\}_{i \in \omega}$ of banks in ω and the the profile of retail liquidity rates $\{r_n\}$ posted by all banks in the economy. Furthermore, the liquid cash holding by each bank $j \in \omega^c$ can also be deployed to cover the liquidity shortage of banks in ω . On date 2, these liquid cash lent on date 1 needs to be paid back at the price according to the outside option of bank $j \in \omega^c$, which is 1.

The characterization of the planner's optimal allocation in liquidity raising on date 1 proceeds exactly the same as in our analysis in Proposition 1. Specifically, we can show that the optimal safe asset creation α_P in the planner's allocation is determined by

$$k \cdot g(t^*, \alpha_P) + N \cdot d(r^*; \alpha^P) = N \cdot \alpha^P - (N - k)$$

where the optimal liquidity raising strategy (t^*, r^*) is determined by

$$\begin{aligned} \frac{d(r^*; \alpha^P)}{d'(r^*; \alpha^P)} + r^* &= R / \frac{\partial g(t^*, \alpha^P)}{\partial t} \\ k \cdot R(\alpha^P - t^*) &= N \cdot r^* \cdot d(r^*; \alpha^P) + (N - k) \cdot (1 - \alpha_P) \end{aligned}$$

Safe Asset Creation in the Decentralized Economy

When the economy is decentralized, the liquid cash held by banks not by liquidity shocks on date 1 would in general not be at the price that reflects lending banks' outside option. This is because when borrowing banks' reservation value from their outside options is low, lending banks will be able to charge a positive mark-up in the trading price of the liquid cash they lend.

As such, by serving as the outside option for borrowing banks in their bargaining with liquidity-surplus banks on date 1, the pool of liquidity that is commonly shared in the economy becomes even more importantly. This is because the existence of such common liquidity pool in the economy improves borrowing banks' bargaining position and thus allows them to purchase the privately owned liquidity (the date-0 cash holding) from liquidity-surplus banks at more fair prices.

We elaborate the argument above by analyzing a special case in which $k = 1, N = 2$. WOLOG, assume that bank 1 is hit by the liquidity shock on date 1 while bank 2 is not. Suppose both banks choose α on date 0. Then after a liquidity shock hits bank 1 on date 1, the trading deal $(q_{1,2}^*, r_{1,2}^*)$ it establishes with bank 2 is determined as the bargaining solution that solves

$$(q_{1,2}^*, r_{1,2}^*) = \arg \max_{(q_{1,2}, r_{1,2})} \left[V_1(q_{1,2}, r_{1,2}; \alpha, \tau) - V_1^R(\alpha, \tau) \right]^\beta \cdot \left[V_2(q_{1,2}, r_{1,2}; \alpha, \tau) - V_2^R(\alpha, \tau) \right]$$

Now being able to lend out its liquid cash holding, bank 2's valuation from an arbitrary

trading deal $(q_{1,2}, r_{1,2})$ (such that $q_{1,2} > 1 - \alpha$) is

$$V_2(q_{1,2}, r_{1,2}; \alpha, \tau) = q_{1,2} \cdot r_{1,2} - (1 - \alpha) - r_2 \cdot [q_{1,2} - (1 - \alpha)]$$

where the rate r_2 it posts satisfies $s(r_2; \cdot) = q_{1,2} - (1 - \alpha)$.

The wholesale liquidity bank 2 delivers to bank 1, the total volume of which is $q_{1,2}$, consists of two parts. The first part is bank 2's own liquid cash holding, $1 - \alpha$. The marginal cost of lending out this part of liquidity is the return of these liquid cash to bank 2, which is unity. The second part of the wholesale liquidity is the same as in our original model, which are raised by bank 2 from the retail market by posting a rate r_2 . The marginal cost of this part of wholesale liquidity, the quantity of which is $q_{1,2} - (1 - \alpha)$, is the rate r_2 that bank 2 needs to post in the retail market in order to raise this quantity of liquidity.

When the retail market competitiveness τ is low, bank 1's reservation from its outside option, which is to reach out to the retail market when no deals could be made with bank 2, would be low due to the inelastic retail liquidity supply. This weakened outside option allows bank 2 to extract rents from the bargaining and thus drives up the wholesale liquidity price $r_{1,2}$ above the marginal costs of its two components.

Accordingly, more competitive retail liquidity market (higher τ) improves borrowing banks' outside option and thus reduces the mark-ups in wholesale liquidity price. With the privately owned liquidity (date-0 cash holding) being able to be traded in the wholesale market, this improvement in the borrowing banks' outside option becomes even more valuable. This is so because a competitive retail liquidity market not only brings down the mark-up in the wholesale liquidity that raised from the retail market, it also brings down the mark-up lending banks charged on their privately owned liquidity.

In this sense, when banks' privately owned liquidity can also be traded in the wholesale market, the under-production problem becomes even more acute. This is because a natural hold-up problem exists on banks' privately owned liquidity and the alleviation of such natural hold-up relies crucially on the creation of a commonly shared liquidity pool in the economy.

As such, it becomes even more important to ensure that sufficient incentives can be provided for the creation of such common liquidity pool in the economy.

CHAPTER 2

BANK LIQUIDITY PRICE AND BANKING MARKET COMPETITION

2.1. Introduction

Two salient features of banking sector in an economy is its heavy reliance on short-term funding as the provider of liquidity insurance (Diamond and Dybvig (1983b), Diamond and Rajan (2001b)) and the existence of imperfect competition in the banking markets (Acharya et al. (2012), Drechsler et al. (2016)). Many works have been done and has shown that deterioration in banks' short-term liquidity condition can generate profound negative impact on the real economy by forcing banks to cut down their credit supply, as well as imperfect competition exists in both wholesale and retail market of bank short-term funding. However, little is known about how perfect/imperfect competition in banking markets can affect real economic outcomes through its impact on the determination of banks' short-term funding cost. This paper sets the goal to empirically answer this question.

Exploiting the exogenous variation in banking market competition resulting from the US banking deregulation in 80s and early 90s, this paper documents two novel facts about the real outcome implications of banking market competition.¹ First, while banks' loan making in general tend to be less local than deposit taking, variations in banking market competition can significantly affect the degree of this geographic mismatch between banks activities on two sides of their balance sheets. Second, examination of the lending dynamics of banks hit by the 1986 oil price shock reveals a mixed effect of banking market competition on economy's resilience to unexpected shocks. These real effects of banking market competition are shown to be generated through its impact on how supply/demand shocks on bank short-term funding are transmitted to banks' short-term (retail/wholesale) liquidity prices. Let us now elaborate.

1. The banking market deregulation during this episode and considered in this paper is the deregulation of bank funding markets. More details of the banking deregulation are discussed in Section 2.

The largest chunk of banks' liability are deposits, which are liquid and often redeemable on demand. As shown in Figure 2.1, over 80% of U.S. banks' liabilities are in the form of bank deposits. Such a heavy reliance on liquid deposit financing implies a natural sensitivity to variations in short-term liquidity conditions for the banking sector. Our analysis starts from the following simple fact— banks are concerned of their short-term liquidity raising cost, thus banking market competition can affect banks' behavior through its impact on the determination of short-term liquidity prices.

The first novel fact we document, that the geographic mismatch between banking activities is acutely influenced by banking market competition, hinges on how a particular form of supply-side shock transmits into short-term liquidity prices. The credit extend by banks to their borrowers will circulate in the economic system, in which process it creates fresh supply of deposits to the banking sector.² Through exploiting the intrastate deregulation of three states that happened in early 90s and detailed loan-level observation from SBA small business loan dataset, we empirically document a quantitatively significant “deposit creation” effect of bank loans.³ As such, an increase in credit flow to an area generates a positive shock to the supply of short-term liquidity for banks located in this area.

While a positive supply shock on banks' short-term liquidity generally implies a lowered price at which banks can raise liquidity, the exact transmission and the reduction in liquidity price hinge on the competition in banking markets. In a highly competitive environment, an increased supply of short-term liquidity in a local area is likely to translate little into the reduction in liquidity price for local banks. This is because a competitive banking market allows banks from nearby areas to come in and bid for liquidity once the price of short-term liquidity in a local area becomes low. Symmetrically, under the competitive market setting, banks are able to capture (at least) some benefits of lowered liquidity price from credit

2. This idea of “loans create deposits” can be related to a canonical view of bank money creation that loans will immediately create a matching deposits. The stand we take in this paper is that loans will create deposits, but in an indirect way through enlarging the supply of short-term funding for the banking sector.

3. These three states are Iowa, Arkansas and Minnesota, which deregulate their bank funding markets in 1994, 1994 and 1993. We focus on these three states because the SBA small business loan dataset starts from 1990.

flowing to nearby areas.

Empirically, we show that before the intrastate deregulation, a 10% expansion in the credit received by adjacent area businesses is only associated with a 0.2% decrease in a bank's average wholesale funding costs, while the number becomes 3.75% after the deregulation. Relatedly, a 10% expansion in credit inflow from outside the region to local businesses was associated with 2.5% decrease in local banks' wholesale funding costs before the intrastate deregulation, but predict no significant changes in local banks' wholesale funding cost after the deregulation. The same patterns are also consistently observed for changes in retail liquidity prices.

These results on how banking market competition may affect the transmission of such a positive supply shock on bank short-term funding to bank liquidity price have some natural implications on banks' real activities. In particular, the geographic scope of banks' activities on both sides of their balance sheets is likely to be distorted by the liquidity price transmission outcomes. Under a segmented banking market, by making loans to firms in the same local area, banks are able to reap the benefit of the "deposit creation" effect of loans and enjoy a lowered prices of short-term liquidity subsequently. However, for loans extended to businesses outside the local area, the loan-making banks are unlikely to be able to gain much from the enlarged supply of short-term liquidity created by these loans. Therefore, when banking markets are segmented such that banks' ability to raise deposits from outside areas is limited, banks tend to concentrate in their local area in making loans.

Empirically, we show that banks in these three states (Iowa, Arkansas, and Minnesota) that deregulate the banking sector in early 90s significantly widen their average geographic lending distance immediately after the intrastate deregulation. For instance, before deregulation only an average of around 10% of Iowa banks' small business lending portfolio was allocated to distant borrowers outside of their network structure; after the intrastate deregulation initiated in 1994, the average distant portfolio started to rise significantly, by the time of 1997, Iowa banks allocated around 20% of their small business loans to distant borrowers

outside of their branching networks.⁴ We also run a couple of placebo tests showing that this enlarged geographic mismatch between banking activities accompanying banking market deregulation is more pronounced for banks with higher sensitivity to short-term liquidity prices and for loans made to labor intensive industries.

The second novel fact this paper documents, that banking market competition has a mixed effect on economic stability, is related to the role played by banking market competition in the transmission of demand-side shocks to short-term liquidity prices. Such demand-side shocks could be driven by a sudden increase in the withdrawal of deposits, an increased draw down in the credit commitment by borrowing firms, or an increased rate of delay or default in the loan payment. In this paper, we consider the following specific scenario under which banking sector experiences a spike in its demand for short-term funding. The 1986 oil price bust unexpectedly hit the U.S. oil industry as well as the banking sector that makes loans to it. Upon the shock hit, firms in oil industry suffer a sudden decrease in their profits and cash flow. Many of these firms thus have to delay or even default on their loan payments. The resulting spikes in the short-term overdue ratio for banks that made loans to these oil firms effectively implies an enlarged demand for short-term liquidity for these banks— to meet their obligations on the liability side.

An increased demand for short-term liquidity from the banking sector generally implies a higher price of liquidity, but exact transmission to liquidity prices would depend on how competitive the banking markets are, as well as the relative scale of the shock. Depending on the geographic distribution of oil-related businesses, the scale of the demand shock on short-term bank liquidity induced by the oil price bust can vary substantially across regions. For areas where oil-related businesses are concentrated, the fraction of banks experiencing increased demand for short-term liquidity is likely to be high in these areas. For other areas with fewer oil firms operating inside, the fraction of troubled banks is likely to be low.

Let's consider first an area that is lightly hit by the shock, in which only a small fraction

4. The borrower being outside the branching networks of the loan-making bank means that there is no branch of the loan-making bank located in the same county in which the borrower is located in. See detailed discussion in Section 3.2.

of the local banks are in need of increased amount of short-term liquidity. In such an area for banks hit by the demand shock on short-term liquidity, the wholesale liquidity from the inter-bank market is likely to be a non-trivial source of liquidity to accommodate their increased demand for short-term funding. When banking markets are competitive, the wholesale liquidity traded in the inter-bank market can be purchased at a price close to the marginal cost. This is because competitive banking markets can effectively improve the threat points for liquidity-needy banks in their bargaining with banks surplus in liquidity. On the contrary, when banking markets are segmented, banks facing liquidity stress can be severely extracted in their inter-bank trading due to their limited outside option and end up incurring a substantially higher wholesale funding cost. Empirically, we estimate an reduction of 64 basis points in wholesale liquidity rate increase for shocked banks in lightly hit areas, if they are in states that have deregulated the banking sector.

For heavily hit areas, the story is totally different. In these areas the retail prices of short-term bank liquidity are what more attention should be paid to as the wholesale liquidity market becomes silent once an aggregate liquidity shortage kicks in. Competitive banking market now becomes undesirable - it allows banks to easily steal retail liquidity in other areas by simply offering a slightly more attractive rate than that offered by local banks in these areas. As a consequence, the price of short-term liquidity in the retail market gets bid up, to a point where no banks have incentive to steal liquidity from others' local areas. In this way, the whole system could be trapped in a high interest rate equilibrium, in which all banks are forced to pay an inefficiently high price for short-term liquidity. Empirically, we estimate an extra 213 basis points increase in retail liquidity raising cost for shocked banks in heavily hit areas, if they are in states that have deregulated the banking sector.

These patterns on how an increased demand for liquidity from the banking sector transmits to the prices of short-term liquidity implies a mixed effect of banking market competition on the economy's resilience to negative shocks. To test this prediction, we conduct a diff-in-diff analysis on the lending dynamics of banks hit by the 1986 oil price shock. Our findings show that for lightly hit areas where the shock is relatively idiosyncratic, a more competitive

banking market can increase the economy's resilience to the shock and maintain a relatively stable level of corporate lending from the banking sector. On the contrary, for heavily hit areas where the shock is systemic, a more segmented banking market can increase the economy's resilience to the shock and maintain a relatively stable level of corporate lending from the banking sector.

Related Literature The first strand of literature this paper is closely related with is an extensive literature on banks' heavy reliance on short-term funding, in performing their role as the liquidity provider in the economy. Diamond and Dybvig (1983b) and Diamond and Rajan (2001b) recognize the benefits and necessity for banks to finance themselves with short-term debt, as well as point out the potential risks associated with doing so. Kashyap et al. (2002) made the argument that commercial banks' deposit-taking and loan-making are actually unified by a more primitive function of banks that differentiate banks from other savings institutions, which is the provision of liquidity on demands. Importantly, they argue that loan-making and deposit-taking generate synergies within a bank so long as the liquidity shocks on depositors and firms are not perfectly correlated. Their findings provide evidences suggesting short-term liquidity concerns can affect banks' activities on their asset side. Gatev and Strahan (2006) provides supporting evidence for this view through examining the funding inflow conditions when there is market-wide liquidity dry-up in the CP market. Acharya and Mora (2015) provides evidence that systemic shocks to banks' liquidity and deposit funding negatively impair banks' role as liquidity providers in an economy and thus dampen loan making.

The second strand of literature this paper is closely related with is a large body of research studying how banking deregulation or in general banking market competition affect real economic outcomes. The most representative set of works include Drechsler et al. (2016), Rice and Strahan (2010), Black and Strahan (2002), Jayaratne and Strahan (1996), Huang (2015), Chava et al. (2013), Karceski et al. (2005), Cetorelli and Gambera (2001), Cetorelli and Strahan (2006), Berger et al. (1998). The contribution of our paper to this strand of literature is that our paper provides a novel angle through which changes in bank funding

market competition could affect real outcome— through its impact on determination of short-term liquidity prices.

The third strand of literature the paper relates to is the work investigating dynamics of bank lending distances and the factors affecting the lending distances. Recent representative works include Granja et al. (2019), Nguyen (2019), Presbitero et al. (2014), Degryse and Ongena (2005), Beck et al. (2010), etc. Our paper is the first to document the fact that increases in banking market competition will induce banks to lend to distant borrowers and enlarging the geographic mismatches their activities on the two sides of balance sheets.

Our paper is also related to works studying how banks' short-term liquidity raising cost spikes affect real economic outcomes, primarily through impacting their lending behavior. This strand of works include Correa et al. (2016), Khwaja and Mian (2008a), Schnabl (2012).

The rest of the paper is organized as follows. In Section 2.2, we introduce the institutional background and the natural experiment setting for this empirical study. Section 2.3 describe the data source and measurement construction for key variables in our empirical analysis. Section 2.4 lays out the framework for our empirical tests, from which hypotheses to be test are drawn. Section 2.5 investigates how banking market competition can affect the transmission of a particular supply-side shock to the short-term liquidity prices, as well as its implication on the geographic scope of banking activities. Section 2.6 examines the role played by banking market competition in the transmission of demand-side shocks to the short-term liquidity prices, and what it implies for the relation between banking market competition and economic stability. Section 2.7 concludes.

2.2. Institutional Background and Natural Experimental Setting

2.2.1. Institutional Background

In order to causally investigate how changes in banking market structure affect the determination of banks' short-term liquidity price determination through supply and demand side factors, it is important that we could have an experimental setting where we are able

to compare whether the same (group) of banks' short-term liquidity price determination has ever changed when the local banking market structure changed. Static cross-sectional correlations between short-term liquidity price determination and measures of local banking market structure are limited in explaining power due to the presence of reverse causality issues.

The major historical episodes for which we conduct empirical analysis on is the U.S. banking sector deregulation that spanned from late 1970s to the middle of 1990s following the pass of Depository Institutions Deregulation and Monetary Control Act by Congress. One of the major chapters of this phenomenal wave of banking deregulation was the intrastate deregulation, under which restrictions on banks' branching operations within the state was lifted⁵.

In 1970s, legislatures of most states in the U.S. restricted intrastate bank expansions (Gatev and Strahan (2006)). Starting from late 1970s, states started to lift the within-state restrictions on local banks' branch openings⁶.

There are two important features of intrastate-deregulation that makes it an ideal laboratory for studying our research question. The first is the nature of intrastate deregulation transformed local banks' retail deposit market segmentation. The most important steps of intrastate banking deregulation was to allow banks to expand their branches within states through mergers and acquisitions. This act permitted banks to convert offices of subsidiary banks (existing or acquired) into branches of a *single* bank. Before the implementation of this act, deposit markets were fairly segmented. They were only allowed to take deposits within one piece of geographical region. Even if a bank could have several branches across

5. There are two main chapters of banking deregulation during this episode, the first is the intrastate deregulation, which is featured with removals of within-state branching restrictions; while the second is the interstate banking deregulation, which is featured with allowance of cross-state branch acquisition under reciprocal agreement. For the purpose of our paper, intrastate deregulation, the intrastate deregulation is the relevant deregulation instruments for the purpose of identifying increased competitiveness in local deposit market, since various previous research has demonstrated that the intra-state deregulation had more significant effect on local banking market structure (Amel and Liang (1992), Jayaratne and Strahan (1996)).

6. In 1970, only 12 states allowed unrestricted statewide branching. Between late 1970s and 1994, however, 38 states deregulated their restrictions on branching.

adjacent counties, a depositor of one branch in county A would not have access to her deposit through another branch of the same bank in county B.⁷ The second prominent features of the intrastate deregulation was a lasting process that occurred across states at different times throughout the early-1980s to mid-1990s episode in a piecemeal manner. For instance, Alabama launched the intrastate deregulation through vertical integration in 1981, while Arkansas didn't went through the intrastate deregulation until 1994. Since the goal of our paper is to explore how differences in local banking market competitiveness change the supply and demand side factor' impact on local banks' short-term liquidity price, the slow-moving chronicle feature of deregulation across states is crucial. As it gives us environment when a potential factor that will impact local banks' liquidity price took place, there are both states with more competitive banking sectors and those without.

2.2.2. *Experimental Set-up*

In this paper, we utilize two experimental settings under the background of intrastate banking sector deregulation. The first setting is a the post-1991 episode for three late intrastate deregulation states, for which we will utilize the combination of deregulation with local liquidity supply shock; the second setting is the 1986 oil-price shock episode, which could be interpreted as a negative liquidity demand side shock.

There were three states that went through intrastate banking deregulation after 1990. They are Arkansas in 1994, Iowa in 1994 and Minnesota in 1993. The starting year of SBA small business loan data is 1991. The overlap between the three late intrastate deregulation states and the availability of local small business lending database allows us to compare how does changes in banking sector competitiveness transform the impact of credit supply shock on local banks' short-term liquidity price determination *within* region pre-deregulation and post-deregulation.

7. The empirical verification of this increased deposit-market competition in the true sense is that the HHI in (state-level) local banking markets decreased though the country-level total banking market become more concentrated (Black and Strahan (2002)). Deregulation increased deposit market competition competition at the level of the local banking market.

On the credit demand side shocks, we are able to utilize the 1986 oil-price shock which caused sudden shrink in oil companies' revenues in the upcoming years, and thus unable to repay their credit lines on time. This shock from the credit demand side posed serious questions to banks who lent heavily to oil companies ex-ante. Importantly, the shock-affected banks are located in different states where some of them already finished intrastate banking deregulation while others not. Holding other factors unchanged, this gives us exogenous variation on local banking market competitiveness when they went through a liquidity shock from credit demand side. Moreover, depending on the ex-ante loan exposure to oil companies and local banks' geographic proximity to oil companies, some local regions are *systemically* affected by oil shocks, these are primarily oil states including Texas, Arkansas, Louisiana, Oklahoma and New Mexico; in other states, the oil price shock only idiosyncratically hit the local banks' liquidity conditions. Further, within the five systemically hit states, Texas, Louisiana and Oklahoma went through intrastate deregulation ⁸ when the oil price shock was still on-going. This gives us perfect opportunity to study how local banking sector competitiveness increase interact with systemic liquidity shock from credit supply side. The details of this episode is done in Section 2.6.

2.3. Data and Main Variable Construction

2.3.1. Local Small Business Loans

We get our data on local small business loans from Small Business Administration (SBA), which contains a list of all SBA-guaranteed loans under the 7(a) program from 1991 to 2010. It also contains loan-level information about the identity, address, city, and zip code of the borrowers and lenders as well as loan characteristics such as total amount, the amount of SBA's loan guarantee, initial interest rate, approval date, industry of the borrower, and loan status (performing/default). The dataset also includes information on the charge-off date

8. All of the three went through intrastate deregulation in 1988, while the oil-price plummet happened in the end of 1986, and continued all the way till 1989.

and on the amount charged-off by the SBA on its loan guarantee when the loan is charged-off by the bank. Following Brown and Earle (2017), we exclude cancelled loans from the analysis because the cancellation may be at the initiative of the borrower. For the SBA dataset, using the University of Chicago Geographic Information Service (GIS), we geocode the geographic coordinates of approximately 1 million borrowers and their lenders. We are unable to locate the geographic coordinates of approximately 0.6% of the SBA borrowers in the dataset and we discard those observations. We compute the distance between borrowers and lenders in the dataset as the geodetic distance between the reported addresses of borrowers and respective lenders in the SBA dataset.

2.3.2. *Local Bank Branch and Lending Distance*

An important component of our empirical analysis is the locations of banks branches in local geographic areas. We obtain information on geographic characteristics of all branches of commercial banks from the Summary of Deposits database (SOD) provided by FDIC. There are two parts of the database, the first part contains the relevant information starting from 1994, which is directly available for download from the FDIC's webpage;⁹ the second part the data before 1994, which is extracted from the digitized copies of the *Databook – Operating Banks and Branches* that's available from Hathitrust online library. This dataset contains information on the geographical coordinates (in particular the county where the bank branch is located in) and deposits of each branch of a given bank in the United States. We complement the SOD dataset by assigning latitudes and longitudes to each branch address whenever geographic coordinate data are missing. For each bank, we take out the counties where it has branches in, and get the information of the latitudes and longitudes of the geographic centroids that county.¹⁰ In this way, we are able to form the entire branching network structure of a given bank b (we denote this network as Ω_b). The SBA small business

9. <https://www.fdic.gov/regulations/resources/call/sod.html>

10. The longitude and latitude of county centroids are available here: https://en.wikipedia.org/wiki/User:Michael_J/County_table.

lending dataset contains information on the small businesses' and the corresponding lending bank's location at the zip-code level.¹¹ In this way, we are able to calculate the geodetic distance between the borrowing small business and the lending bank, based on the banks' branching network structure we obtained from the SOD dataset. Following Granja et al. (2019), we define $D_{b,i}$ the length of the shortest curve between bank b 's branching network and borrower firm i 's location.¹² Thus for each bank in a given year t and a given bank b with branching network Ω_b , we can calculate its weighted average lending distance to small businesses:

$$L_{b,t} = \sum_i \frac{l_{b,i,t}}{\sum_i l_{b,i,t}} D_{b,i,t}$$

Getting ready this distance variable prepares us for the analysis on the effect of local banking sector deregulation on the banks' lending distance changes for the three states that went through intra-state deregulation in the early 1990s. The three late deregulated states are AR, MN and IA. The summary statistics of the late deregulated states' small business lending characteristics and lending distances are provided in Table 2.1.

2.3.3. *Bank balance sheet data*

The bank balance sheet data is from U.S. Call Reports provided by the Federal Reserve Bank of Chicago. We use data from 1982 to 2000. The data contains quarterly data on the income statements and balance sheets of all U.S. commercial banks. Table 2.2 shows the summary statistics of banks' balance sheet items. Panel (A) shows the summary statistics of banks located in non-oil states, and Panel (B) shows the summary statistics of banks in the five oil states: TX, NM, LA, OK, and AR.¹³ In the summary statistics, we show the

11. The latitude and longitude of the all the U.S. zip-codes are provided here: <https://public.opendatasoft.com/explore/dataset/us-zip-code-latitude-and-longitude/table/>.

12. Mathematically, $D_{b,i} = \min_{br \in \Omega_b} \{d_{b(br),i}\}$

13. In our sample of oil-state banks, we have excluded those banks that failed or merged into other banks during the 1986 oil-price shocks. A bank is defined as failed or merged into others if it disappeared from the Call Report since 1986.

bank size in the natural log of banks' total assets in thousands of dollars, the decomposition of banks' loans, the banks' liability structure, and the banks' funding costs (wholesale and retail). As can be seen through comparing Panel (A) and Panel (B), all of the important summary statistics are very similar between the oil and non-oil state banks.

Another spectrum of our empirical analysis compares banks in the three-digit zip-code areas that were systemically hit by the oil-price shock and those that were idiosyncratically hit by the oil-price shock.

2.3.4. Measurement of banks' liquidity raising cost

As we are interested in investigating how local banking market structure affects local banks' short-term liquidity funding cost determination, it is crucial that we have good proxy of banks' short-term funding rate. We construct the implied retail and wholesale funding rate using information from Call Report following Acharya et al. (2012). In particular, we take the interest expenses on deposits and wholesale funding and then divided by the total stock of deposits and wholesale liabilities.

$$\begin{aligned} \text{Retail rate} &= \frac{\text{Interest expense on deposits}}{\text{Deposits}} \\ \text{Wholesale rate} &= \frac{\text{Interest expense on Fed funds purchased and securities sold under agreements to repurchase}}{\text{Fed funds purchased and securities sold under agreements to repurchase}} \end{aligned}$$

where "Interest expense on deposits" is RIAD4170, "Interest expense on Fed funds purchased and securities sold under agreements to repurchase" is RIAD4180, availability of both of these two sequences of variables start from the first quarter of 1983. "Deposits" is RCON2200, which is the total stock of domestic deposits; "Fed funds purchased and securities sold under agreements to repurchase" is RCFD3353, which is the quarterly average of wholesale liabilities.

Figure 2.2 shows the evolution of (weighted average) commercial banks' retail funding rate and wholesale funding rate over 1976-2013.

2.4. Framework of Empirical Tests

In this section, we lay out the framework of the empirical tests of the paper. The goal of the paper is to investigate how banking market competition generates real impact on banking activities, through affecting the determination of bank short-term funding prices. In organizing the empirical tests, we examine how the level of banking market competition affects the transmission of supply-side and demand-side shocks on bank short-term funding to bank liquidity prices respectively.

2.4.1. *Supply-side shocks and Implications*

Changes in the supply of bank short-term funding can affect the price of bank liquidity. In this part, we discuss how a particular form of liquidity supply shock transmits to the price of bank short-term liquidity, as well as the role played by banking market competition in this process. Based on these intuitions, we further discuss how the geographic mismatch in banking activities is likely to be affected by banking market competition.

A) *A supply-side shock: Loans create deposits*

Borrowers do not borrow to sit idle with the money. Instead, the credit received by a borrower—be it a firm or a household, will be circulating in the economy. Whoever receives this credit in the subsequent transactions triggered by the outlay of the initial borrower will have a demand to find a safe store to place this credit. Such a demand for safe store to place this credit effectively generates a fresh supply of short-term liquidity for the banking sector in this economy.

In this way, corporate loans extended to firms located in an area will generate an enlarged supply of short-term liquidity for banks residing in this area. Following this logic, a sudden increase in the credit flow to an area could be viewed as a positive supply shock on the short-term liquidity to banks in this area, which is likely to affect the price of liquidity for these banks.

B) *Transmission to liquidity prices and banking market competition*

A positive shock on the supply of bank short-term liquidity generally implies a reduced price at which banks can raise liquidity. However, the exact transmission and the reduction in liquidity price hinge on the competition in banking markets.

In a highly competitive environment, an increased supply of short-term liquidity in a local area is likely to translate little into reduction in liquidity price for local banks. This is because a competitive banking market allows banks from nearby areas to come in and bid for liquidity once the price of short-term liquidity in a local area becomes low. Symmetrically, under the competitive market setting, banks are able to capture some benefits of lowered liquidity price from credit flowing to nearby areas. These intuitions hold consistently for both short-term liquidity in both retail markets and wholesale markets.

As a comparison, in an environment of highly segmented banking market, the impact of increased credit flow on liquidity price for local banks is likely to be different. Following a sudden increase of credit flow received by firms in a local area, banks in this area are likely to be able to enjoy a significantly lowered price of short-term liquidity. This is because local banks are protected by the segmented banking market, which prohibits banks from nearby areas to come inside and hence allows local banks to reap most of the benefits from enlarged supply of short-term liquidity. Symmetrically, while segmented banking markets enables banks to better enjoy the lowered liquidity price after positive supply shock to their local areas, it also makes harder for banks to gain benefits from enlarged supply of short-term liquidity in nearby areas.

C) Implication: Geographic mismatch between banking activities

The above discussions on how banking market competition may affect the transmission of such a positive supply shock on bank short-term funding to bank liquidity price have some natural implications on banks' real activities. In particular, the geographic scope of banks' activities on both sides of their balance sheets is likely to be distorted by the liquidity price transmission outcomes.

Being the major provider of credit in the economy, banks' activities on their asset side play a critical role in generating real economic growth. As an important aspect of banks'

lending behavior, the geographic scope of bank lending has been examined by a large body of literature. While it has been well documented that banks' loan making are less geographically local than their deposit taking, how this geographic mismatch between banking activities is related to banking market competition has not been fully understood.

Our analysis about how banking market competition affects the liquidity price transmission of supply-side shock has a clear implication on the geographic mismatch between banking activities. That is, more competitive banking markets are likely to enlarge the geographic mismatch between banks' deposit taking and loan making. To be more precise, when banking markets become more competitive, banks are likely to increase their lending distances.

This prediction is easy to understand. Under a segmented banking market, by making loans to firms in the same local area, banks are able to reap the benefit of the "deposit creation" effect of loans and enjoy a lowered prices of short-term liquidity subsequently. However, for loans extended to firms outside the local area, the loan-making banks are unlikely to be able to gain the enlarged supply of short-term liquidity created by these loans. Therefore, when banking markets are segmented such that banks' ability to raise deposits from outside areas is limited, banks tend to concentrate in their local area in making loans. This pattern would be pronounced for banks care much about their short-term liquidity condition.

Conversely, with a highly competitive banking market, there would be little point for banks to focus on local lending for liquidity perspective. Loans made to local firms and hence fresh supply of short-term liquidity generated in the local areas are unlikely to translate much into lowered liquidity price for the loan-making banks. Despite the weak protection of locally generated supply of short-term liquidity, competitive banking markets allow banks to gain at least some benefits from loans extended to borrowers from outside areas. Therefore in such cases, banks are unlikely to focus on lending to local borrowers for liquidity considerations.

2.4.2. Demand-side shocks and Implications

The second part of the empirical analysis examines how demand-side shocks on banks' short-term funding transmit to real outcomes and the role played by banking market competition in the process. In particular, we study scenarios in which banks are faced with liquidity stress, featuring an increased demand for short-term liquidity from the banking sector.

A) A demand-side shock: The 1986 oil price bust

The 1986 oil price bust unexpectedly hit the U.S. oil industry as well as the banking sector that makes loans to it. Upon the shock hit, firms in oil industry experienced sudden decrease in their profits and cash flow. Many of these firms thus have to delay or even default on their loan payments. The resulting spikes in the short-term overdue ratio for banks that made loans to these oil firms effectively enlarged the demand for short-term liquidity for these banks— to meet their obligations on the liability side.

As such, the oil price bust which took place in early 1986 and last for more than one year effectively creates a demand-side shock on short-term funding to the U.S. banking sector. Depending on the area's risk loading on oil industry, for instance, the number of oil-related firms in the area, the shock is a systemic one for some areas while more of an idiosyncratic one for others. In what follows, it becomes clear that the scale of the shock is a key parameter in assessing the affect of banking market competition on economic stability.

B) Transmission to liquidity prices and banking market competition

While the distinction between retail and wholesale liquidity stays silent in the above analysis of supply-side shocks transmission, it makes a critical difference in our analysis of the demand-side shock.

For a lightly hit area where the shock is idiosyncratic, banks hit by the shock will actively engage in inter-bank trading to borrow wholesale liquidity from those surplus in liquidity. For these lightly hit areas, the functioning of the wholesale liquidity market and the pricing of wholesale liquidity are crucial determinants of the economy's resilience to the shock. As

a sharp comparison, for heavily hit areas where the shock is more systemic, the inter-bank market becomes less relevant as there is a system-wide shortage of liquidity in these areas. In such cases, conditions in the retail liquidity markets and the pricing of retail liquidity are more relevant determinants for the economy's resilience to the shock.

An increased demand for short-term liquidity from the banking sector generally implies a higher price of liquidity, but the size depends on how competitive the banking markets are. Let's consider first an area that is lightly hit by the shock. In such an area banks in need of short-term liquidity are likely to rely on wholesale market to accommodate their increased demand for short-term funding. When banking markets are competitive, wholesale liquidity is likely to be traded at a price close to the marginal cost. This is because competitive banking markets effectively improves the threat points of liquidity-needy banks in their bargaining with banks surplus in liquidity. On the contrary, in a setting of segmented banking markets, liquidity-surplus banks are able to extract rents from inter-bank trading and charge positive mark-ups in the wholesale liquidity lent to banks in need of liquidity.

For heavily hit areas, the story is totally different. In these areas the retail prices of short-term bank liquidity are what should be paid more attention to as the wholesale liquidity market becomes silent once an aggregate liquidity shortage kicks in. Competitive banking market now becomes undesirable— it allows banks to bid up prices of retail markets in an effort to raise enough liquidity to meet their demand. As a consequence, the whole system could be trapped in a high interest rate equilibrium, in which all banks are forced to pay an inefficiently high price for short-term liquidity. On the other hand, segmented banking market can resolve this problem— all banks are perfectly disciplined in their liquidity raising behavior and thus no bank would be concerned that the retail liquidity price in their local area gets bid up too high.

C) Implication: Mixed effect on economic stability of banking market competition

Banking sector's ability to weather stress on their short-term liquidity is critical in determining an economy's resilience to negative shocks. Our analysis above on how banking market competition affects the transmission of increased demand for short-term liquidity to

bank liquidity prices suggests a potentially mixed role played by banking market competition in affecting the stability of real economy.

For lightly hit areas, competitive banking market enables banks in need of liquidity to borrow wholesale liquidity from those surplus in liquidity at reasonably low prices. Through this way, these banks hit by the demand shock on short-term liquidity do not have to cut their illiquid lending much. However, for lightly hit areas where banking markets are segmented, banks facing an increased demand (or concern of) short-term liquidity will have to respond by cutting illiquid lending significantly, as the price of liquidity they can borrow from the wholesale markets is likely to be high. In sum, for lightly hit areas where the shock is relatively idiosyncratic, a more competitive banking market can increase the economy's resilience to the shock and maintain a relatively stable level of corporate lending from the banking sector.

For heavily hit areas, competitive banking market now becomes counter-productive— it makes the local economy trapped into a high interest rate equilibrium in which all bank need to pay an inefficiently high price for short-term liquidity in the retail market. As a result, banks hit by the shock have to cut their illiquid lending substantially and the economy experiences a severe freeze-up in economic activities. On the other hand, segmentation in banking markets turns out to be valuable for these heavily hit areas— it allows each of the hit banks to raise short-term liquidity from their local retail market at reasonably low prices. To sum up, for heavily hit areas where the shock is systemic, a more segmented banking market can increase the economy's resilience to the shock and maintain a relatively stable level of corporate lending from the banking sector.

2.5. Geographic Mismatch between Banking Activities and Banking Market Competition

In this section, we start our analysis by illustrating a particular form of supply shock on bank short-term liquidity— that loans create deposits. We then investigate how this

supply shock on bank short-term funding translates into prices of bank liquidity and the role played by banking market competition in this process. Based on these results, we document a novel finding about the geographic scope of banking activities— that more competitive banking markets enlarges the geographic mismatch between between deposit taking and loan making. Evidences are provided suggesting that this pattern is driven by the impact of banking market competition on the determination of bank short-term liquidity prices.

2.5.1. *A Supply Shock on Bank Short-term Liquidity: Loans Create Deposits*

Loans made by one bank can generate fresh supply of short-term liquidity for the banking sector as those who receive the credit would have a demand for a safe store to place these credit. In this part, we empirically document this “deposit creation” effect of loan making, through examining loan-level data and bank balance-sheet data that contain detailed information on geographic locations. In what follows, we start by documenting empirically that positive credit supply shock to a local economy is indeed positively correlated with local banks’ deposit growth.

A) *Baseline results*

To explore the effect of credit growth on local banks’ deposit growth, we collapse banks’ balance sheet data and the SBA small business loan data to county level. In order to establish the “deposit creation” effect of loan making, we need to deal with an important reverse causality, which is the fact that an increase in local credit could be instead driven by the increase in local banks’ deposit. To get around this reverse causality issue, instead of using the credit received by local small businesses from local banks, we utilize credit received by local small businesses from banks outside of the county where the business is located in. We then investigate whether increases in credit inflow from banks *outside* of a county is associated with deposit growth of local banks *inside* the county. We write down the following regression specification:

$$\Delta \text{Deposit}_{i,z,t}^{\text{local}} = \alpha_{i,z} + \mu_t + \beta \Delta \text{Loan}_{z,t}^{\text{outside}} + \epsilon_{z,t} \quad (2.1)$$

where i indexes bank, z indexes a three-digit zip-code area, t indexes year, $\Delta\text{Deposits}_{i,z,t}^{\text{local}}$ is defined as $\text{Ln}(\text{Deposit})_{i,z,t} - \text{Ln}(\text{Deposit})_{i,z,t-1}$ which is the log differences in the total deposits of bank i in area z between year t and year $t - 1$, and $\Delta\text{Loan}_{z,t}^{\text{outside}}$ is log of the sum of total local small business lending that was lent by banks located outside of the local area during the year-quarter t . Higher values of $\Delta\text{Loan}_{z,t-1}^{\text{outside}}$ means higher volume of credit received by local businesses from lenders outside of the local area itself during the year-quarter. To get rid of time-invariant bank-specific factors and county-level characteristics that might interfere with the correlation between local credit growth and local branch-level deposit growth, we add bank fixed effects and 3-digit zip-code fixed effects. Time fixed effects, 3-*zip*-time fixed effects and state-time fixed effects are also taken into consideration. We further include a set of bank-level control variables to control for bank-level time-varying factors. The baseline control variables include the share of commercial and industrial loans in total loans outstanding, the share of real estate loans in total loans outstanding, and the lagged log of the banks' total asset to control for the bank's size. Table 2.3 presents the regression results of the above specification.

The main coefficient of interest is β . In column (1) of Table 2.3's Panel (A), we run the baseline specification with only bank-level fixed effects, county-level fixed effects and time fixed effects, we find that a 10% expansion of loans from other banks outside of the local area is associated with an average of 5% increase in local banks deposit increase. In column (2) of Table 2.3, we add bank-level controls to control for time-varying bank-level characteristics, in column (3) we add county-time fixed effects, and in column (4) we add state-time fixed effects. Gradually adding control variables and fixed effects do not alter our results qualitatively or quantitatively. This tells us that expansion in banks' loan making (proxied by higher volume of credit inflow into the county from banks outside the county) predicts deposit growth in the local county.

B) *Placebo tests*

To get a stronger interpretation of the effect of local credit expansion on local banks' deposit growth, we conduct a pair of placebo test. In Panel (B) of Table 2.3, we show the

regression results following the baseline structure in equation (2.1), but instead of using the one-period lagged loan expansion from outside-county banks to local businesses, we use two period lagged loan expansion, $\Delta\text{Loan}_{z,t-1}^{\text{outside}}$ and $\Delta\text{Loan}_{z,t-2}^{\text{outside}}$ respectively, and we find that while the two-period lagged loan expansion towards local businesses from distant banks is still strongly predicting the deposit growth in local banks' balance sheet, the three-period lagged local expansion from outside banks display much weaker magnitude in the correlation coefficient. Importantly, we run the same specification but for credit expansion from outside banks one-period and two-period ahead of the current period t , we find only slightly positive and non-statistically significant coefficient estimates associated with $\Delta\text{Loan}_{z,t+1}^{\text{outside}}$ and $\Delta\text{Loan}_{z,t+2}^{\text{outside}}$. The sharp comparison between the lagged or lead credit inflows into a given county in explaining local banks' deposit growth indicate that the observed baseline results are not driven by reverse causality or serial correlation. This strengthens the deposit creation effect of new loans.

To further sharpen our results, we run the same set of specification but differentiate between labor-intensive and non-labor intensive industry. The idea is that the higher the credit inflow towards local labor-intensive business¹⁴, the more labor income is going to be paid off locally and thus the higher the deposit growth when these newly hired workers' income is deposited into the banks accounts locally. In particular, we write down the following regression specification

$$\begin{aligned} \Delta\text{Deposit}_{i,z,t}^{\text{local}} = & \alpha_{i,z} + \mu_t + \beta_1 \Delta\text{Loan}_{z,t}^{\text{outside,l}} \\ & / + \beta_2 \Delta\text{Loan}_{z,t}^{\text{outside,nl}} + \epsilon_{z,t} \end{aligned} \tag{2.2}$$

where the subscripts are the same as defined in 2.1. The difference here is that we split the total sum of new credit generated by outside banks to a local area's businesses by labor-intensive industries and non-labor-intensive industries. $\Delta\text{Loan}_{z,t}^{\text{outside,l}}$ is the total sum

14. Labor intensive and non-labor intensive industries classifications are based on the businesses' NAICS Code and <https://www.bls.gov/ces/>. Labor intensive industries are those with 2-digit NAICS codes: 11, 21, 31-33, 53, 72, 81, 92.

of loans received by local labor-intensive businesses from banks outside of the local area in period t , and $\Delta\text{Loan}_{z,t}^{\text{outside,nl}}$ is the total sum of loans received by non-labor-intensive businesses from banks outside of the local region in period t .

The coefficient of interests are β_1 and β_2 . Table 2.4 presents results on regression specification defined by 2.2. Column (1) and column (4) of Table 2.4 includes all the relevant fixed effects and bank-level control variables. It is very clear that average local bank-level deposit growth is much more strongly driven by credit inflow (from outside banks) towards labor-intensive businesses rather than non-labor intensive businesses. A 10% increase in credit inflow from banks outside of a region into a county's labor intensive businesses can lead to an average of 6.2% increase in local banks' deposit growth, but a same magnitude of outside credit extension to non-labor intensive businesses will only lead to 0.5% increase in local banks' deposits on average. Comparing this cross-industry baseline results with the results in Table 2.3, we find that the coefficient on credit received by local labor-intensive businesses absorbs and even outrun the coefficient on overall credit received. This highlights the fact that banks' loan-making increases deposits through generating new *local* labor income that's going to be re-deposited into local banks. Column (2) & (4) and column (3) & (6) conduct the same set of comparisons with standard errors clustered at state and year level respectively. Robust empirical estimates are consistently observed.

2.5.2. Transmission to Short-term Liquidity Prices and Banking Market Competition

In the above subsection, we established a general fact that increase in local businesses' loan received from distant banks outside of the local region predicts local banks' deposit growth through the channel that new business lending generates higher labor income and thus more deposit. The loan-making's deposit creation effect is more strongly associated with labor-intensive businesses' credit receiving. In this part, we investigate how such a positive shock on the supply of short-term liquidity can be translated into the prices of local banks' short-term funding and how this transmission process is affected by banking market

competition.

A) *Transmission to Prices of Short-term Bank Liquidity*

A major portion of commercial banks' liability are the demand deposits they raise from local households. When local businesses receive more credit and pay out more labor income, this process increases the supply of fresh deposits to the local banks. Therefore, holding other factors unchanged, this deposit-supply increase will have an impact on local banks' retail liability raising costs because the supply of deposit has increased. Meanwhile, as the retail market's supply gets ampler, it will indirectly increase the bargaining position of a bank that tries to borrow in the inter-bank market. Through the improvement in bargaining position, a bank's wholesale liquidity raising cost will also be impacted. In this part, we explore the general correlation between an increase in local deposit supply and the local banks' retail and wholesale liquidity raising costs.

Similar with the design in the above subsection, we want to get rid of reverse causality issues between local banks' liquidity position and local businesses' loan issuance condition. So instead of using total new credit received by businesses in a county, we use the total amount of new loans received by local businesses from banks outside of the county to measure credit supply shock to a county. To investigate how does increase in local new credit impact local banks' retail and wholesale liquidity raising cost, we write down the following specification:

$$\begin{aligned} \text{Ave. Retail rate}_{i,z,t}^{local} &= \alpha_{i,z} + \mu_t + \beta^{retail} \Delta \text{Loan}_{z,t}^{outside} + \epsilon_{z,t} \\ \text{Ave. Wholesale rate}_{i,z,t}^{local} &= \alpha_{i,z} + \mu_t + \beta^{wholesale} \Delta \text{Loan}_{z,t}^{outside} + \epsilon_{z,t} \end{aligned} \quad (2.3)$$

where the explanatory variable is the same as defined in the previous subsection, the left-hand side variables are the quarterly average retail and wholesale funding cost of bank i located in 3-digit-zip z during the year-quarter t . The detailed definition of these two variables are provided in section 2.3.4.

The main coefficients of interest are β^{retail} and $\beta^{wholesale}$. Table 2.5 presents the results of the above regression specification. In column (1) and column (3), we include bank-

level fixed effects, 3-digit zip-level fixed effects, and time fixed effects as baseline results. Consistent with our conjecture, expansion in loans received by local businesses, measured as the total amount of loans provided by banks outside of the county to local firms, is significantly and negatively correlated with local banks' retail and wholesale liquidity raising costs. Specifically, a 10% increase in the total new loans received by local businesses is associated with an average of 2.4% decrease in retail deposit cost, and an average of 2.87% decrease in the local banks wholesale funding cost. The results are both qualitatively and quantitatively unchanged when we include county-year fixed effects, state-year fixed effects and bank-level controls as reported in column (3) and (4) respectively.

B) *Banking market competition and Shock transmission*

In the above subsections, we establish the fact that new credit flows into a county's local businesses increases the local deposit supply and the more ample local supply of fresh deposits tend to enable local banks to raise short-term liquidity at lower average costs on average. While more abundant supply generally implies lowered price, the exact transmission would be affected by other factors such as market competition. Suppose the local banking market is perfectly competitive, then an enlarged supply of short-term liquidity in the local area won't do much in terms of lowering local banks' deposit raising costs. This is because competitive banking markets allow banks from other areas to easily come in and compete for deposits whenever the price of short-term liquidity in a local area becomes lower.

In this subsection, we explore how variations in local banking market competition could affect the transmission of enlarged supply of short-term liquidity resulting from increased credit inflow to the price of short-term liquidity for banks in local areas.

B.1) *Specification of empirical tests*

In order to cleanly identify the effect of banking market competition on liquidity price determination, we utilize a natural experiment on the changes in local banking market competitiveness. As discussed in section 2, the natural experiment we utilize here is the banking sector deregulation that lasted from the beginning of 1980s till the middle of 1990s. In this

section, we utilize the three states that went through intra-state banking deregulation in the middle of 1990s, so that there is an intersection between the states' pre/post deregulation periods and the SBA data-sets. The three states that went through intra-state banking deregulation in 1990s are Arkansas (1994), Iowa (1994) and Minnesota (1993). Specifically, we would like to investigate how local banks' average wholesale and retail funding cost change when there's impulsive credit inflow into a local region's own area and into its adjacent area, before intrastate deregulation and after intrastate deregulation.

$$\begin{aligned}\Delta y_{i,z,t} &= \alpha_i + \mu_{z,t} + \beta^{adj} \times \Delta \text{Adjacent area loan}_{z,t}^{out} + \text{FE's} + \epsilon_{i,z,t} \\ \Delta y_{i,z,t} &= \alpha_i + \mu_{z,t} + \beta^{local} \times \Delta \text{Local area loan}_{z,t}^{out} + \text{FE's} + \epsilon_{i,z,t}\end{aligned}\tag{2.4}$$

where i indexes bank, z indexes three-digit zip-code area and t indexes year¹⁵. The right-hand side variable in the upper equation is the natural log of credit flow to the adjacent 3-digit zip-code areas of bank i 's located area z , and $\Delta \text{Local area loan}_{z,t}^{out}$ is the natural log of credit flow to the bank i 's own 3-digit zip-code area z . Both credit inflow measures are calculated using the lending from banks outside of the respective region. The dependent variable $\Delta y_{i,z,t}$ on the left-hand side are either the year-to-year change in average wholesale funding cost or retail funding cost of bank i located in the three-digit zip-code area in year t . To figure out how change in local banking market competitiveness could affect the impact of credit supply on local banks' average retail and wholesale funding cost, we run the above set of regressions both before intrastate deregulation and after intrastate deregulation according to the exact year where bank i 's location state finished intrastate banking deregulation.

The coefficients of interests are β^{adj} and β^{local} , and especially the comparison within between $\beta_{\text{before deregulation}}^{adj}$ versus $\beta_{\text{after deregulation}}^{adj}$ and $\beta_{\text{before deregulation}}^{local}$ versus $\beta_{\text{local deregulation}}^{adj}$. Table 2.6 and Table 2.7 presents the results of the above regression specification. Panel (A) of Table 2.6 and Table 2.7 shows the results comparing how bank-level wholesale funding cost's response towards adjacent area's businesses have changed post the intrastate banking

15. Since we focus our examination to three late intrastate deregulation states, we switch our basic unit of observation to bank-year level.

deregulation; and Panel (B) of Table 2.6 and Table 2.7 presents the paralleling comparison for average retail liquidity funding costs. Column (1) and (3) of the two tables include basic fixed effects at bank level, 3-digit zip-code level and state level, while column (2) and (4) of Table 2.6 and Table 2.7 include all relevant fixed effects.

B.2) *Estimation results*

Through comparing the column (2) and column (4) of Table 2.6 Panel (A), we find that before intrastate banking deregulation, positive credit expansion to the banks' adjacent area businesses was only weakly negatively correlated with a bank's average wholesale funding cost during, a 10% expansion in the credit received by adjacent area businesses is only associated with a 0.2% decrease in a bank's annual wholesale funding costs; but after the intrastate banking deregulation, a same 10% expansion in the credit received by adjacent area businesses is associated with 3.75% decrease in a bank's annual wholesale funding costs. The difference is both quantitatively and statistically significant.

This sharp comparison in the above coefficient estimates is consistent with our discussion in section 4.1(B). Before intrastate deregulation, banking markets are highly segmented as banks are limited to conduct deposit taking only within its own local geographic area. Therefore an increase in the supply of short-term liquidity in adjacent area won't do much in improving banks' bargaining position in their wholesale liquidity trading. As such, the transmission of increased supply of short-term liquidity in adjacent area into lowered wholesale price would be minimal before the intrastate deregulation. However, things will completely change after the prohibition of intrastate deposit competition gets lifted. Free of geographical deposit-taking restrictions, whenever adjacent area see a credit supply or better growth potential of deposit supply, that means a bank can freely dip into that deposit pool, the possibility of doing this improves a bank's bargaining position (regardless of whether in equilibrium the bank really dipped into the adjacent deposit market), and lead to a decrease in its average wholesale funding costs.

In Panel (B) of Table 2.6, we report the estimation results on how a local bank's average wholesale funding cost interact with credit expansion from outside to local businesses, before

and after the intrastate banking deregulation. Contrary to the patterns about credit expansion to adjacent area businesses, before deregulation, higher volume of credit inflow from outside the area to local businesses was associated with a decrease in local banks' average wholesale funding costs, a 10% expansion in credit inflow from outside the region to local businesses was associated with 2.5% decrease in local banks' wholesale funding costs; however, after the intrastate banking deregulation, higher credit inflow into the local businesses does not predict significant decrease in local banks' wholesale funding costs.

The reasoning beneath Panel (B) of results is in line with that in Panel (A). Before the intrastate deregulation, when banks from outside the local area could not easily enter the local deposit market, increases in credit received by local businesses and the so generated supply of short-term liquidity in the local area can substantially benefit local banks residing in this area. In particular, a well-protected access to local deposit supply can effectively improve banks' threat point of bargaining in their wholesale liquidity trading and hence materializes into a lowered wholesale short-term funding cost. After the intrastate deregulation however, when other banks from outside the local region can freely dip into local deposit market, the access to newly increased local deposits is no longer well protected. Thus the impact of positive local credit supply no longer result in non-trivial decrease in average wholesale liquidity funding cost for local banks. The comparison can be easily seen from column (2) and (4) of Panel (B).

Paralleling the analysis on wholesale liquidity raising cost, we study how banks retail liquidity raising cost interacts with credit supply to local and adjacent areas, before and after intrastate banking deregulation. The results of this part are shown in Table 2.7. Comparing column (2) and column (4) of Panel (A), we find that both before and after the intrastate banking deregulation, positive credit supply towards a bank's adjacent regions doesn't have a significant impact on the retail liquidity raising price of a local bank. However, through comparing column (2) and column (4) of Panel (B), it is clear that before deregulation, positive credit inflow into a bank's geographic area is associated with a significant decrease in local banks' retail liquidity funding cost, specifically, 10% expansion in the credit inflow

volume towards local business will lead to 2.38% decrease in local banks' retail liquidity funding costs. The reasoning is that before deregulation, other banks outside of a local geographic region could not dip into local deposit market. When local businesses received higher volume of loans, expand their business and write off more wage bills to their employees, local deposit supply will increase, allowing local banks to raise retail liquidity at lower costs. However, when banks from other locations can freely enter the local deposit market, the local banks deposit market privilege tend to be diluted by the competition from distant banks.

2.5.3. Bank Lending Distances before and after Intrastate Deregulation

Up until now, we have mainly focused on how changes in local banking market structure affect liquidity raising costs on the wholesale and retail liquidity market through credit supply shocks to local businesses. When local deposit market gets more competitive, banks' short-term liquidity prices become less sensitive to local credit supply shocks but start to respond to credit supply changes in adjacent areas. These results hold true for both retail and wholesale liquidity.

A natural implication from these patterns then is: how would bank lending distance respond to changes in banking market competition? In this subsection, we provide answer to this question through examining changes in geographic distance of bank lending before and after the intrastate banking deregulation.

A) Measuring bank lending distance

The experimental environment of conducting this lending distance change analysis is the same as in the previous section, where we have three late intrastate deregulation states (Iowa, Arkansas, and Minnesota) and the availability of transaction-level small business loans from SBA. The methodology we utilize follows Granja et al. (2019).

In particular, we take each bank's geographic location information in the call report data, and merge with SBA loan dataset over years. The combination of these two datasets gives us location of lending banks and the locations of their all their lending in a given year. In

order to measure the distance of lending of a given bank, we geocode the respective locations of the borrowing business and the lending bank, getting their latitudes and longitudes, and calculate the distance between the two geographic coordinates. This gives us a continuous measurement of the distance of a business loan.

One important issue in terms of this measurement is that it is likely that after the intrastate deregulation, banks start to expand their branching network to other geographic units and thus the actual distance between a borrowing small local business and a lender is shorter than the calculated version using the SBA dataset. As has been discussed in the variable construction section, we deal with this problem by coding out the geographical coordinates of all branches of a given bank *over time*, and calculate the *shortest* distance between the loan receiver's location and the lending bank's branches. This gives us a good measurement in the sense of taking into consideration the time-varying changes of any specific bank's branching network. This refinement of the measure allows us to robustly get how expanded did a bank's shortest lending distance become after the intrastate deregulation compared with before.

B) *Baseline results*

Figure 2.3 to Figure 2.5 visualize the change in local banks' lending distances in the three late deregulated states before and after the intrastate deregulation. In Figure 2.3, we display how banks' average ratio of portfolio allocating to borrowing businesses outside of their branching network has evolved during the episode of intrastate deregulation. In panel (a) of Figure 2.3, we show that before deregulation, an average of around 10% of Iowa banks' small business lending portfolio was allocated to distant borrowers outside of their network structure; after the intrastate deregulation initiated in 1994, the average distant portfolio started to rise significantly, by the time of 1997, Iowa banks allocated around 20% of their small business loans to distant borrowers outside of their branching network. Similar pattern holds for Arkansas and Minnesota, though differences exist among states in the pre-deregulation trend.

In panel (b) of Figure 2.3, we plot the lending distance patterns of banks in other regions

of the economy during the same period, and find no significant expansion patterns. This suggests that intrastate deregulation was indeed the driver of this change distant portfolio allocation. In Figure 2.4 and Figure 2.5, we conduct the similar exercises. In particular, Figure 2.4 shows the weighted average of banks' lending distances in miles (weighted by the total small business loan amount) for banks located in the three late deregulated states. In Figure 2.5, we show the median of banks' lending distances in miles of banks in late deregulated states. Using these two alternative measures of bank lending distances, we find consistent results suggesting that banks in these three states significantly increases the geographic scope of their activities on the asset side immediately after the implementation of intrastate deregulation. Both exercises are compared with banks in other regions of economy that didn't gone through intrastate deregulation during the same episode. The fact that other states do not witness such increases in bank lending distance around the same periods reinforces our argument that more competitive banking market is a major driving force between the enlarged geographic mismatch between banking activities.

These changes in geographic distance of banks lending before and after the banking market deregulation can be easily related to our findings on short-term liquidity price in previous subsections. As documented in section 2.5.1, the "deposit creation" effect of loans made to local businesses can enlarge the supply of short-term liquidity in local areas. Before the intrastate deregulation, banks are not able to directly touch other geographic areas' deposit pool except borrow from banks in those areas. Symmetrically, banks from other areas are also not able to come in and steal away the local deposits. As a result, for any banks, if they make lending outside their own geographic area, the deposit created by loans they extend is unlikely to do much benefit for them. However, the fresh supply of deposits generated in local area by their loans extended to local businesses can substantially lower future liquidity price for these banks, as outside banks cannot easily come in and steal them away. Therefore, banks won't have too much incentive to lend outside of their own geographic area before the intrastate banking deregulation, given their concerns of liquidity issues.

After the intrastate deregulation however, any local lending will no longer going to local

banks' account since banks from other geographic units can freely enter and compete for the newly created liquidity with attractive prices. Conversely, lending to business in nearby areas now can provide (at least) some benefit to the loan-making banks. That being said, banks' incentive to confine their lending to local businesses is likely to be weakened. Following this line of reasoning, the hypothesis that we can test is after the intrastate deregulation, banks from specific geographic units are likely to extend their lending to businesses located in more distant geographic units.

2.5.4. Placebo Tests on Bank Lending Distance Variations

To further strengthen our findings, we conducted a couple of placebo tests. The goal of this subsection is to provide empirical evidences that allows us to claim the variations in bank lending distance documented above is indeed driven by the short-term funding price channel.

A) Placebo test I: labor-intensive loans v.s. non labor-intensive loans

First, we consider the *within-bank* changes in lending distances to firms from industries with different labor intensity. The intuition is as follows, before the intra-state deregulation, all banks could only get the deposit from their local geographic units, knowing this, they will be more willing to lend to firms that operates and hire labor in local areas. The localness of lending should be more profound to businesses that are labor-intensive because these businesses that could generate more local deposit supply. As a result, we expect that on average the small business lending to firms in labor-intensive industries should have shorter lender-borrower distance, and should be more likely to be in the same county as the lender. Indeed, for the three late-deregulated states, average small business lending distance to labor-intensive businesses was 5.53 miles before intrastate deregulation; while the average distance to non-labor-intensive businesses was 15.76 miles, a triple of the labor-intensive distance.¹⁶ Furthermore, because the labor-intensive business loans are more geographically constrained

16. Post deregulation however, the average labor-intensive distance went up to 11.21 miles, and the average non-labor-intensive distances went up to 16.44 miles.

compared with non-labor-intensive loans, we should expect to see that the labor-intensive small business loans are more responsive toward the intra-state deregulation. To verify this reasoning, we run the following regression specification:

$$y_{b,l,t} = \alpha_b + \beta_1 1[\text{Post deregulation}]_t + \beta_2 1[\text{Post deregulation}]_t \times 1[\text{Labor-intensive}]_{l,b,t} + \epsilon_{b,l,t}$$

where b indexes bank, l indexes a small business loan, and t indexes year. The dependent variable is either the natural log of lending distances (in miles), or a dummy variable that equals to 1 if the credit-receiving small business is located in a county that's within the bank b 's branching network. The main explanatory variables are $1[\text{Post deregulation}]$ and its interaction with $1[\text{Labor-intensive}]$ and $1[\text{Non-labor-intensive}]$.

Table 2.8 displays the results of the regression analysis under this specification. Post the deregulation, average within-bank lending distance increased by 3.5 miles, and importantly, the expanded lending distance seemed to be mostly attributed to lending towards labor-intensive industries. In particular, the average lending distance towards labor-intensive businesses expanded by 5.8 miles; while the lending distance towards non-labor-intensive businesses expanded by only 2.7 miles on average.

Similarly, if we consider the the likelihood that a bank lend towards businesses outside of their branching network, we find that post the intra-state deregulation, the average within-bank likelihood that a loan is directing towards a within-network small business decreased by 16.4%. However, it is the loans towards labor-intensive businesses that the likelihood witnessed more significant decrease: post the deregulation, likelihood of labor-intensive lending towards within-network businesses decreased by a significant 18.2%. The non-labor-intensive businesses lending also became more likely to be out of branching network, but not as significant compared with the before-deregulation trend: post the deregulation, the likelihood of lending towards within-network non-labor intensive businesses decreased by only 7.6%.

B) *Placebo test II: banks' deposit structure*

The second set of placebo test that we run is from the angle of banks' reliance on short-term funding. Similar with the reasoning in the business labor-intensity exercise, in this part we investigate which types of banks are more likely to expand lending distances post the deregulation. If the increased local banking market competition alters bank lending behavior through transforming the underlying determination of short-term liquidity prices, then it must be banks who are more sensitive to short-term liquidity shocks that will respond more drastically in altering their lending behavior. In this regard, we conduct the following regression specification:

$$y_{b,l,t} = \alpha_b + \beta_1 1[\text{Post deregulation}]_t + \beta_2 1[\text{Post deregulation}]_t \times S_b + \epsilon_{b,l,t}$$

where b indexes bank, l indexes loan, and t indexes year. S_b is a bank-level measure of the bank's short-term liability funding reliance.

In this part of exercise, we utilize two variables to measure banks' reliance on short-term funding need, the first variable is the ratio of transaction deposits over time deposits (the ratio between item RCON2215 and (RCON6648+RCON2604)); and the second variable is the ratio of uninsured time deposits over time deposits (the ratio between item RCON2604 and (RCON6648+RCON2604)). Both these two variables captures banks' sensitivity to short-term liquidity prices— the higher these two variables, the more banks care about the price at which they can raise short-term liquidity. We calculate each bank's reliance on the short-term liquidity funding and tag a bank as having high reliance on short-term liquidity funding if the bank's S_b is above the top 25-the percentile in the relevant sample of analysis. In the static cross-sectional and over-all sample analysis, the S_b measures are calculated using the bank's entire history of observations; in the diff-in-diff part of analysis for banks in the late-deregulated states, the S_b measures are calculated using the banks' balance sheet between 1982-1992.

Table 2.9 presents the overall-sample bank-loan correlation between the bank's short-term liquidity funding needs and the average outcome of its lending distances. In the first

two columns, we find that banks that are more reliant on short-term liquidity funding are more likely to grant a loan to firms within their branching network; in column (3) and (4), and compared with the other banks, average lending distances are 4.8 miles shorter.

Table 2.10 presents the diff-in-diff analysis on banks in the late-deregulated states. In this setting, we are able to trace how within-bank lending distances have evolved post the intra-state deregulation compared with before the deregulation. In the first part of the table, we show that post the deregulation, average likelihood of an outside-network loan being made by the banks increases by 11.7%, and this transformation tend to be most significant and primarily driven by banks with high short-run liquidity funding needs pre-deregulation, as can be read from column (3) and (4) of the first part of the table, controlling for the interaction between 1[Post deregulation] and the indicator that the bank is of high short-run liquidity funding reliance, we find the coefficient β_2 on the interaction absorbs the magnitude of β_1 . Similar with pattern shown for the likelihood of lending outside branching network, in the second part of the table, we show that within-bank average lending distance increased significantly after the intra-state deregulation, and the change was primarily driven by banks with high short-term funding need.

2.6. Economic Stability and Banking Market Competition

In Section 5, we examined how changes in banking market competition may affect how enlarged supply of bank short-term funding be transmitted to banks' retail and wholesale liquidity raising costs, as well as its implication on the geographic scope of banking activities. In this section, we look at the other side of price determination—how the demand-side shocks on bank short-term funding transmit to the prices of bank liquidity and the role played by banking market competition in the process. The analysis of the demand-side shock transmission is perhaps more important, since banking sector's resilience to unexpected negative shocks is a critical determinant of the real economic stability.

To make clean identification on how changes in banking market competition may impact the determination of banks' short-term liquidity raising costs, we utilize a natural experiment

setting that combines staggered intrastate banking deregulation across states during the 1980s and the 1986 oil price bust. The oil-price shock event provide the ideal setting for the purpose of our study for clean identification purpose. The reasons are as follows. First, the occurrence of this oil price bust was mainly due to supply side factors (in middle East countries) that were unexpected and orthogonal to the U.S. banking deregulation. Second, banks that were exogenously hit by the event in terms of their liquidity conditions were also located in states that were at different status of intrastate banking deregulation. Third, due to nature of the shock that is from one specific industry, there exist substantial variations across geographic units in turns of the scale of the shock that local banking sector is suffering. These special features of the episode allows us to draw a full picture of how different levels in banking market competition would transform the determination of banks' short-term liquidity raising costs when the liquidity condition suddenly turns tight; and what happens to this transformation when such a demand shock is a systemic one versus the case where it is an idiosyncratic one.

2.6.1. 1986 Oil Price Bust

In this subsection, we provide some details on the 1986 oil price bust and explain how the US banking sector was affected. Specifically, we show evidences suggesting that the occurrence of the shock was unlikely to be correlated with the process of banking deregulation; moreover, we show that banks around U.S. were hit by the shock in their liquidity conditions and that they were located across a wide range of areas covering both deregulated and underegulated states.

Throughout the year of 1986, the price of crude oil went through a dramatic drop. As shown in Figure 2.6, crude oil price slumped from 30.8 dollars per barrel to 12.8 dollars per barrel. The cause of the sudden oil price drop was that in late 1985, Saudi Arabia unilaterally engineered a substantial reduction in the price of oil by increasing its daily production of crude from two million to four million barrels.¹⁷ The sudden drop in oil price due to external

17. Saudi Arabia was the largest oil-reserve economy and Saudi Arabia increased output and drove oil

reasons suddenly lead to huge revenue loss of U.S. oil-related companies and drove them into serious negative liquidity conditions to repay their short-term debt. This is reflected in Figure 2.7. Before the after the oil-price hit, oil-related companies' net income slumped from around 0 to -0.3; while, their current ratio went down drastically from 5 to less than 4.¹⁸

The oil companies' sudden revenue losses quickly translated into negative liquidity shocks on related banks who had non-trivial portion of their loan portfolio in energy loans. In the left-hand side panel of Figure 2.7, we calculate the banks' NPL dynamics during the episode by comparing banks located in the energy states and those located elsewhere. It is clear that those banks whose loan portfolio were more likely to be from oil companies (proxied by the fact that they are geographically closer to oil firms) witnessed a sharp increase in their NPL from around 2% to nearly 4.5%, though their pre-shock NPL is at a very comparable level with banks that were not so much exposed to the shock elsewhere in the country. Indeed, the shock happened so unexpectedly and to such a severe extent that it drove exposed banks into severe liquidity situations. It appeared that bankers had limited things they could do to protect their liquidity issues from the unexpected and precipitous decline in oil prices that occurred in 1986. Frank Anderson, an analyst with Weber, Hall, Sale & Associates in Dallas, expressed the following opinion:

”At \$18 a barrel, you'll start seeing a little squirming... If oil prices come down gradually, the banks have a number of things they can do to their energy credits, like add more collateral or restructure the loans. They have a lot more flexibility. But if the price drops suddenly to \$15 a barrel, they will have no time to react.”¹⁹

prices lower to force other OPEC members to adhere to agreed-upon production quotas (Gately (1986)).

18. Mac McGee, marketing director of the Cactus Drilling Company, one of the largest drillers in West Texas, observed in early 1986 that everybody geared up and borrowed. The banks can't afford to carry companies very long. If things dont pick up some, it's going to be a real tragedy. The situation, however, only worsened. The changing times were tellingly reflected in the prevailing bumper stickers. Oil-patch workers bumper stickers had read ”\$85 (a barrel) in 85”. In contrast, a slogan displayed in late 1986 read ”Chapter 11 in 87”.

19. Lisabeth Weiner and Richard Ringer, Falling Oil Prices Could Bleed Portfolios of Energy Banks, *American Banker* (January 22, 1986), 2.

The most extreme reflection of this oil-price induced bank liquidity shock is the bank failures in some of the traditional energy states, notably the state of Texas. From 1986 through 1989, 387 Texas commercial banks failed, including 9 of the state’s 10 largest bank holding companies. In 1988, 175 Texas banks failed with assets of \$47.3 billion, 25 percent of the state’s 1987 year-end banking assets. All in all, we have established that the 1986 oil price shocks inflicted severe negative short-term funding shocks to banks that were exposed to oil company loans beforehand.

2.6.2. Defining Shocked Banks and Shock Scale across Geographic Areas

In the last section, we established that the 1986 oil-price shock was driven by external factors unrelated to the banking deregulation in U.S. throughout 80s, and that this oil price shock presents serious liquidity issues to banking sector due to increases in delayed or failed loan repayments by borrowers in oil-related businesses. In this section, we provide a clear definition on how liquidity-shocked banks are empirically specified. Based on our identification of banks facing increased demand for short-term liquidity, we further give our empirical specification of the shock scale for each geographic units at 3-digit zip-code level.

A. Identifying Shocked Banks

The oil-price shock led to serious liquidity issues at banks who have outstanding loans extended to firms in oil industry, reflected by a sharp spike in the ratio of delayed or defaulted loan payment. Following this logic, we identify banks facing increase demand for short-term liquidity by examining the short-term overdue ratio of each bank. Banks observed to experience a sharp increase in their short-term overdue ratio would have an enlarged demand for short-term liquidity to respect their liability side obligation. Empirically, we use changes in the “within 3-month overdue ratio” to proxy for each banks’ demand for short-term liquidity.²⁰

20. Mathematically, the “within 3-month overdue ratio” for each bank is calculated by RCFD1403-RCFD1407, where RCFD1403 is the “TOTAL LOANS AND LEASE FINANCE RECEIVABLES: NONACCRUAL” and RCFD1407 is “TOTAL LOANS AND LEASE FINANCING RECEIVABLES: PAST DUE 90 DAYS OR MORE AND STILL ACCRUING”.

More specifically, we identify a banks as being facing an increased demand for short-term liquidity after the oil shock if and only if its post-shock level of “within 3-month overdue ratio” increased by more than 30% compared with its pre-shock level. Mathematically, this definition goes as follows:

$$\frac{Ave.within\ 3\text{-month\ overdue}_{86-87}}{Ave.within\ 3\text{-month\ overdue}_{85}} - 1 > 0.3$$

Banks satisfying the above condition are empirically identified as the ones that receive a shock on their short-term liquidity demand, so as to accommodate the routine outflow of deposits.

B. Measuring the Shock Scale

Given our empirical specification that identifies banks receiving a demand shock on short-term liquidity, we can further measure the scale of this demand shock for the local banking sector in each geographic area. Our specification of the geographic unit for the empirical analysis is at 3-digit zip-code level.²¹ For our following analysis of how banking market competition may affect economic stability, we distinguish the demand shocks on short-term liquidity into idiosyncratic shocks and systemic shocks, for the banking sector in each geographic units.

Empirically, we specify the banking sector of an 3-digit zip-code area as being hit by a systemic demand shock on short-term liquidity, if and only if more than 35% of the local banks in this area satisfy our above specification of a shocked bank. In other words, the shock on demand for short-term funding is a systemic one if a large share of the local banks are experiencing an increase in their short-term overdue ratio. On the contrary, if only a few banks in a 3-digit zip-code are shocked by the oil price bust as defined above, then the

21. In Figure 12, we plot the flow expense in wholesale liquidity for banks hit by the demand shock on short-term liquidity. The distinction between systemically hit area versus idiosyncratically hit area is under the 3-digit zip-code specification. As illustrated in the figure, the hit banks substantially increase their flow expense on wholesale liquidity if located in an idiosyncratic area, whereas decrease their wholesale funding expense if located in a systemically hit area. These results suggest that specifying the geographic unit at 3-digit zip-code level is empirically appropriate. We discuss this issue in more details in Section 6.3.

demand shock on short-term liquidity is an idiosyncratic one for the local banking sector in this area.

The graphical visualization of the distribution of the 3-digit zip-code areas is displayed in Figure 2.8. The darker blue shaded three-digit zip-code areas are those that are defined receiving systemic liquidity shocks in the local banking market, and the orange dots are the locations of oil and gas companies. The locations of these companies are constructed from Compustat for firms in the 2-digit SIC code 13. The message comes clear from the figure that systemically hit geographic areas were pretty diversely located all over the economy. In particular, each states had some 3-digit zip-code areas that were significantly more severely hit than others. This is crucial because the diverse locations across both deregulated and underregulated states allows us to really investigate the effect of having a more competitive local banking sector on short-term liquidity costs determination when the scope of the shocks is different. Also, these systemically hit areas' locations also tend to be very correlated with the distribution of firms in energy industry, which validates that the measurement is a good mapping between oil companies and the banks whose short-term liquidity conditions were severely affected.

2.6.3. Empirical Specifications and Results

In this subsection, we elaborate the specifications of our empirical tests and discuss our empirical findings.

A. State level analysis

As a beginning point of this section, we start with documenting the C&I lending dynamics of banks that receive a demand shock due to the oil price bust. These banks are identified with the methodology specified in section 2.6.2. In particular, we group states into systemically hit states and idiosyncratically shocked states. Systemic shocked states include Oklahoma, Louisiana, New Mexico, California, North Dakota, Wyoming, Arkansas, Utah and Alaska.²² Idiosyncratic shock states include all other states that contains at least

22. We do not include Texas in our analysis as Texas's concentration on oil industry is much higher than

one 3-digit zip code are that is defined as exposed to shocks in section 2.6.2.

Figure 2.9 displays the weighted average of these shocked banks' C&I lending amount in both the systemically shocked states and those in the idiosyncratically shocked states, standardized using the banks' C& I lending in year 1985 as base year. In the left-hand side panel of Figure 2.9, we compare the C&I lending of banks in systemically shocked states that were already deregulated and the systemically shocked states that were underegulated in 1986. The red line represents the deregulated states and the dark blue line represents the underegulated states. Before the oil-price shock in 1986, banks in deregulated and underegulated states that were systemically hit by oil price shock ex-post see no difference in their C&I lending trend; however, after being hit by the oil-price plunge, banks in deregulated states witnessed a more significant contraction in their C&I lending (an average decrease of about 20% during 1986-1987) compared with in those underegulated states (an average decrease of less than 10%).

Interestingly, on the right-hand side panel, we show the same pair of comparison for the idiosyncratically shocked states. Contrary to the pattern shown in the systemically shocked states however, banks in deregulated states didn't see significant contraction in their C& I lending since the onset of oil-price shock; rather, banks in states that hadn't gone through intrastate deregulation saw a heavier contraction in their C&I lending.

B. 3-digit zip-code level analysis: bank lending dynamics

To tighten the statistical significance of this pattern, we estimate the following regression specification, the difference is here is that instead of looking at the average trend of C&I lending at state level, we look at the average trend of local banks' C&I lending at 3-digit zip-code unites level:

$$y_{b,z,q}^{\text{Deregu./Underegu.}} = \alpha_i + \gamma_{z,q} + \sum_{t=1982, t \neq 1985}^{t=1990} \beta_t 1[\text{Year}=t] + \beta_3 \mathbf{X} + FE_s + \epsilon_{b,z,q} \quad (2.5)$$

any other states. So we exclude Texas in our cross-state analysis to ensure that states in our analysis are comparable with each other.

where $y_{b,z,q}$ is the natural log of bank b 's C& I lending who's located in the 3-digit zip-code area z in year q . We take into consideration bank-level time-invariant factors by including bank control, we also include zip-area and time fixed effects, and bank's time-varying control variables including the natural log of total assets, the banks' agricultural loan share and real estate loan share in total loans outstanding.

The coefficient estimates and the 95% confidence intervals are plotted in Figure 2.10. The time 0 is taken to be year 1985. The coefficient plots at the 3-digit zip-code level are consistent with the patterns in the state level weighted averages: more competitive local banking market seems to have exacerbated the contraction in C& I lending when local banking sector were systemically hit in their liquidity; on the other hand, if the local banking sector were only idiosyncratically hit by the shock in their liquidity conditions, banks in the less competitive banking market seem to be contracting their C& I lending after the liquidity shock.

Table 2.11 show the average different treatment effects of being located in a deregulated banking market as opposed to a underegulated one when the liquidity shock comes:

$$y_{b,z,q} = \alpha_i + \gamma_{z,q} + \beta_1 1[\text{Post}] + \beta_2 1[\text{Deregulated}] \times 1[\text{Post}] + \beta_3 \mathbf{X} + FEs + \epsilon_{b,z,q}$$

where $1[\text{Post}]$ is a dummy variable that switches to 1 from 1986. $1[\text{Deregulated}]$ is equal to 1 if the state the bank is located deregulated no later than 1987. The panel covers all banks that were in operation from 1982 to 1990.

The different bank lending behavior in response to the sudden liquidity shock when banks were located in deregulated and deregulated geographic units is a reflection of the fact that banking market competitiveness does have a differential real impact when there's short-term liquidity shocks. If the pre-shock bank and local level variables were comparable across banks located in early and late deregulated geographic areas, it must be that differences in local banking market structure has differentially affected the determination of short-term liquidity funding costs among the local banks.

C. 3-digit zip-code level analysis: short-term liquidity price responses

In the following part of this section, we investigate how shocked banks' wholesale and retail funding costs had evolved differently post the liquidity shock when banks are located in geographic units that had gone through intrastate banking deregulation compared with those that had not yet.

We start this part of analysis by investigating how banks' retail and wholesale interest flow expenses evolved if they were located in geographical areas that went through liquidity shocks of different scale. Similar with the specification we run for the investigation on banks' C&I lending behavior, we write down the following regression specification and plot the coefficient estimates for banks in different treatment control groups:

$$E_{b,z,q} = \alpha_i + \gamma_{z,q} + \sum_{t=1982, t \neq 1985}^{t=1990} \beta_t 1[\text{Deregulated}] \times 1[\text{Year}=t] \\ + \mu 1[\text{Deregulated}] + \beta_3 \mathbf{X} + FEs + \epsilon_{b,z,q}$$

where $E_{b,z,q}$ is either the natural log of wholesale interest expenses or retail interest expenses of bank b in the 3-digit zip-code area z in year q .

Figure 2.11 and Figure 2.12 graphically show the dynamics of local banks' wholesale and retail interest expenses before and after the oil-price shock. By comparing the patterns in Figure 2.11 and Figure 2.12, we can see a clear comparison among how banks meet their short-term liquidity needs when they were hit by the oil-price shock. In areas systemically hit by the oil-price shock, banks tended to have increased their retail interest expenses while decreased their wholesale interest expenses. On the other hand, for banks in local geographic units that are not systemically hit, these banks tend to substantially increase their wholesale interest expenses. This comparison suggests when banks in a local area were all experiencing increased demand for short-term liquidity, the local wholesale funding market is unlikely to be where banks in this area raise short-term liquidity from. Instead, shocked banks in this area are likely to rely more on local retail funding market, which explains why the retail interest expenses went up higher in systemically hit regions than in idiosyncratically hit

regions.

This interpretation can also be alternatively confirmed from a different angle, as shown by the regression analysis in Table 2.14. In this table, we regress a bank's net wholesale asset holding on net wholesale liability of other banks that were located in the same 3-digit zip-code area and on the net wholesale liability of banks that were located in other three-digit zip-code areas in the same state. The regression covers all banks in operation from 1980-1990 and covers the years spanning from 1980-1990. We find that during the 1980s, a banks' wholesale liability moves closely with local banks' wholesale asset holding, indicating a non-trivial part of banks' wholesale trading are done locally.

We then move on to investigate the dynamics of wholesale and retail funding rate of shocked banks in systemically hit areas and idiosyncratically hit areas respectively. Importantly, we examine the role played by banking market competition in the determination of these short-term bank funding rates. We write down the following regression specification:

$$Y_{b,z,q} = \alpha_i + \gamma_{z,q} + \beta_1 1[\text{Post}] + \beta_2 1[\text{Deregulated}] \times 1[\text{Post}] + \beta_3 \mathbf{X} + FE_s + \epsilon_{b,z,q} \quad (2.6)$$

where $Y_{b,z,q}$ is either the retail funding rate or wholesale funding rate (as defined in section 2.3.4) of bank b in 3-digit zip-code are z in year q . $1[\text{Post}]$ is a dummy variable that switches to 1 from 1986. $1[\text{Deregulated}]$ is equal to 1 if the state the bank is located deregulated no later than 1987.

In Table 2.12 displays the results of changes in retail funding rate comparing pre and post oil shock, as well as how they interact with the status of intrastate deregulation. We find that after the oil price shock, shocked banks' average retail funding rate increased significantly both in systemically hit 3-digit zip-code areas (an average increase of 220 basis points) and in idiosyncratically 3-digit zip-code areas (an average increase of 36 basis points). More importantly, for the 3-digit zip-code areas that had been systemically hit, the retail funding rate increase was more substantial in those areas located in a state that has deregulated its banking sector. In particular, these systemically shocked and deregulated areas see an extra

213 basis point increase in the retail rate post oil price shock. For the idiosyncratically hit areas, on the contrary, 3-digit zip-code areas with more competitive local banking market didn't witness significantly higher increase in their retail rate.

Similarly we conduct the same set of analysis for the treatment effect of deregulation on the transmission of the liquidity demand shock to changes in shocked banks' wholesale funding rate. The results are reported in Table 2.13. It can be seen clearly that post the oil price bust, shocked banks located in both systemically hit and idiosyncratically hit areas saw a significant increase in their wholesale short-term funding rates. Specifically, wholesale funding rate for the shocked banks in idiosyncratic areas on average increases by 121 basis points and 128 bps for banks systemically hit areas. More importantly, while the status of deregulated or not does not affect wholesale funding cost for shocked banks in systemically hit areas, it has an economically impact on the wholesale funding cost for those in idiosyncratically hit area. In particular, for the shocked banks in idiosyncratic hit 3-digit zip-code area, the increase in its wholesale funding cost will be lowered by 64 basis points if the state has deregulated its banking sector.

These results are consistent with the empirical predictions based on our discussions in Section 4.2 (C). In a systemically hit area where many banks facing increased demand for short-term liquidity, local wholesale funding market is unlikely to be the main source from which shocked banks raise liquidity. Instead, conditions in local retail funding market will be critical in determining the resilience of these shocked banks. Under this circumstance, more competitive banking market can trigger fierce competition for retail liquidity and may trap the local banking sector in a high interest equilibrium in which all shocked banks are paying a substantially higher prices for short-term liquidity raised from local retail market. As a consequence, these shocked banks would have to severely cut their credit supply in such a competitive environment.

On the contrary, for shocked banks in the idiosyncratically hit 3-digit zip code areas, things will be a complete turn-around, as reflected in the significant negative coefficient on the interaction term between 1[Post] and 1[Deregulated]. This is because for shocked banks in

a idiosyncratically hit area, wholesale funding market is non-trivial source of liquidity raising. For such an area in deregulated states, local banks are shocked in their liquidity demand could easily compete with each other on getting new deposits in adjacent or even more distant area. This off-equilibrium status strictly improves hit banks' bargaining position when they borrow from local peers, thus bringing down their wholesale rate relative to a bank in similar idiosyncratically liquidity-hit position but located in a geographic location that's "border-closed".

Using an alternative way to visualize our findings above, we run the following dynamic diff-in-diff to capture the heterogeneous treatment effect of oil shock with heterogeneity coming from whether the bank is located in a deregulated or underegulated geographic unit.

$$y_{b,z,q}^{\text{Deregu./Underegu.}} = \alpha_i + \gamma_{z,q} + \sum_{t=1982, t \neq 1985}^{t=1990} \beta_t 1[\text{Year}=t] + \beta_3 \mathbf{X} + FE_s + \epsilon_{b,z,t}$$

where $y_{b,z,q}^{\text{Deregu./Underegu.}}$ is bank b 's retail rate or wholesale rate in 3-digit zip-code area z in year q . Figure 2.13 and Figure 2.14 show the dynamics of short-term liquidity cost and the deregulation status under systemically and idiosyncratically hit local areas.

2.7. Conclusion

In this paper, we investigate how competition in bank funding market generates real impact through affecting the determination of short-term liquidity prices for banks. Exploiting the exogenous variation in banking market competition resulting from the US banking deregulation in 80s and early 90s, this paper documents two novel facts about the real outcome implications of banking market competition.

First, while banks loan making in general tend to be less local than deposit taking, more competitive banking market enlarges this geographic mismatch between banks activities on two sides of their balance sheets. This effect of banking market competition on the geographic scope of banking activities is more pronounced for banks with high sensitivity to short-term

liquidity prices and loans made to borrowers in labor-intensive industries. Evidences are provided suggesting that a main driving force behind this result is the impact of banking market competition on the transmission of a particular supply shock to the prices of short-term bank funding.

Second, examination of the lending dynamics of banks hit by the 1986 oil price shock reveals a mixed effect of banking market competition on economy's resilience to unexpected shocks. More competitive banking market provides better hedging against idiosyncratic shocks for lightly hit areas, but may lead to more severe freeze-up in bank lending for heavily hit areas where the shocks are more systemic. Evidences show that such a mixed effect on economic stability is largely due to the role banking market competition plays in the transmission of demand-side shocks to the prices of short-term bank liquidity.

2.8. Appendix

Commercial Bank Liability Structure

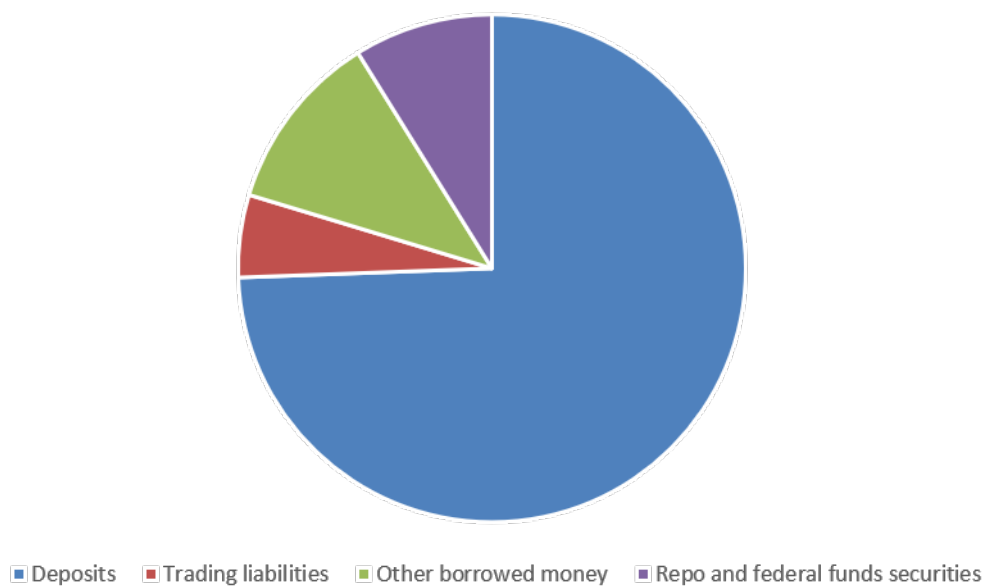


Fig. 2.1. Banking Sectors' Liability Structure

This figure displays (weighted average by size) liability structure of U.S. commercial banks using bank balance sheet data from Call Report 1976-2013.

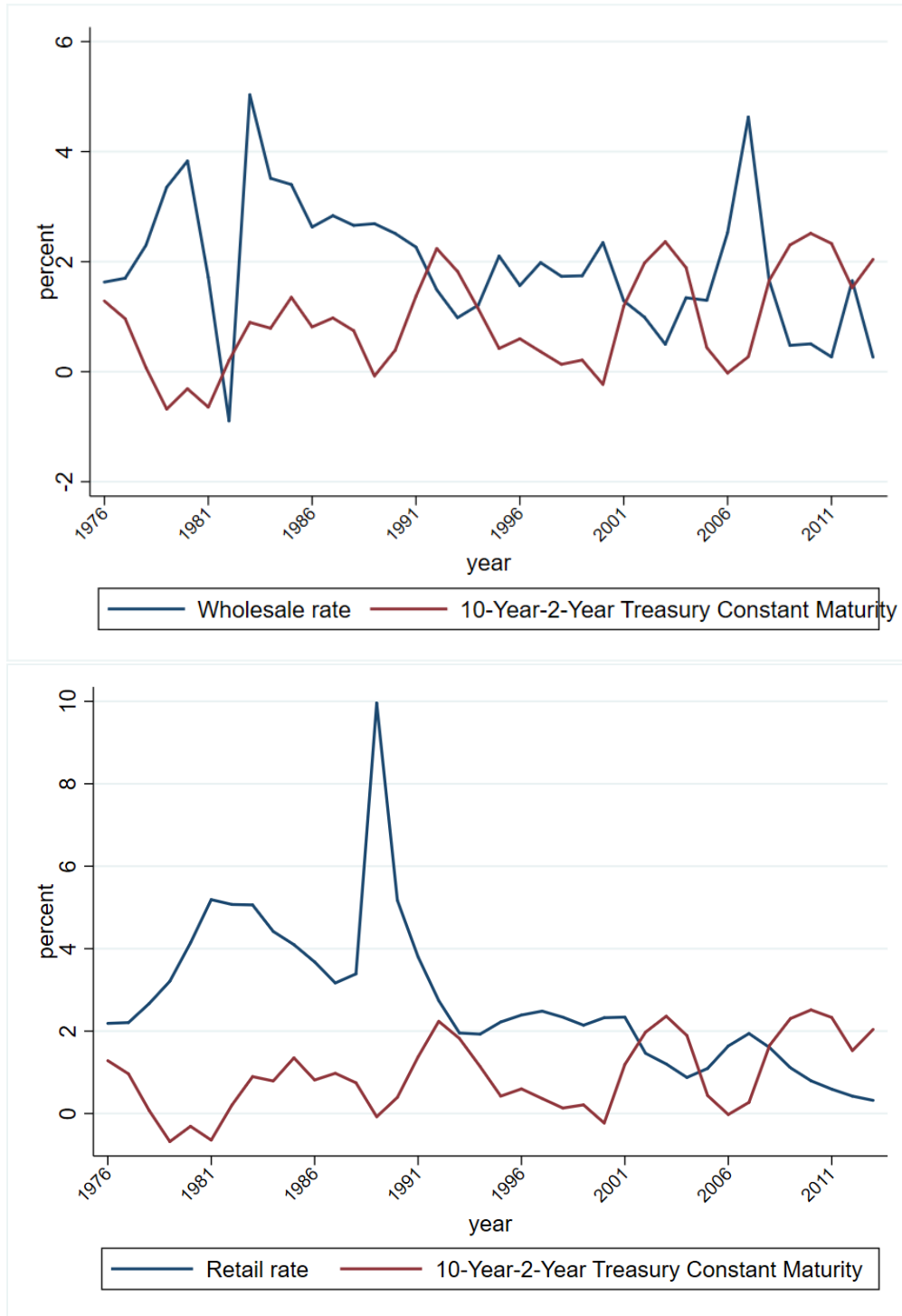


Fig. 2.2. Banks' wholesale and retail funding cost

This figure displays the dynamics of commercial banks' implied wholesale and retail funding rate from 1976-2013 based on the definition provided in Section 2.3.4 as well as the evolution of the spread between 10-Year Treasury Constant Maturity (BC10YEAR) and 2-Year. The Treasury bond data used in calculating interest rate spreads is obtained directly from the Treasury Constant Maturity (BC2YEAR) from U.S. Treasury Department.

Table 2.1. Small Business Lending Characteristics and Lending Distances:
1990-2000

Panel A: Overall states						
	N	Mean	Sd.	p(25)	p(50)	p(75)
Loan amount	329115	156456.84	171468.15	44704.00	88920.00	199500.00
Maturity (months)	329115	122.70	83.15	60.00	84.00	180.00
1[Charge-off]	329115	0.10	0.30	0.00	0.00	0.00
Distance	329115	481.14	583.07	35.27	233.02	743.37
Panel B: Late-deregulated states						
	N	Mean	Sd.	p(25)	p(50)	p(75)
Loan amount	21928	121362.44	139286.70	37716.00	72000.00	144137.50
Maturity (months)	21928	107.58	63.35	60.00	84.00	144.00
1[Charge-off]	21928	0.11	0.31	0.00	0.00	0.00
Distance	21928	106.09	193.83	5.98	24.28	122.93

Table 2.2. Bank Balance sheet Summary Statistics: 1982-2000

Panel A: Non-oil states					
	Mean	Sd.	p(25)	p(50)	p(75)
Asset size (Ln.)	11.71	1.53	10.68	11.49	12.44
Deposits/Total liabilities	0.92	0.12	0.91	0.95	0.97
Time deposits/Deposits	0.47	0.14	0.38	0.47	0.56
Uninsured deposits/Deposits	0.11	0.11	0.05	0.08	0.14
Demand deposit/Deposits	0.16	0.10	0.11	0.14	0.20
Real estate loan/Total loan	0.45	0.19	0.32	0.45	0.58
Agricultural loan/Total loan	0.08	0.14	0.00	0.01	0.08
C& I loan share/Total loan	0.22	0.14	0.12	0.20	0.29
Retail funding costs	0.03	0.16	0.02	0.03	0.04
Wholesale funding costs	0.02	0.42	0.01	0.01	0.02
Wholesale liability/Total liabilities	0.05	0.08	0.01	0.03	0.06
Panel B: Oil states					
	Mean	Sd.	p(25)	p(50)	p(75)
Asset size (Ln.)	11.54	1.06	10.79	11.52	12.25
Deposits/Total liabilities	0.94	0.09	0.93	0.96	0.98
Time deposits/Deposits	0.50	0.12	0.42	0.50	0.57
Uninsured deposits/Deposits	0.16	0.08	0.09	0.14	0.20
Demand deposit/Deposits	0.16	0.08	0.12	0.15	0.19
Real estate loan/Total loan	0.46	0.17	0.33	0.46	0.58
Agricultural loan/Total loan	0.06	0.11	0.00	0.02	0.07
C& I loan share/Total loan	0.24	0.14	0.14	0.22	0.32
Retail funding costs	0.03	0.54	0.02	0.12	0.04
Wholesale funding costs	0.02	0.10	0.01	0.01	0.02
Wholesale liability/Total liabilities	0.04	0.06	0.01	0.02	0.04

Table 2.3. Local Credit Growth and Local Banks' Deposit Growth

Panel A: Baseline Results

	$\Delta\text{Deposit}_{z,t}^{\text{local}}$			
	(1)	(2)	(3)	(4)
$\Delta\text{Loan}_{z,t}^{\text{out}}$	0.513*** (0.0524)	0.441*** (0.0425)	0.335*** (0.0943)	0.341*** (0.0940)
Observations	160650	159673	159523	159497
R^2	0.123	0.169	0.182	0.190
Bank FE	✓	✓	✓	✓
3-zip FE	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓
3-zip-year FE	N	N	✓	✓
State-year FE	N	N	N	✓
Controls	N	✓	✓	✓

Panel B: Placebo Tests

	$\Delta\text{Deposit growth}_{z,t}^{\text{local}}$			
	(1)	(2)	(3)	(4)
$\Delta\text{Loan}_{z,t-1}^{\text{out}}$	0.462*** (0.0615)			
$\Delta\text{Loan}_{z,t-2}^{\text{out}}$		0.103*** (0.00805)		

$\Delta\text{Loan}_{z,t+1}^{\text{out}}$			0.0263 (0.0773)	
$\Delta\text{Loan}_{z,t+2}^{\text{out}}$				0.0192 (0.0708)
Observations	163276	157859	150282	141706
R^2	0.200	0.183	0.199	0.203
Bank FE	✓	✓	✓	✓
3-zip FE	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓
3-zip-year FE	✓	✓	✓	✓
State-year FE	✓	✓	✓	✓
Controls	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table presents the regression results of equations (2.1):

$$\Delta\text{Deposit}_{i,z,t}^{\text{local}} = \alpha_{i,z} + \mu_t + \beta\Delta\text{Loan}_{z,t}^{\text{outside}} + \epsilon_{z,t}$$

The table presents regression showing the correlation between local credit growth and deposit growth at local bank level. The dependent variable of both Panel (A) and Panel (B) is the the log differences in the total deposits of bank i in area z between year t and year $t-1$. The right-hand side variable in Panel (A) is log of the sum of total local small business lending that was lent by banks located outside of the local area during the year-quarter t . The right-hand side variables in Panel (B) are conceptually the same as in Panel (A) but taken the lag or lead for one or two period. Standard errors are clustered at the state level.

Table 2.4. Local Credit Growth and Local Banks' Deposit Growth

	$\Delta\text{Deposit}_{z,t}^{local}$					
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\text{L-I sector credit}_t^{out}$	0.616*** (0.0847)	0.613*** (0.0660)	0.613*** (0.0631)			
$\Delta\text{Non L-I sector credit}_t^{out}$				0.0539 (0.0538)	0.0539 (0.0525)	0.0539 (0.0604)
Observations	150910	150910	150910	150910	150910	150910
R^2	0.156	0.161	0.161	0.144	0.152	0.152
Bank FE	✓	✓	✓	✓	✓	✓
3-zip FE	✓	✓	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓	✓	✓
3-zip-year FE	✓	✓	✓	✓	✓	✓
State-year FE	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓
Clusters		State	Year		State	Year

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table presents the regression results of equations (2.2):

$$\Delta\text{Deposit}_{i,z,t}^{local} = \alpha_{i,z} + \mu_t + \beta_1 \Delta\text{Loan}_{z,t}^{\text{outside,l}} / + \beta_2 \Delta\text{Loan}_{z,t}^{\text{outside,nl}} + \epsilon_{z,t}$$

The table presents regression showing the correlation between local labor-intensive/non-labor-intensive firms' credit growth and deposit growth at local bank level. The dependent variable is the the log differences in the total deposits of bank i in area z between year t and year $t1$. The independent variable for column (1)-(3) is the total sum of loans received by local labor-intensive businesses from banks outside of the local area one period earlier, and independent variable for column (4)-(6) is the total sum of loans received by non-labor-intensive businesses from banks outside of the local region one period earlier. Standard errors are clustered at state level for column (2) and (5) and are clustered at year level for column (3) and (6).

Table 2.5. Local Credit Growth and Local Banks' Liquidity Raising Cost

	Δ Retail rate		Δ Wholesale rate	
	(1)	(2)	(3)	(4)
$\Delta \text{Local credit}_t^{\text{out}}$	-0.244***	-0.269***	-0.287***	-0.272***
	(0.0382)	(0.0311)	(0.0415)	(0.0470)
Observations	170765	166425	55970	54869
R^2	0.342	0.379	0.420	0.428
Bank FE	✓	✓	✓	✓
3-zip FE	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓
3-zip-year FE	N	✓	N	✓
State-year FE	N	✓	N	✓
Controls	N	✓	N	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table presents the regression results of equations (2.3):

$$\text{Ave. Retail rate}_{i,z,t}^{\text{local}} = \alpha_{i,z} + \mu_t + \beta^{\text{retail}} \Delta \text{Loan}_{z,t}^{\text{outside}} + \epsilon_{z,t}$$

$$\text{Ave. Wholesale rate}_{i,z,t}^{\text{local}} = \alpha_{i,z} + \mu_t + \beta^{\text{wholesale}} \Delta \text{Loan}_{z,t}^{\text{outside}} + \epsilon_{z,t}$$

The table presents regression showing the correlation between local credit growth and retail/wholesale funding cost at the bank level. The dependent variable of column (1) and (2) is the implied retail rate at the bank level and the dependent variable of column (3) and (4) is the implied wholesale rate at the bank level. The concrete definitions for implied retail rate and implied wholesale rate are provided in Section 2.3.4. The independent variable is the log of the sum of total local small business lending that was lent by banks located outside of the local area during the year-quarter t .

Table 2.6. Local and Adjacent area credit growth, wholesale funding cost: before and after deregulation

Panel A: Adjacent area credit expansion				
	Before deregulation		After deregulation	
	(1)	(2)	(3)	(4)
Δ Adjacent area loans ^{out}	-0.0229	-0.0309	-0.375***	-0.389***
	(0.0409)	(0.0507)	(0.0811)	(0.0103)
Observations	9796	9631	12833	12579
R^2	0.093	0.095	0.098	0.109
Bank FE	✓	✓	✓	✓
County-year FE	N	✓	N	✓
Bank-year FE	✓	✓	✓	✓
Panel B: Local credit expansion				
	Before deregulation		After deregulation	
	(1)	(2)	(3)	(4)
Δ Local area loans ^{out}	-0.252**	-0.283***	0.0154	0.0263
	(0.0487)	(0.0527)	(0.0244)	(0.0355)
Observations	9795	9630	12822	12567
R^2	0.108	0.223	0.113	0.259
Bank FE	✓	✓	✓	✓
County year FE	N	✓	N	✓
Bank year FE	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table presents the regression results of the following equations:

$$\Delta y_{i,z,t} = \alpha_i + \mu_{z,t} + \beta^{adj} \times \Delta \text{Adjacent area loan}_{z,t}^{out} + \text{FE's} + \epsilon_{i,z,t}$$

$$\Delta y_{i,z,t} = \alpha_i + \mu_{z,t} + \beta^{local} \times \Delta \text{Local area loan}_{z,t}^{out} + \text{FE's} + \epsilon_{i,z,t}$$

The table presents regression showing the correlation wholesale funding rate changes and the flow of credit to adjacent area businesses at bank-year level. The regression covers bank from the three late-deregulated states MN, AR and IA. The dependent variable is the year-to-year change in average wholesale funding rate of bank i located in the three-digit zip-code area z in year t . The independent variable of Panel (A) is Δ Adjacent area loan^{out} _{z,t} , which is the natural log of credit flow to the adjacent 3-digit zip-code areas of bank i 's located area z in year t . The independent variable of Panel (B) is Δ Local area loan^{out} _{z,t} , which is the natural log of credit flow to the bank i 's own 3-digit zip-code area z in year t .

Table 2.7. Local and Adjacent area credit growth, retail funding cost:
before and after deregulation

Panel A: Adjacent area credit expansion				
	Before deregulation		After Deregulation	
	(1)	(2)	(3)	(4)
Δ Adjacent area loans ^{out}	0.00177	0.00220	-0.00619	-0.00823
	(0.00471)	(0.00502)	(0.00468)	(0.00668)
Observations	6285	6285	12514	12514
R^2	0.013	0.018	0.011	0.011
Bank FE	✓	✓	✓	✓
County year FE	N	✓	N	✓
Bank year FE	✓	✓	✓	✓
Panel B: Local credit expansion				
	Before deregulation		Post deregulation	
	(1)	(2)	(3)	(4)
Δ Local area loans ^{out}	-0.238**	-0.292***	0.0324	0.0363
	(0.0433)	(0.0427)	(0.0446)	(0.0582)
Observations	9795	9630	12822	12567
R^2	0.085	0.248	0.109	0.221
Bank FE	✓	✓	✓	✓
County year FE	N	✓	N	✓
Bank year FE	✓	✓	✓	✓

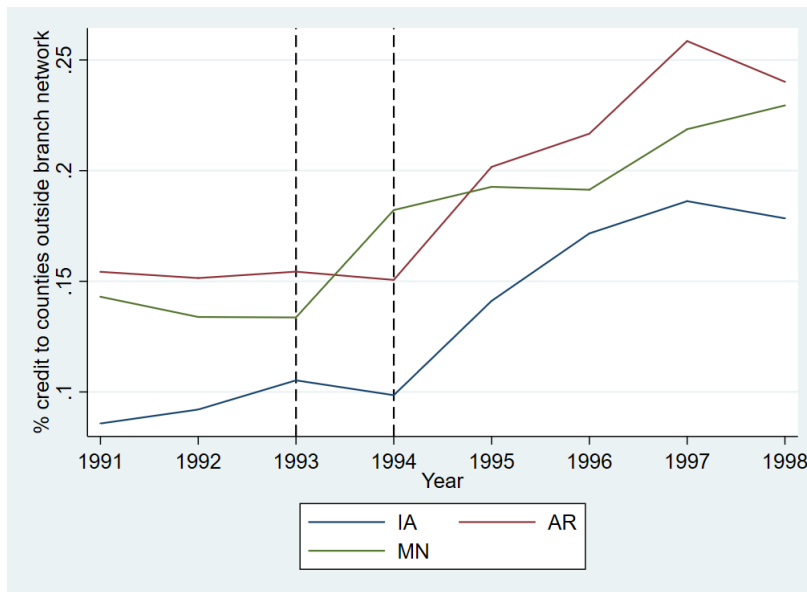
Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

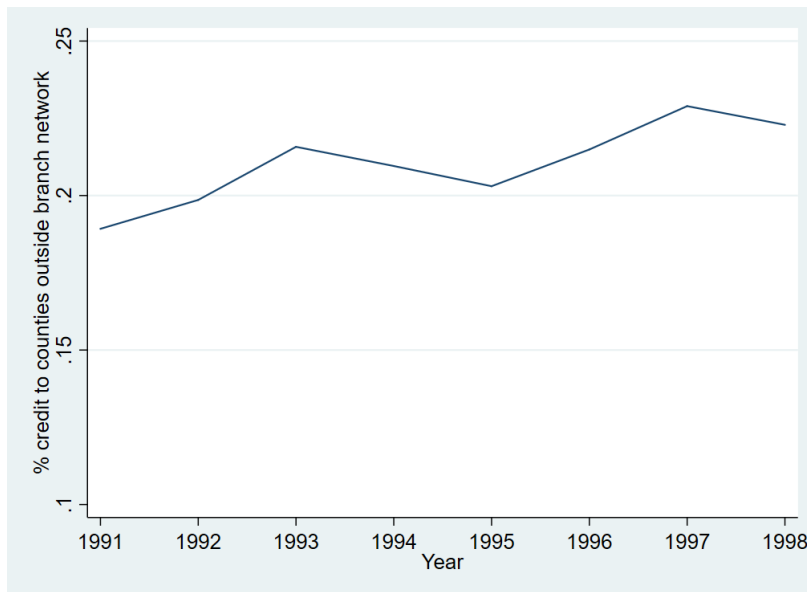
This table presents the regression results of the following equations:

$$\begin{aligned}\Delta y_{i,z,t} &= \alpha_i + \mu_{z,t} + \beta^{adj} \times \Delta \text{Adjacent area loan}_{z,t}^{out} + \text{FE's} + \epsilon_{i,z,t} \\ \Delta y_{i,z,t} &= \alpha_i + \mu_{z,t} + \beta^{local} \times \Delta \text{Local area loan}_{z,t}^{out} + \text{FE's} + \epsilon_{i,z,t}\end{aligned}$$

The table presents regression showing the correlation retail funding rate changes and the flow of credit to adjacent area businesses at bank-year level. The regression covers bank from the three late-deregulated states MN, AR and IA. The dependent variable is the year-to-year change in average retail funding rate of bank i located in the three-digit zip-code area z in year t . The independent variable of Panel (A) is Δ Adjacent area loan^{out} _{z,t} , which is the natural log of credit flow to the adjacent 3-digit zip-code areas of bank i 's located area z in year t . The independent variable of Panel (B) is Δ Local area loan^{out} _{z,t} , which is the natural log of credit flow to the bank i 's own 3-digit zip-code area z in year t .



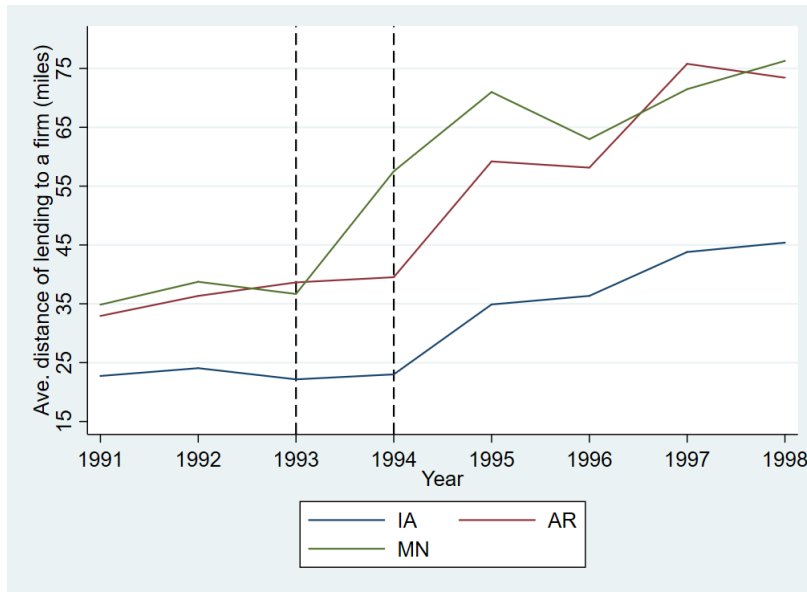
(a) Banks' lending distance change around deregulation in deregulated states



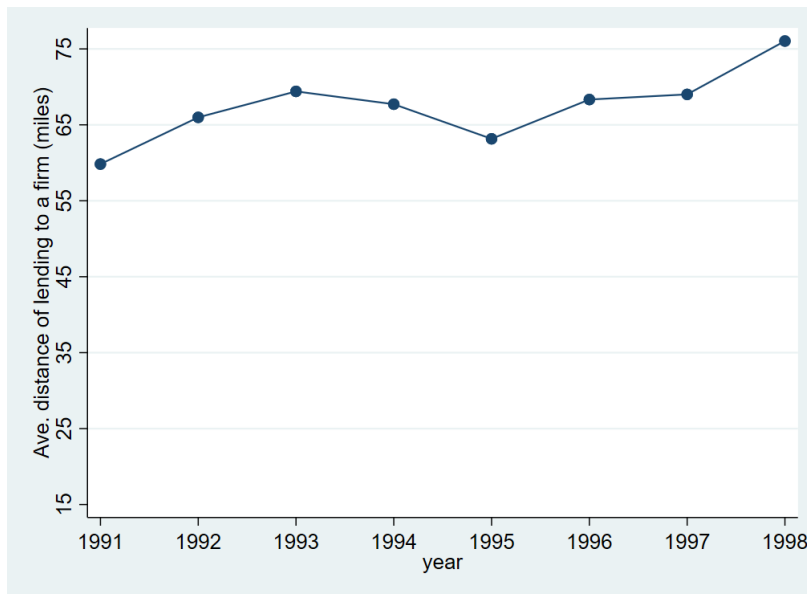
(b) Banks' lending distance in other states during the same episode

Fig. 2.3. Banks' lending portfolio towards businesses outside of branching network: late-deregulated states and other states

Notes: This figure shows the average of banks' portfolio to borrowing small businesses located outside of their branching network. Panel (a) shows the evolution of out-of-network portfolio of banks in late-deregulated states and panel (b) shows the evolution of out-of-network portfolio of banks in all the other states during the same episode.



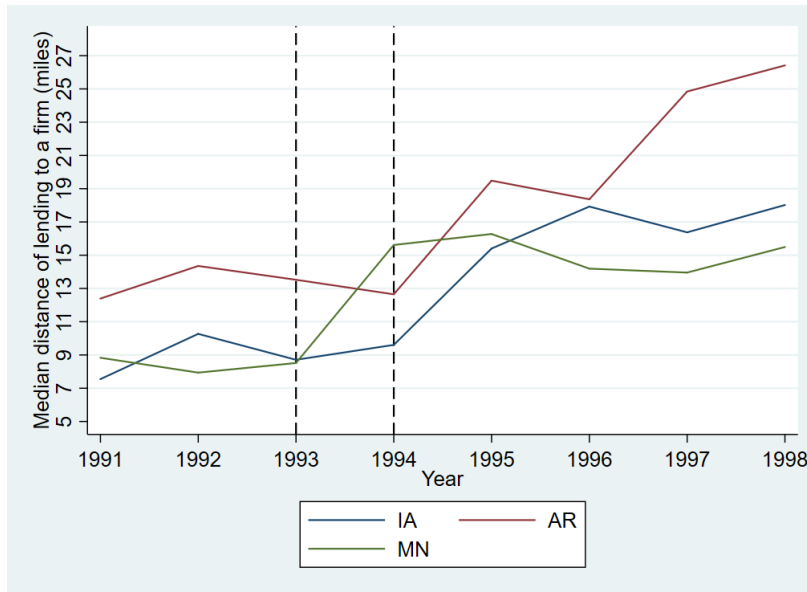
(a) Banks' lending distance change around deregulation in deregulated states



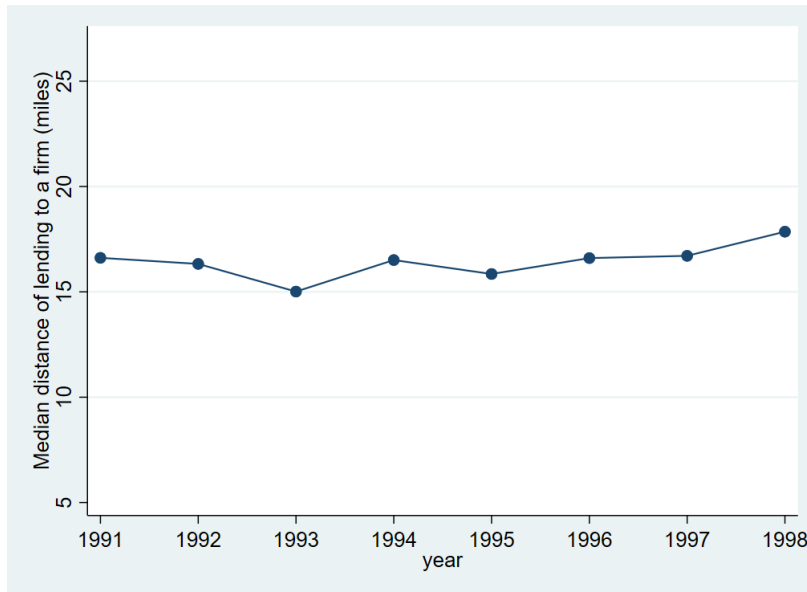
(b) Banks' lending distance in other states during the same episode

Fig. 2.4. Banks' lending distance in deregulated states and other states (weighted average)

Notes: This figure shows the average of banks' lending distance, weighted by the lending amount and banks' size. Panel (a) shows the evolution of weighted average of lending distances of banks in late-deregulated states and panel (b) shows the evolution of weighted average of lending distances of banks in all the other states during the same episode.



(a) Banks' lending distance change around deregulation in deregulated states



(b) Banks' lending distance in other states during the same episode

Fig. 2.5. Banks' lending distance in deregulated states and other states (median)

Notes: This figure shows the median of banks' average lending distances. Panel (a) shows the evolution of median of banks' lending distances (weighted by each loan's total amount) in late-deregulated states and panel (b) shows the evolution of the evolution of median of banks' lending distances (weighted by each loan's total amount) in all the other states during the same episode.

Table 2.8. Bank Lending Distance and Labor Intensity of Borrowers

	Ln(Distance)		1[Within network]	
	(1)	(2)	(3)	(4)
1[Deregulation]	1.222*** (0.266)		-0.164* (0.111)	
1[Deregulation]×1[Labor-intensive]		1.712*** (0.127)		-0.182** (0.0592)
1[Deregulation]×1[Non-labor-intensive]		0.966 (0.722)		-0.0763 (0.0556)
Observations	21928	21928	21928	21928
R^2	0.082	0.099	0.079	0.097
Bank FE	Y	Y	Y	Y
State FE	Y	Y	Y	Y
County FE	Y	Y	Y	Y

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: This table presents the bank-loan level regression on banks' small business loan distances for banks in the late deregulated states. The regression covers all banks in late-deregulated states during the episode of 1990-1996. The left-hand side variable in columns (1) and (2) are both the natural log of the shortest lending distance between a credit-receiving small business and the lending banks' branching network. The dependent variable in column (3) and (4) is the dummy variable that equals to 1 if the credit-receiving firm is from counties that are within lending banks' branching network after the deregulation.

Table 2.9. Bank Short-term Liquidity Reliance and Lending Distance

	1[Within network]		Ln(Distance)	
	(1)	(2)	(3)	(4)
High $\frac{\text{Transactional deposits}}{\text{Time deposits}}$	0.112*** (0.0231)		-0.762**	
High $\frac{\text{Uninsured deposits}}{\text{Deposits}}$		0.136*** (0.0297)		-0.828*** (0.187)
Observations	321982	321982	321982	321982
R^2	0.117	0.109	0.108	0.105
Bank FE	Y	Y	Y	Y
State FE	Y	Y	Y	Y
County FE	Y	Y	Y	Y

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: This table presents bank-loan level cross-sectional regression about banks' small business loan distances on the banks' reliance on short-term liquidity funding. The regression covers all banks during the episode of 1990-2000. The dependent variable in column (1) and (2) is the dummy variable that equals to 1 if the credit-receiving firm is from counties that are within lending banks' branching network. The left-hand side variable in columns (3) and (4) is the natural log of the shortest lending distance between a credit-receiving small business and the lending banks' branching network.

Table 2.10. Responses of Bank Lending Portfolio to Distant Areas

Panel A:	1[Outside network]		
	(1)	(2)	(3)
1[Post Deregulation]	0.117*** (0.00237)	0.0463*** (0.00702)	0.0622*** (0.0105)
1[Post Deregulation] × High $\frac{\text{Transaction deposits}}{\text{Time deposits}}$		0.102*** (0.00232)	
1[Post Deregulation] × High $\frac{\text{Uninsured deposits}}{\text{Deposits}}$			0.133** (0.0438)
Observations	21928	21928	21928
R^2	0.011	0.012	0.016
Bank FE	Y	Y	Y
State FE	Y	Y	Y
County FE	Y	Y	Y
Panel B:	Ln(Distance)		
	(1)	(2)	(3)
1[Post deregulation]	0.691*** (0.121)	0.0882*** (0.0236)	0.0729** (0.0212)
1[Post deregulation] × High $\frac{\text{Transaction deposits}}{\text{Time deposits}}$		0.599*** (0.0611)	
1[Post Deregulation] × High $\frac{\text{Uninsured deposits}}{\text{Deposits}}$			0.565*** (0.0642)
Observations	21928	21928	21928
R^2	0.012	0.013	0.013
Bank FE	Y	Y	Y
State FE	Y	Y	Y
County FE	Y	Y	Y

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: This table presents the bank-loan level regression on banks' small business loan distances for banks in the late deregulated states. The regression covers all banks in late-deregulated states during the episode of 1990-1996. The left-hand side variable in Panel (A) is the dummy variable that equals to 1 if the credit-receiving firm is from counties that are outside of the lending banks' branching network after the deregulation. The dependent variable in Panel (B) is the natural log of the shortest lending distance between a credit-receiving small business and the lending banks' branching network.

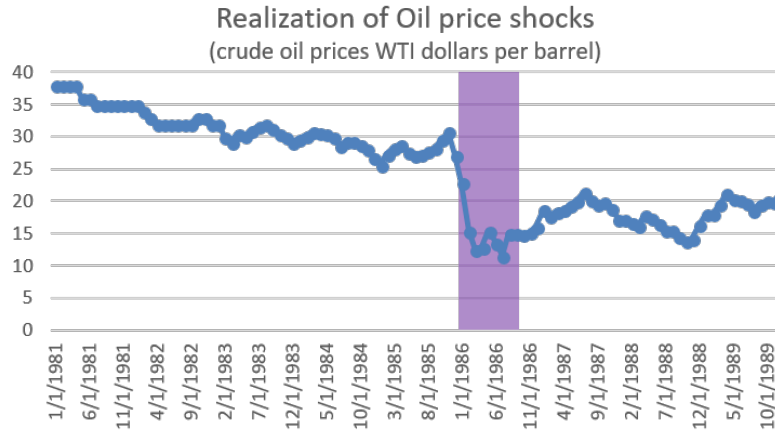


Fig. 2.6. 1986 oil shock

The figure shows the oil price dynamics retrieved from FRED's West Texas Intermediate oil price series.

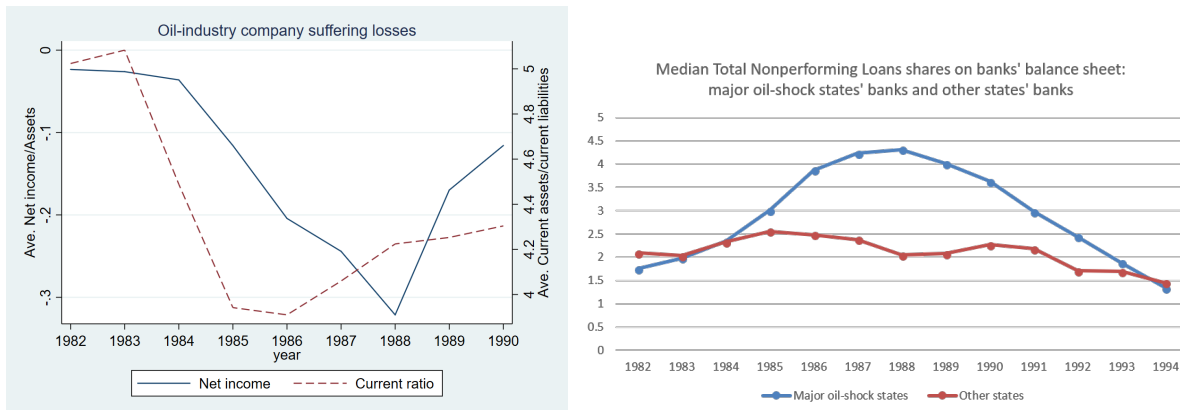


Fig. 2.7. U.S. oil company losses after the oil price glut 1986 and Banks' NPL dynamics

The figure shows the oil firms' losses after the 1986 oil price glut. The blue line shows the weighted average of Net Income/Assets of all firms with SIC code 1311 in Compustat (Annual) on the left-axis; on the right-axis is the dynamics of weighted average of current ratio of firms during this period. Current ratio is calculated as current assets/current liabilities. On the right panel we show the average NPL of banks in oil-states and those in other states in U.S.. NPL the total non-performing loans scaled by total loans outstanding. Total nonperforming loans equals the sum of Total Loans and Lease Finance Receivables, Nonaccrual (call report RCFD1403) and Total Loans and Lease Finance Receivables, Past Due 90 Days and More and Still Accruing (call report RCFD1407). Total loans equals Total Loans and Leases, Net of Unearned Income call item RCFD2122.

Table 2.11. Treatment effects of oil-price shock on bank lending in deregulated and non-deregulated states

	Systemic		Idiosyncratic	
	(1)	(2)	(3)	(4)
1[Post]	0.154*** (0.0243)	-0.160*** (0.0227)	-0.0945*** (0.0203)	-0.114*** (0.0294)
1[Post]×1[Deregulated]	-0.0336*** (0.00979)	-0.0155*** (0.00814)	0.0467*** (0.00638)	0.0159*** (0.00388)
Observations	46940	46940	161172	161172
R^2	0.939	0.958	0.949	0.960
Bank FE	✓	✓	✓	✓
3-zip FE	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓
State FE	✓	✓	✓	✓
Controls	N	✓	N	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

$$y_{b,z,q} = \alpha_i + \gamma_{z,q} + \beta_1 1[\text{Post}] + \beta_2 1[\text{Deregulated}] \times 1[\text{Post}] + \beta_3 \mathbf{X} + FE_s + \epsilon_{b,z,q}$$

b refers to bank, z refers to 3-digit zip code area, t refers to year-quarter, $y_{b,z,t}$ is $\ln(\text{C\&I loans})$ of bank b in 3-digit zip z in year-quarter t . The panel covers all banks in operation from 1982-1990. 1[Post] switch on to 1 from 1986. 1[Deregulated] is equal to 1 if the state the bank is located deregulated no later than 1987. Controls are bank-level controls including log of assets, agricultural loan share and real estate loan share.

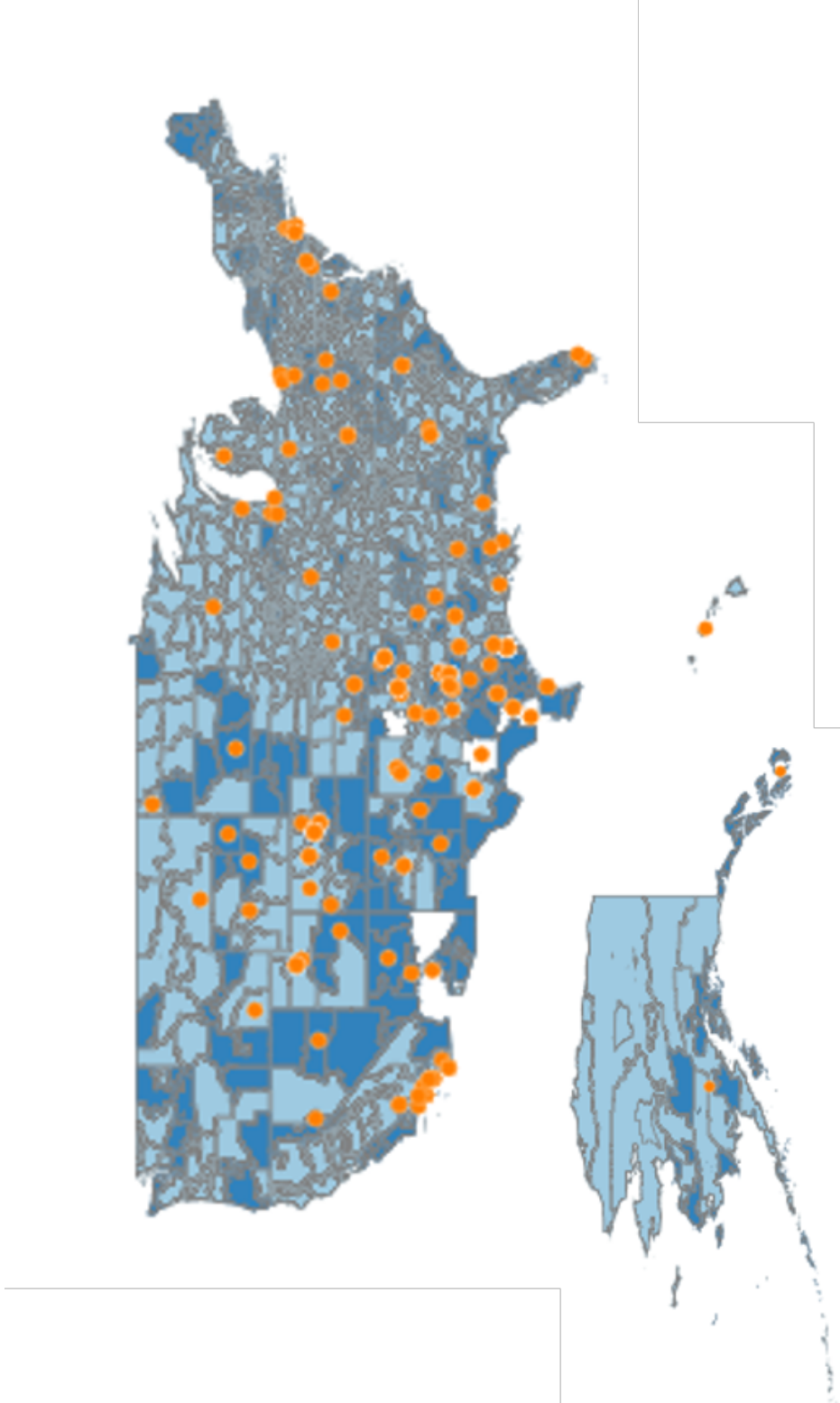


Fig. 2.8. Distribution of hit geographic units

The figure shows the distribution of the hit 3-digit zip-code geographic units defined in section 2.6.2, and the distribution of oil companies. The figure in darker blue shows the 3-digit zip code areas that are defined as being systemically exposed to the oil-price shocks. The orange dots show the location of oil companies in 1985. Locations of oil companies are constructed from Compustat with two-digit SIC code 13. The dark blue shaded three-digit zip-code areas are those with $Ave. \frac{within_3\text{-month_overdue}}{Total\ assets}_{85} > 3.35\%$, the average is the weighted average weighed by bank's total assets in 1985.

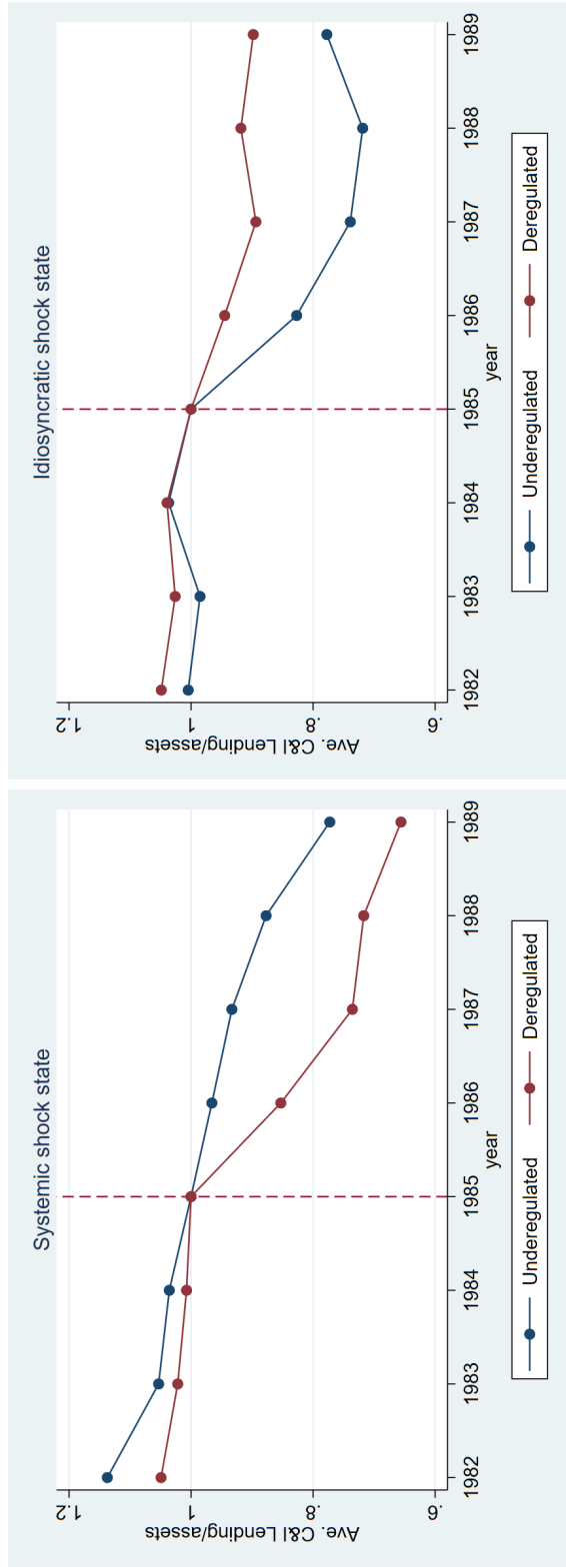


Fig. 2.9. C&I lending dynamics of banks in deregulated and underegulated states

Notes: The figure plots the dynamics of average bank C&I lending dynamics of banks in Oil states and Non-Oil states. Each dot represents the weighted average of C&I lending of banks in the states. Systemic shock states include Oklahoma, Louisiana, New Mexico, California, North Dakota, Wyoming, Arkansas, Utah and Alaska; Idiosyncratic shock states include all other states that contains at least one three-digit zip code are that is defined as exposed to shocks.

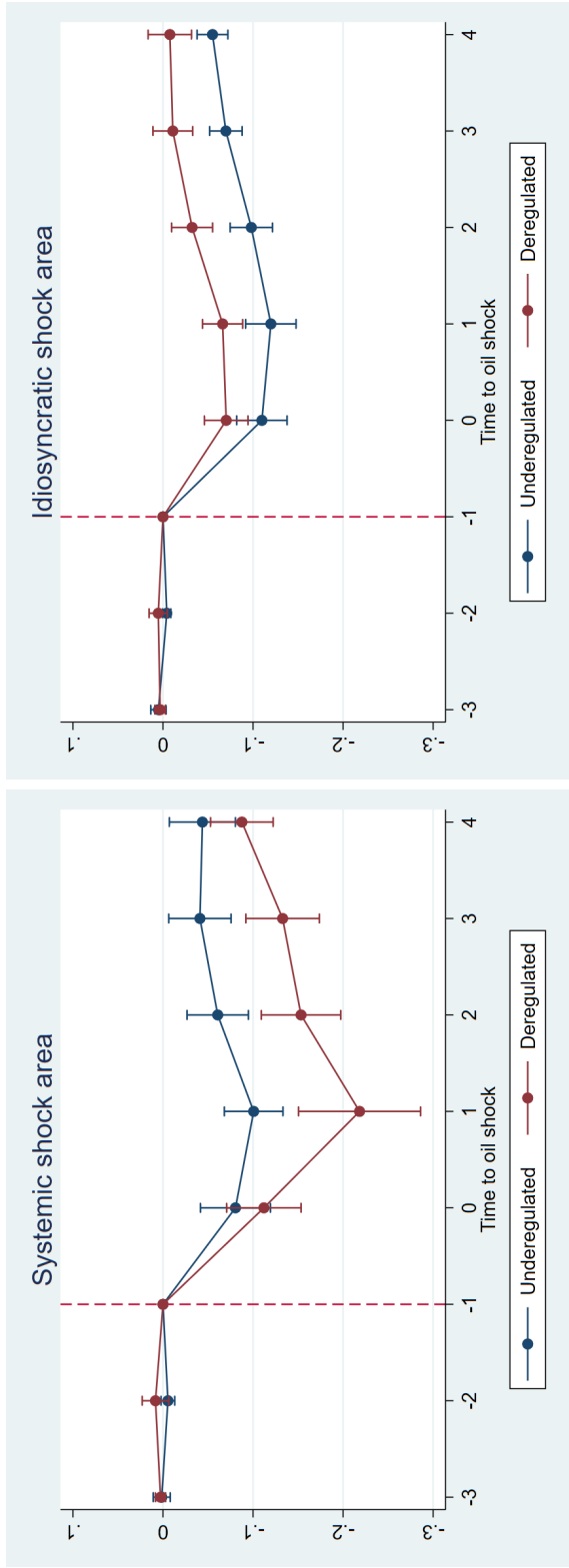


Fig. 2.10. C&I lending dynamics of banks in deregulated and underregulated states

$$y_{b,z,q} = \alpha_i + \gamma_{z,q} + \sum_{t=1982,t \neq 1985}^{t=1990} \beta_t 1[\text{Deregulated}] \times 1[\text{Year}=t] + \mu 1[\text{Deregulated}] + \beta_3 \mathbf{X} + FE_s + \epsilon_{0,z,q}$$

$$y_{b,z,q}^{\text{Deregu./Underregu.}} = \alpha_i + \gamma_{z,q} + \sum_{t=1982,t \neq 1985}^{t=1990} \beta_t 1[\text{Year}=t] + \beta_3 \mathbf{X} + FE_s + \epsilon_{0,z,t}$$

Notes: The regression includes three-digit zip area, bank and state fixed effects and standard errors are clustered at state level. Control variables include log of banks' assets, agricultural loan share and real estate loan share. To make the above figure, the second equation is run and coefficients are plotted separately.

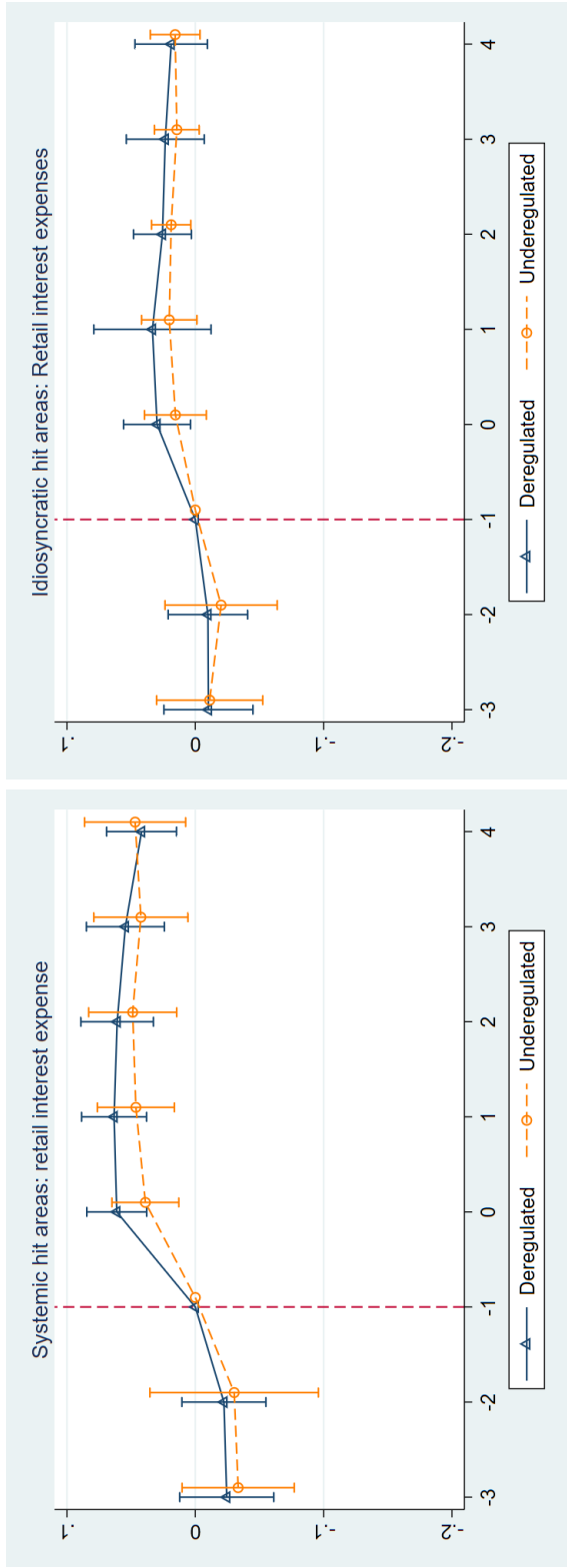


Fig. 2.11. Retail funding costs changes of banks in deregulated and underregulated states

$$\begin{aligned} \text{Ln}(\text{Retail int. expense})_{b,z,q} &= \alpha_i + \gamma_{z,q} + \sum_{t=1982, t \neq 1985}^{t=1990} \beta_t 1[\text{Deregulated}] \times 1[\text{Year}=t] \\ &+ \mu 1[\text{Deregulated}] + \beta_3 \mathbf{X} + FE_s + \epsilon_{b,z,q} \end{aligned}$$

Notes: The figure plots the dynamics of exposed banks' retail interest expenses by whether the bank is located in a systemically hit or idiosyncratically hit three-digit zip code area.

Table 2.12. Treatment effects of oil-price shock on banks' retail funding costs in deregulated and non-deregulated states

	Systemic		Idiosyncratic	
	(1)	(2)	(3)	(4)
1[Post]	0.0131*** (0.00416)	0.0221*** (0.00469)	0.00364*** (0.00101)	0.00358** (0.00112)
1[Post]×1[Deregulated]	0.0172*** (0.00398)	0.0213*** (0.00471)	0.00394 (0.0106)	0.00382 (0.00548)
Observations	46214	46202	60365	60167
R^2	0.182	0.194	0.185	0.209
Bank FE	✓	✓	✓	✓
3-digit zip FE	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓
Controls	N	✓	N	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

$$\text{Retail rate}_{b,z,q} = \alpha_i + \gamma_{z,q} + \beta_1 1[\text{Post}] + \beta_2 1[\text{Deregulated}] \times 1[\text{Post}] + \beta_3 \mathbf{X} + FE_s + \epsilon_{b,z,q}$$

Notes: b refers to bank, z refers to 3-digit zip code area, t refers to year-quarter, retail rate $_{b,z,t}$ is $\frac{\text{Interest expense on deposits}}{\text{Ave. quarterly deposits}}$ of bank b in 3-digit zip z in year-quarter t . The panel covers all banks in operation from 1982-1990 (bankrupted banks are excluded). 1[Post] switch on to 1 from 1986. 1[Deregulated] is equal to 1 if the state the bank is located deregulated no later than 1987. Controls are bank-level controls including log of assets, agricultural loan share and real estate loan share.

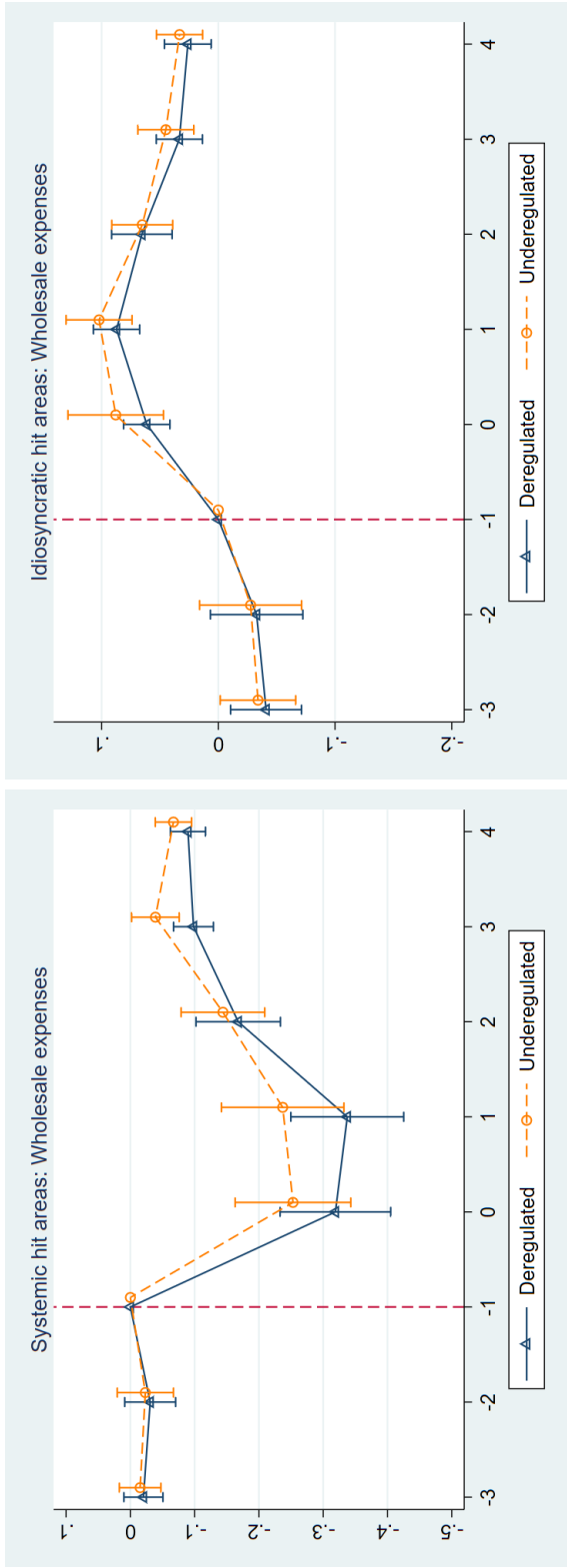


Fig. 2.12. Retail funding costs changes of banks in deregulated and underregulated states

$$\begin{aligned} \text{Ln}(\text{wholesale int. expense})_{b,z,q} &= \alpha_i + \gamma_{z,q} + \sum_{t=1982, t \neq 1985}^{t=1990} \beta_t 1[\text{Deregulated}] \times 1[\text{Year}=t] \\ &+ \mu 1[\text{Deregulated}] + \beta_3 \mathbf{X} + FE_s + \epsilon_{b,z,q} \end{aligned}$$

Notes: The figure plots the dynamics of exposed banks' wholesale interest expenses by whether the bank is located in a systemically hit or idiosyncratically hit three-digit zip code area.

Table 2.13. Treatment effects of oil-price shock on banks' wholesale funding costs in deregulated and non-deregulated states

	Systemic		Idiosyncratic	
	(1)	(2)	(3)	(4)
1[Post]	0.0138*** (0.00311)	0.0128*** (0.00321)	0.0129*** (0.00322)	0.0121*** (0.00256)
1[Post]×1[Deregulated]	-0.00126 (0.00218)	-0.00108 (0.00262)	-0.00577** (0.00119)	-0.00639*** (0.00125)
Observations	18273	17917	60685	59781
R^2	0.199	0.276	0.172	0.193
Bank FE	✓	✓	✓	✓
3-digit zip FE	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓
Controls	N	✓	N	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

$$\text{wholesale rate}_{b,z,q} = \alpha_i + \gamma_{z,q} + \beta_1 1[\text{Post}] + \beta_2 1[\text{Deregulated}] \times 1[\text{Post}] + \beta_3 \mathbf{X} + FE_s + \epsilon_{b,z,q}$$

Notes: b refers to bank, z refers to 3-digit zip code area, t refers to year-quarter, $\text{wholesale rate}_{b,z,t}$ is Interest expense on federal funds and repo liabilities (RIAD4180) of bank b in 3-digit zip z in year-quarter t . The panel covers all Ave. quarterly federal funds and repo liabilities (RCFD3353) banks in operation from 1982-1990 (bankrupted banks are excluded). 1[Post] switch on to 1 from 1986. 1[Deregulated] is equal to 1 if the state the bank is located deregulated no later than 1987. Controls are bank-level controls including log of assets, agricultural loan share and real estate loan share

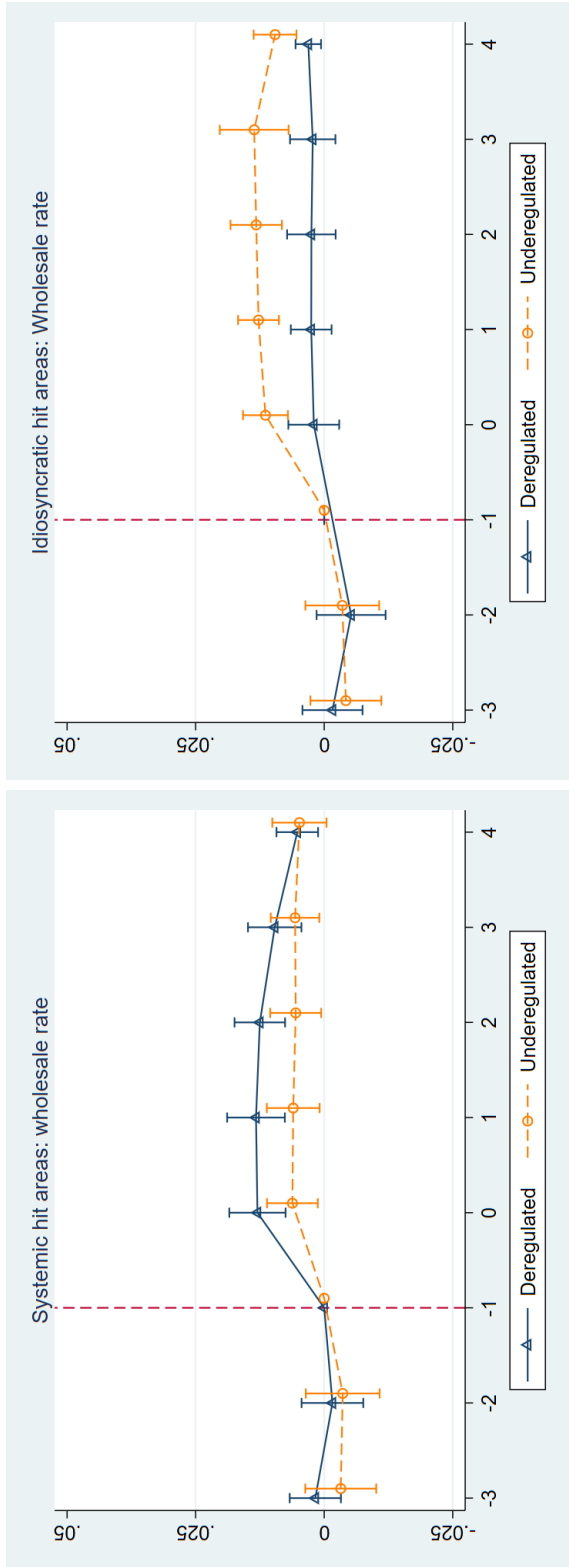


Fig. 2.13. Wholesale funding costs changes of banks in deregulated and underregulated states

$$y_{b,z,q} = \alpha_i + \gamma_{z,q} + \sum_{t=1982,t \neq 1985}^{t=1990} \beta_t 1[\text{Deregulated}] \times 1[\text{Year}=t] + \mu 1[\text{Deregulated}] + \beta_3 \mathbf{X} + FE_s + \epsilon_{b,z,q}$$

$$y_{b,z,q}^{\text{Dereg.}/\text{Underregu.}} = \alpha_i + \gamma_{z,q} + \sum_{t=1982,t \neq 1985}^{t=1990} \beta_t 1[\text{Year}=t] + \beta_3 \mathbf{X} + FE_s + \epsilon_{b,z,t}$$

Notes: The regression includes three-digit zip area, bank and state fixed effects and standard errors are clustered at state level. Control variables include log of banks' assets, agricultural loan share and real estate loan share. To make the above figure, the second equation is run and coefficients are plotted separately.

Table 2.14. Wholesale liability issuance by local banks from adjacent and distant banks

	Δ Net Wholesale assets	
	(1)	(2)
	Adjacent region	Distant region
Δ Net wholesale Liabilities	0.113***	0.0152
	(0.0224)	(0.0211)
Observations	64090	14630
R^2	0.101	0.122
Bank FE	✓	✓
3-digit zip FE	✓	✓
3-digit zip-year FE	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

$$\Delta \text{Net wholesale assets}_{c,t} = \alpha_c + \Delta \text{Net wholesale liabilities}_t^{\text{Adj./Dist.}} + FE's + \epsilon_{c,t}$$

Notes: the above regression is specified at the county level and standard errors are clustered at three-digit zip-year level.

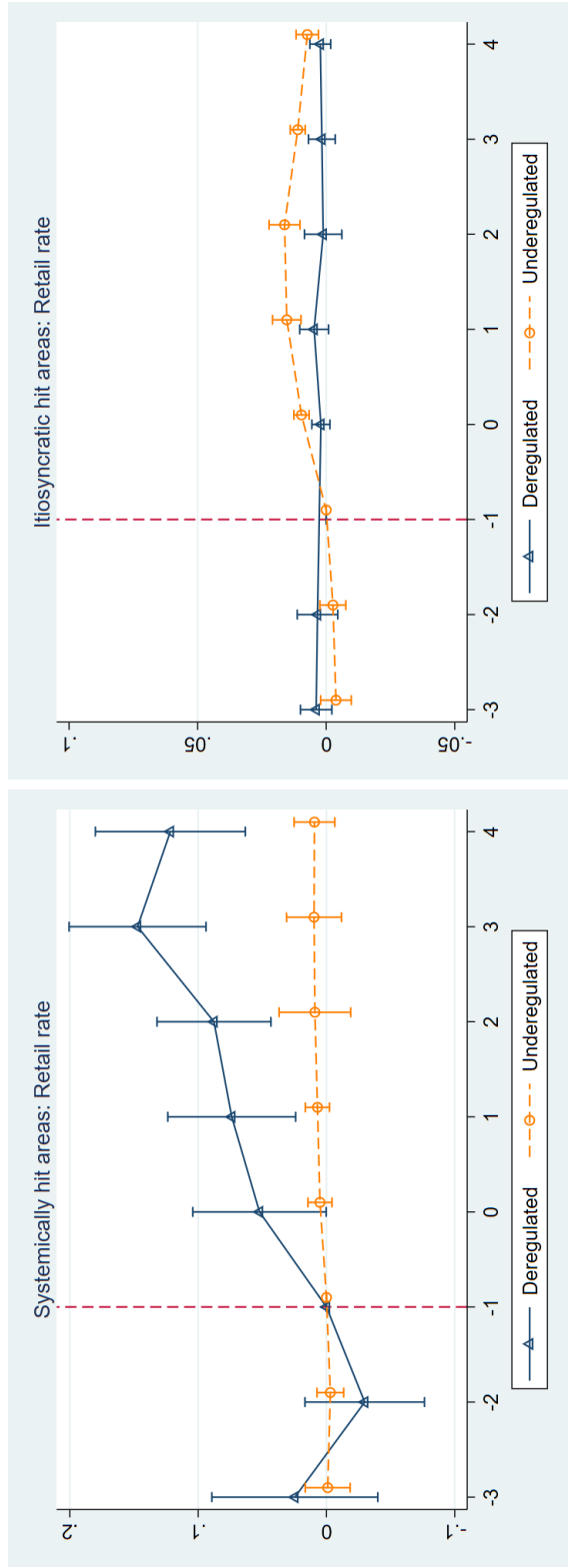


Fig. 2.14. Retail funding costs changes of banks in deregulated and underegulated states

$$\text{Retail rate}_{b,z,q} = \alpha_i + \gamma_{z,q} + \beta_1 1[\text{Post}] + \beta_2 1[\text{Deregulated}] + \beta_3 \mathbf{X} + FE_s + \epsilon_{b,z,q}$$

Notes: b refers to bank, z refers to 3-digit zip code area, t refers to year-quarter, retail rate $_{b,z,t}$ is $\frac{\text{Interest expense on deposits}}{\text{Ave. quarterly deposits}}$ of bank b in 3-digit zip z in year-quarter t . The panel covers all banks in operation from 1982-1990 (bankrupt banks are excluded). $1[\text{Post}]$ switch on to 1 from 1986. $1[\text{Deregulated}]$ is equal to 1 if the state the bank is located deregulated no later than 1987. Controls are bank-level controls including log of assets, agricultural loan share and real estate loan share.

Table 2.15. Variable Definition and Source

Variable	Source and definition
Total Assets	Call report RCFD2170
Deposits	Call report RCON2200: Total Domestic Deposits
Uninsured Deposits	Call report RCON2604 before 2009Q4 and RCONJ474 after that: Uninsured deposits are deposits greater than \$100k until 12/31/2009 and greater than \$250k after that.
Transaction deposits	Call report RCON2215: Total Transaction accounts.
Time deposits	Call report (RCON2604+RCON6648): Sum of total time deposits accounts more than \$100,000 and time deposits accounts less than \$100,000.
Total loans	Call report RCFD1400+RCFD2165 before 1984 and RCFD1400 after 1984: Total Loans and Leases.
Wholesale Liability	Call report RCFD2800 before 2002Q1 and (RCFDB993+RCFDB995) after 2002Q1: Fed funds purchased and securities sold under agreements to repurchase.
Wholesale Assets	Call report RCFD2800 before 2002Q1 and (RCFDB993+RCFDB995) after 2002Q1: Fed funds purchased and securities sold under agreements to repurchase.
Interest expense on wholesale funding	Call report RIAD4180: Interest expense on Fed funds purchased and securities sold under agreements to repurchase.
Interest expense on retail funding	Call report RIAD4170: Interest Expenses on Deposits
C& I Loans	Call report RCFD1350 before 2002Q1 and RCFDB987+RCFDB989 after 2002Q1: Fed funds sold and securities purchased under agreements to resell.
Real Estate Loans	Call report RCFD1410.
Agricultural Loans	Call report RCFD1590.
Short-term overdue	Call report RCFD1403-RCFD1407: total past due loans minus the past due loans over 3 months.

CHAPTER 3

RISE OF DOMESTIC BANKS IN EME CROSS-BORDER CREDIT INTERMEDIATION

3.1. Introduction

Cross-border capital has played an important role in boosting and sustaining the growth of emerging market economies (EMEs). Since the 1970s, most EMEs across the world have liberalized capital accounts to allow for international capital inflow. Following capital account liberalization, there was a steady growth in the volume of cross-border capital that flowed into EMEs from developed economies during the last two decades of the 20th century. Near the end of the century, the volume of foreign credit received by many emerging market countries rose above 30% of their GDP level.

While an extensive literature has documented the growing importance over the last half century of cross-border capital to EMEs, a more recent and equally striking transformation that has taken place in EMEs has received little attention.¹ During the past three decades, the volume of foreign capital received by EMEs scaled by their GDP has not increased much, but its structure has changed dramatically.² Before the 1990s, more than 90% of the cross-border capital that moved to the EME's corporate sector was channeled directly by foreign banks from developed markets; by 2010, an average of more than 50% of cross-border credit was being channeled by domestic banks in EMEs.

What caused this structural change in how cross-border capital flows to EMEs? More importantly, would such a change in capital flow structure materialize into real changes that have a non-trivial economic significance? This paper addresses these questions.

1. See, for instance, Kose et al. (2009) for a comprehensive survey of the literature that documents the increasing degree of financial globalization since the 1970s. In this literature, most of the research has focused on the volume of cross-border capital that flows to emerging market economies.

2. Throughout this paper, the dimension of the structure of cross-border credit that is of interest is how it flows into EMEs. Of special interest is the question of who channels these cross-border credits to borrowers from EMEs.

The structural change in how credit from developed markets is channeled to emerging markets is marked by the rise of domestic global banks in EMEs, which can raise money from the global funding market and then lend it to their domestic corporations. We find that the rise of these domestic global banks in EMEs and the growing importance of the role they play in channeling cross-border capital coincides with drastic changes in the structure of money markets in developed economies.

The U.S. money market, which is a major source of the cross-border capital that flows to EMEs around the world, experienced significant changes towards the end of the 1980s. Although the first appearance of the money market mutual fund can be dated back to 1971, the market share in the U.S. capital market taken by these institutions did not rise to a non-trivial figure until the late 1980s. Since the 1988-1989 savings and loans crisis in the US, the share of S&L institutions in U.S. capital market has greatly shrunk. At its 1988 peak, S&L institutions took up nearly a third of the US capital market; by the mid 1990s, this number had fallen below 10%. Much of the market share that S&L institutions lost was gained by money market mutual funds (MMMF).³ Unlike S&L institutions, whose investment choices are bounded by strict regulatory constraints, MMMFs are given much larger flexibility to place the money they raise. In particular, MMMFs will (and can) deploy a non-trivial part of the money they gain from S&L institutions to pursue profitable oversea investment opportunities, which is what traditional banks have been doing since the 1970s. Empirically, we find that US mutual funds' foreign asset holdings (as shares of total asset) increased from less than 1% in 1986 to more than 12% in 1996.

Yet money market mutual funds and traditional commercial banks from developed markets show drastic differences in how they transmit credit to emerging markets. Since commercial banks from the developed market began lending to EMEs, a predominant fraction of this cross- border capital has been directly received by non-financial corporations in EMEs. This is not surprising: these foreign commercial banks know very well how to deal with

3. Some recent studies have attributed the quick rise of MMMF around early 1990s to the demographic change in US during that period. See for instance Ordoñez and Piguillem (2018).

(screen and monitor) corporate borrowers. There is thus no reason to add an extra layer to the splitting of the pie.

On the contrary, shadow banking institutions like MMMFs generally are not equipped with the screening or monitoring technologies that are necessary for financing corporate firms. Lacking such direct financing techniques, these non-bank lenders from the developed market have to rely on an extra layer to transmit capital to emerging market borrowers. Indeed, we show that over 80% of U.S. mutual funds' long-term foreign lending is received by the financial sector of credit-receiving EMEs, which then allocates this capital to the corporate sector. By comparison, nearly two thirds of the credit channeled by U.S. commercial banks to EMEs is directly received by the corporate sector.

A natural question arises: If the manner in which cross-border capital is transmitted to EMEs were to change, would this make an economically non-trivial difference? Our paper suggests that it would: such a change would induce significant changes in who receives these credits and in how these credits are received. We now elaborate.

The point made in this paper hinges on the following fact: when they extend credit to firms in EMEs, foreign lenders and domestic lenders employ significantly different lending technologies. The origins of the differences between the lending technologies of domestic and foreign lenders when facing borrowers in EMEs lie in the constitution of corporate firms' borrowing capacity. The debt capacity of any corporate firm can be broadly categorized into two exclusive sources: those that are tangibility-based and those that are transparency-based. The most common form of tangibility-based lending is the secured loan backed by hard assets as collateral, the value of which is usually insensitive to a firm's own performance.⁴ Examples of transparency-based lending include unsecured loans and loans secured by the cash flow of borrowing firms, which often involve the inclusion of EBITDA-related covenants in the credit agreements.

The value that lenders can recover from the collateral assets, be it hard assets or bor-

4. Hard assets that are often pledged as collateral in corporate loans include land, real estate properties, machines and equipment, inventories, etc. It often requires frequent and timely monitoring and checking to guarantee the efficacy of these hard assets as collateral.

rower’s cash flow, determines a firm’s debt capacity. Consequently, a firm’s debt capacity is likely to be lender-specific. In emerging markets, the liquidation of defaulting borrowers’ hard assets often features prolonged liquidation process and a low net recovery rate due to a relatively weak legal protection of creditor rights. Thus, a lender’s ability to conveniently conduct a timely monitoring of the pledged collateral could be crucial in weak legal environments. In this paper, we show that although no significant differences can be discerned between foreign and domestic banks in lending on the basis of borrower transparency, this lender identity difference becomes noticeable in the case of hard-asset-based lending.

Empirically, we find that among the loans extended to borrowers from emerging markets, over 60% of those extended by domestic banks are backed by fixed assets as collateral, while only 20% of foreign bank extended loans are tangibility-based. Furthermore, we find that this distinction is much more pronounced for emerging market countries that have relatively high insolvency resolution costs. While foreign lenders on average are 16.3% less likely than domestic lenders to lend against fixed assets in extending credits to EME borrowers, the difference widens by another 5.3% every one more year it takes to resolve insolvency in the borrower’s economy. In contrast, we observe no significant differences in lending base preferences between foreign and domestic lenders when credit is extended to borrowers from developed markets.

To strengthen our identification of the causal relationship between a lenders’ identity and its lending base preference in extending credit to borrowers from EMEs, we conduct a within firm (and loan package) analysis.⁵ Specifically, through a examination of tranche-level credit agreements data that contains detailed information about collateral structure and lender composition, we exploit the variation across different tranches of credit agreements within the *same* loan package. In this way, We identify a significant difference in lending

5. The main endogeneity issue that we need to deal with when establishing the causal relationship is selection biases on both the lenders’ side and the borrowers’ side. For instance, the fact two firms borrow from foreign and domestic banks against different lending bases could be driven by different asset structures or the business nature of these two firms rather than by differences in lending base preferences on the lender side. We discuss these potential selection issues and how they might affect our causal identifications in Section 3.4.3.

base preference between foreign and domestic lenders when they extend credit to borrowers from EMEs. Empirically, we find that a 15% increase in the foreign banks' share in the total tranche amount is on average associated with a 36% decrease in the likelihood that a loan deal tranche is contracted on fixed assets as collateral. Relatedly, we estimate a 28.1% increase in the likelihood of covenant inclusion after a 15% increase in foreign banks' share in the tranches' total amount.

Having documented this important difference between the lending technologies of domestic and foreign lenders, we show that domestic and foreign banks produce different “outputs” in the cross-border credit market. Specifically, we examine our deal-level observations of foreign credit agreements established in various emerging markets and show that differences in the lender composition would lead to differences in 1) who are more likely to be the receiver of the credit; and 2) the credit volume received by a given borrower.

Running a multinomial logit estimation, we find that a 10% percent increase in domestic bank share in a deal package leads to a 31.2% increase in the probability that the credit will go to a firm in tangible industries and a 21.5% increase in the likelihood that the credit will be received by an unlisted firm. These results are consistent with those obtained for foreign credit volume. Conditional on the credit receiving firm being from a high-tangibility industry (or being a privately traded firm), a 20% increase in the domestic bank share is associated with a 3.7% (or a 3.5%) increase in the deal volume. In contrast, no significant relationship is observed between the lender identity and the volume of a deal package when loans are conditional on borrowers being from lower-tangibility industries or publicly traded borrowers.

These findings at the disaggregate level naturally lead us to answer the question raised at the beginning: What real economic impact can be generated by the rise of domestic banks in transmitting cross-border credit to EMEs? During the era before the rise of the domestic global banks, cross-border capital was predominantly channeled directly and, thus, it was allocated by foreign banks. Consistent with our finding about the lending base preference of foreign banks in extending credit to EME borrowers, the cross-border capital channeled

to EMEs during this period are primarily in the form of unsecured loans or loans secured by borrowers' cash flow or account receivables. Accordingly, we find that the receivers of cross-border credit during such episodes are mostly highly-rated and publicly listed firms, and EBITDA-related covenants are often seen in these foreign currency denominated credit agreements, guaranteeing the required transparency. From 1986 to 1990, only 5.6% of the USD denominated cross border credit was allocated to private firms in EME and less than 4.8% of the USD denominated loans flew to firms in high-tangibility industries.

The structural changes in the money market of developed economies since the early 1990s have given domestic banks from EMEs better access to the global capital market. Now able to borrow foreign credit from institutional lenders in developed economies, these EME banks can compete with their foreign counterparts in transmitting cross-border capital to EMEs. At individual firm level, we show that many firms that formerly relied on foreign banks for cross-border credit switched to domestic banks when the latter gained accesses to the global capital market. These newly risen domestic global banks in EMEs are able to attract firms that originally borrow from foreign lenders because of their "superior" lending technology. The ability to lend against hard assets allows these domestic global banks to offer credit contracts that feature larger loan sizes and fewer restrictive covenants than those offered by foreign lenders, which must rely on the inclusion of covenant to conduct transparency-based lending.

Consistent with this intuition, we find a clear reduction in covenant inclusion in credit agreements associated with borrowers that switch from foreign lenders to domestic lenders. The allocation of cross-border credit at the aggregate level has changed dramatically. Until 2011-2015, 37.6% of the total value of USD denominated cross-border credit was received by the private firms and more than 20% of the cross-border USD denominated credit was allocated to firms in the high-tangibility sectors in EMEs.

While in this paper we do not take a stance on the pros and cons of the rise of domestic global banks in EMEs, we show that the rise of domestic banks in transmitting cross-border capital to EMEs can greatly reshape the industry and capital market structure in EMEs, and

it can increase the susceptibility of these economies to changes in global financial market conditions. Specifically, we find that the average long-term debt (scaled by lagged total assets) of tangible industries increased by 16.2% during the period 1995-2010, compared with its level before 1995; the corporate annual investment rate of tangible industry firms (measured by capital expenditures scaled by lagged total assets) increased by 5.2%. In contrast, no comparable changes are seen in intangible industries. Not surprisingly, we find an overall higher tangible industry share of total GDP in emerging markets around the world. During this period, the average tangible sectors' output value added as a share of GDP of emerging market economies increased from 15.13% to 24.33%, while average employment in tangible industries increased from 14.67% to 23.12%.⁶ Similarly, we find that globalization of banking sector in EMEs also brings additionally faster asset growth and leverage buildup for private and unlisted firms.

In addition to a reshaped industry structure, the sensitivity of real economic outcomes in emerging markets to global financial conditions seems to have increased, accompanying banking globalization in these economies. Comparing the coefficient estimates (before and after 1995) of regressions at the country-year level, we found that before 1995, a 0.5 increase (decrease) in the NFCI index (about half of its standard deviation) is associated with an average of 13 basis point decrease (increase) in real GDP growth rate.⁷ After 1995, a same magnitude change in NFCI is associated with an average 85 basis point change in real GDP growth rates in emerging markets around the world.

In addition to these time trend patterns, we exploit cross-country variation for establishing a causal relationship. In other words, given that the replacement of foreign banks by domestic banks in channeling cross-border credit can occur to different degrees in different countries, we examine whether variations in this dimension will result in different real outcomes. Our estimation results suggest affirmative answers. In particular, compar-

6. The share of tangible industry in total GDP is measured as the manufacturing sector's value added as a percentage of GDP; the share of employment in tangible industries is measured as total share of employment in a country's construction, mining, and manufacturing sectors.

7. "NFCI" stands for the Chicago Fed National Financial Condition Index, which is measure of the global financial conditions for emerging markets.

ing post-1995 levels of real economic variables to their pre-1995 levels, we find that a 10% higher de facto cross-border credit channeled by domestic banks is associated with a 2.13% higher tangible industrial sector value added to GDP, a 2.98% higher employment of those employed in tangible industrial sector and a 5.62% higher average annual investment rate in the tangible sector. Similarly, we show that economies in which domestic banks play a larger role in channeling cross-border capital also exhibit higher real economic outcome susceptibility during the global financial cycles.

To further strengthen this causal relationship, we employ and examine several instrumental variable to extract exogenous variations in the cross-country heterogeneity in the share of domestic bank-channeled foreign credit. One variable we consider is the level of financial literacy of emerging markets. We find that countries that have a higher level of financial literacy feature a larger degree of replacement between foreign and domestic lenders after the capital supply shock—i.e., the structural change in money markets in developed economies. In addition, no significant correlation is found between the volume of foreign capital inflow and the financial literacy of the credit receiving country.

Another instrumental variable we utilize is the pre-1990 degree of the exposure of the domestic banking sector to the global funding market for each emerging market. That is, prior to the structural change in the US money market that occurred during the early 1990s, how much connection had an EME's banking sector built with the global capital market? For those with a higher level of endowed connection to the global funding market, we should expect a greater replacement of foreign banks by domestic banks after the rise of MMMFs in the US money market. Regressions based on these instrumental variables confirms that the rise of domestic banks in transmitting cross-border capital to EMEs can significantly reshape the industry structure of these economies and increase their sensitivity to global finance cycles.

Related literature Our paper is closely related to two main strands in the literature. The first includes a growing body of literature that emphasizes the phenomenon of the global financing cycle and the transmission of center economy financial condition changes to emerging

market economies. Recent research in this area has investigated the increasing co-movement of capital flows, financial flows, and asset prices in global economies: Rey (2013), Miranda-Agrippino and Rey (2015a), Jiang et al. (2018), Gabaix and Maggiori (2015), Obstfeld and Taylor (2017), and Han and Wei (2016). Previous research studied how EME companies react to switches in global financial conditions in a globalized financial market setting: Kalemli-Ozcan et al. (2018), ?, Bruno and Shin (2017), Alfaro et al. (2019). Researchers have also documented how global banks are impacted by center economy conditions and how they intermediate credit from center economy to the EME firms: Avdjiev and Hale (2019), Brauning and Ivashina (2017), Cetorelli and Goldberg (2012), Dages et al. (2000), Ivashina et al. (2015), Giannettiv and Laeven (2012), and Demirgüç-Kunt et al. (2017). Our paper contributes to this strand in the literature by documenting a novel trend wherein the domestic banks that replace foreign banks in the cross-border market can generate new channels of global financing cycle transmission. We also are the first to highlight that when domestic and foreign banks intermediate cross-border credit, they show fundamental differences in leading technologies.

Second, our work is related to the literature that examines how financial development and financial intermediation affect real economic outcomes. The recent representative works in this strand include: Khwaja and Mian (2008b), Mian et al. (2013), Schnabl (2012), Calomiris (2011), Caballero and Krishnamurthy (2001), and Caballero and Krishnamurthy (2003). We contribute to this strand by showing, first, that the global financial market transformation in the 1990s, or more precisely, the emergence of institutional investors in U.S., greatly reshaped the way credit flows from the center economy to the emerging market economy, and, second, that this pure financial market transformation has led to a reshaped industrial structure and real growth susceptibility towards global financial condition switches in EME.

The rest of the paper is organized as follows. Section 3.2 describes the data source and the sample construction for the empirical exercise that this paper conducts. In section 3.3, we document a recent trend in banking globalization that takes place in many EMEs around the

world, and we show its relationship to structural changes in the money markets of developed economies. Section 3.4 examines how domestic banks, which play an increasingly important role in the channeling of foreign capital to EMEs, behave differently from foreign banks when they extend credit to corporations in EMEs. Section 3.5 then investigates the impact of the rise of domestic global banks in EMEs on the allocation and reception of cross-border capital and on its its real impact on economies at aggregate levels. Section 3.6 concludes the paper.

3.2. Data Description

We obtain our data from three categories of data sources. The first is detailed documents of loans issued by domestic and foreign lenders to the emerging market corporate sectors; the second is balance sheet information about firms and banks; and the third is the macroeconomic condition variables. We describe the three categories in more detail.

3.2.1. Loan details and collateral Information

We obtain detailed information about the loans from Thomson Reuters' LoanConnector and LPC Dealscan. These two databases share the same underlying data source, which is syndicated bank loans issued by corporate sectors around the world. The former database focuses on loan characteristic details while the latter focuses on lender composition and borrower information.

We record transaction-level information about syndicated loans to emerging market non-financial corporations. Drawing on on documents extracted from the web-version of LoanConnector, that information includes the loans' borrower, starting date, maturity date, pricing, currency, lender composition (including each banks' contribution), and the details of assets that serve as the loans' collateral. using the documents extracted from the web-version of LoanConnector. Our data's uniqueness lies in the detailed informationit provides about loan collateral.

For at least three reasons, syndicated loans function well for the investigation of trans-

mission of U.S. monetary policy towards emerging markets' corporate sector for at least three reasons. First, syndicated loans constitute more than 50% of the increases in cross-border bank lending and more than thirty percent of on-balance sheet bank claims in the cross-border positions (Cerutti et al. (2015)).⁸ ⁹ Second, given that USD is the dominant currency in international finance and trade (Gopinath and Stein (2018), Brauning and Ivashina (2017)), syndicated lending captures more than 95% of all bank lending transactions denominated in USD by both domestic and global banks. This high coverage allows us to develop a full screen-shot image of dollar-funding cost condition changes. Third, syndicated loans to EME non-financial corporate sector serve the goal of capturing the bank lending in domestic currency. Domestic currency syndicated loans in EME averaged 47.8% of total syndicated loan amount, and on the firm side, the recipient firms cover both publicly-traded firms and private firms.¹⁰

In this paper, we record detailed information about 5019 loan packages (11788 tranches) received by 4490 firms, and we maintain a focus on the assets that serve as collateral from 34 emerging market economies during the period 1992-2018.¹¹ ¹² Two samples of the digitized version of the documents are provided in the appendix. For each digitized record, we document the borrowers and lenders of the syndicated loans, the pricing, maturity, currency,

8. According to the aggregation calculation that uses Dealscan, the foreign-currency syndicated loan amount averages about 25.8% of GDP, which is close to the average external debt non-financial sector debt as a percent of GDP (37.8%).

9. For the reason mentioned, syndicated loans have been found to be ideal for studying international transmissions of monetary policies in a number of previous works including Giannettiv and Laeven (2012), Haas and Horen (2012), Demirgüç-Kunt et al. (2017).

10. Bond financing, an alternative source of financing, grew quickly in emerging market economies after the Great Recession, but bank loans have remained the major source of financing for most firms in emerging markets. According to documentation by Jiang and Sedik (2019), non-financial corporate bond in Asia peaked at 2200 billion USD in 2015, and the issuers were concentrated in about 200 large firms, while syndicated loans totaled 4000 billion with a total of more than 4000 firms. The pattern is also reflected in Brauning and Ivashina (2017).

11. We exclude borrowings from government and special public projects financed by international organizations, such as IFC, Worldbank, ADB.

12. The economies covered include Argentina, Brazil, Bulgaria, China, Chile, Colombia, Czech Republic, Egypt, India, Indonesia, Iran, Israel, Hungary, Korea, Kuwait, Malaysia, Mexico, Morocco, Pakistan, Peru, Philippines, Qatar, South Africa, Saudi Arabia, Romania, South Korea, Russian Federation, Taiwan, Thailand, Turkey, UAE, Ukraine, Vietnam, and Venezuela.

whether there are domestic lenders in the top-tier arrangers (lead banks), the contributions of foreign and domestic lenders in each tranche, and importantly, the assets that serve as collateral. In the second sample, Mandarin Bali Oriental Bali borrowed 108 million USD, and the company pledged one of its properties, "Mandarin Oriental Bali Resorts," as collateral. The category of this collateral is "Real Estate." For all 11788 tranches, we have concrete information about the categories of collateral used, although for some of them we do not have information about the exact assets or goods pledged. The constructed data from all loans that provide concrete details and that are of the collateral type covers 65.8% of the total amount of secured loans to the 34 emerging market economies in the database.

3.2.2. Corporate and bank information

We get the corporate and bank information from Worldscope, BvD ORBIS, Compustat International and Datastream. 2872 of the 4490 firms are public firms, and for more than 80% of the private data/de-listed we obtain balance sheet information from Datastream and the firms' annual report. Further, we take down information about whether the firm is a multinational entrepreneur, whether the firm is a joint venture or whether it has foreign ownership. We rely on the same databases to get information about the lending banks' ultimate parent countries and whether the lending banks' ultimate parent country is the same as the borrowing firm.

3.2.3. Cross-country aggregate variables

We get aggregate variables from Worldbank, IMF IFS, and CEIC. The macroeconomic variables involved in the regression analysis include GDP growth, inflation, domestic credit to GDP ratio, the deposit rate of domestic banks and VIX. Specifically, the external debt of an economy is available in either WorldBank or the country's bureau of statistics website.

3.3. Cross-border Capital Flow to EMEs

In this section, we examine the structure of the cross-border capital that flows to EMEs and how this foreign capital is channeled to EMEs. We document a drastic structural change in the way in which cross-bordered capital has been transmitted to EMEs since the 1990s. We provide evidence that such a structural change in cross-border capital flow to EMEs can (at least partly) be explained by significant changes in the structure of the US money market during the late 1980s.

3.3.1. *A Structural Change in how Foreign Capital Flowing to EMEs*

Over the past several decades, many emerging market economies (EMEs) around the world have experienced unprecedented economic growth. A common factor is often seen behind the fast growth in these EMEs: the flow of cross-border capital to these economies.¹³ Starting in the 1970s, emerging market economies around the world began to liberalize their capital accounts, allowing more financial inflows from lenders in the developed world.¹⁴ Since then, the volume of cross-border capital received by corporations in EMEs has been steadily rising. As shown in Figure 3.1, prior to the mid-1990s, the average private sector external debt in fifty major EMEs as a share of their GDP rose to around 30%. In the most recent two decades, this ratio of foreign currency debt to GDP in EMEs around the world seems to have reached its steady state level and has not increased much further.

While the change in the volume of cross-border capital flow to EMEs has become minimal since the late 1990s, since then a drastic compositional change has taken place. Prior to 1990, the cross-border capital flow to EMEs was predominantly channeled directly by foreign banks from developed economies. In constructing measure of cross-border capital, we classify a sum of credit to be foreign credit if the currency of the denomination of the loan is different from the borrowers' home country currency.¹⁵ As shown by the red line in Figure 3.1, almost

13. See Wei (2018), Kose et al. (2009)

14. See Kose et al. (2009)

15. This measurement of foreign capital inflow is constructed on the basis of loan-level observations as-

all of the foreign currency-denominated credit received by corporations in EMEs during this period was issued by foreign global banks.

We show that beginning in the 1990s, domestic banks in emerging markets started to play a nontrivial role in bringing in foreign credit. When constructing measures of the cross-border capital that is channeled by domestic banks in EMEs, we classify a bank as a domestic bank if the nationality of its parent economy is the domestic emerging market economy that it provides credit to; otherwise it is classified as a foreign bank. For example, when extending credit to a corporation in South Korea, Citibank as well as its branches in South Korea are categorized as a foreign bank, while Woori Bank, a bank headquartered in Seoul, is a domestic bank for South Korea. Based on this categorization, for each emerging market we calculate the fraction of foreign credit received by its corporations that is channeled by its own domestic banks.

In figure 3.1, the red curve displays the worldwide average of the fraction in foreign credit (in terms of face value) that is received by 50 major EMEs and channeled by their own domestic banks. Although this ratio remained at a minuscule level throughout 1980s, it started an ascending trend in the 1990s. Until 2007, the year prior to the global financial crises, domestic banks' foreign-currency credit had reached an amount comparable to that extended by foreign banks. Figure 3.3 uses an alternative measure in which the fraction of domestic-banks-channeled foreign credit is constructed on the basis of whether or not the loan has domestic bank participation; it shows a similar ascending trend with a comparable scale over the last 3 decades.¹⁶ Furthermore, we show that this ascent in the fraction of domestic-lender-channeled foreign credit is a general trend observed in most EMEs across the world; it is not driven by a few large EMEs. In Figure 3.2, we conduct the same calculations with EMEs grouped in different continents. A common pattern can be seen in all four panels: the volume of the cross-border capital inflow started to increase long before

sembled from LPC DealScan, which covers over 95% of the US dollar denominated loans (in terms of face value) that have occurred across the world. Our measurement does not capture the portion of credit that originates in foreign countries but is loaned by domestic banks in domestic currencies.

16. Figure 3.4 displays the same contents as Figure 3.3 using the actual amount channeled by domestic banks rather than the face value of loans with at least some domestic banks participated.

the 1990s, while domestic banks have started to play a role in transmitting foreign capital since then. In Figure 3.21, we show that this temporal trend in the role that domestic banks play in channeling foreign credit is consistently observed at the country level.

3.3.2. What causes this change?

Having documented changes in the way that cross-border capital is channeled to EMEs, we turn our attention to how these changes occur. Specifically, what factors are likely to have caused these changes? Did they occur because these emerging markets saw an internal demand for globalizing their banking sector and, thus, liberalized their domestic banks' access to the global funding market? Or did something happen on the credit supply side that made it easier for domestic banks in EMEs to raise funding from the global market? In this section, we investigate the causes of this structural change in cross-border capital flow to EMEs.

A. Demand Side Factors

The increase in the share of cross-border capital that is channeled by domestic banks could be driven by changes on the credit demand side. Imagine an emerging economy that experiences fast growth in its housing industry and imagine that only domestic banks can finance the housing industry. In this circumstance, we would expect internal demand to globalize this country's banking sector.

However, three lines of evidence in our empirical investigation suggest that changes on the credit demand side are unlikely to cause the increase. First, if internal demand drives banks in EMEs to gain more access to the global funding market, then we would expect that some countries would have developed this demand during the 1980s. But our finding that the foreign capital received by almost all EMEs was predominantly channeled by foreign rather than domestic banks during the 1980s clearly suggests otherwise.

Second, our cross-country evidence suggests that demand side factors cannot be the whole story. In Figure 3.2, we conduct at the continent level the same calculation carried

out in Figure 3.1. A notable similarity is readily seen: on all four continents, the average ratio of foreign credit channeled by domestic banks started to take off during the mid-1990s. In a more detailed country-level calculation, and as displayed in Figure 3.21, we see that this ascending trend in the importance of the domestic-bank transmission of foreign credit is consistently seen in almost all countries. After all, if an analyst were to insist that the structural changes in cross-border capital flow are all driven by internal demand from the credit-receiving EMEs, how would she explain why this internal demand arose everywhere in the world shortly after 1990?

Furthermore, we specifically examine an important alternative – the housing demand in the emerging market world. If the real estate sector can only be financed by domestic lenders (which, in section 3.4, we show is generally true in the case of EMEs), then such a global structural change in foreign credit flow can only be explained if there is an increased demand for housing everywhere in the world.¹⁷

B. Supply Side Story: Changes in the U.S. Money Market

If demand side factors cannot be the main driving force, then it is natural to expect that something happened on the credit supply side that might have contributed to this structural change in credit flow to EMEs. In this subsection, we argue that the rise of domestic banks in channeling foreign credit to emerging market economies is driven by structural changes in the U.S. money market. Translated into structural change in the global funding market, these changes lead domestic banks in the emerging market to increase their direct participation in the transmission of foreign credit.

i) Structural changes in the U.S. money market around 1990

Throughout the 1980s, the U.S.'s financial market went through an important evolution.

17. However, the domestic bank-channeled foreign credit both started during the same period and grew at a similar pace in Emerging Asia and in emerging Europe and emerging Africa. Emerging Asia saw the fastest middle-class population growth during the past two decades, while middle-class population growth stagnated in emerging Europe and emerging Africa Kharas (2011). Given the fact that residential real-estate is the most important durable goods demanded by middle-class population in an economy, these pieces of evidence suggest that housing demand could not be the sole explanation for the rise of domestic banks in the international financing market.

Deregulation in the banking sector and other deposit-taking institutions facilitated the rapid growth of savings and loans institutions and stimulated their investment in a broader set of non-homeowner related loans.¹⁸ As shown in Figure 3.5 panel (a), the asset size of S&L institutions had reached more than half of that owned by commercial banks by the end of the decade. Meanwhile, the share taken by mutual funds in the U.S. money market during the 1980s stayed at a negligible level, although the birth of the first mutual fund can be dated back to 1924.

While many S&L institutions took advantage of the loose regulation and made many speculative real estate investment, the end of the 1980s' witnessed a nationwide crisis, during which many of these S&L institutions went bankrupt.¹⁹ Since then the market share of S&L institutions in the U.S. money market had greatly shrunk. Interestingly, the biggest beneficiary of the fall of S&L institutions had been mutual funds and market market funds. In 1985, the share of assets owned by these “shadow bank” institutions was below 5%. By 1995, this number had exceeded 30%. Before the end of the century, these non-bank institutions had gained a comparable share of the U.S. money market as commercial banks. This rise of mutual funds and money market funds in the U.S. deposit market is also documented by a number of institutional studies (Swamy et al. (1996), Gup (1998), Dow and Elmendorf (1998), Kennickell et al. (1997)).²⁰

A recent literature has documented and attributed the rapid growth of mutual funds during this episode to the demographic change in the U.S. economy. As documented by Ordoñez and Piguillem (2018), the remarkable increase in population expectancy in the U.S. (and also other developed economies) translated into a large increase in demand for savings and investment. According the the Mutual Fund Fact Book (1998), during the fifteen-

18. Before the deregulation, S&L's by law could only lend up to 20% of their assets for commercial loans, and only half of that could be used for small business loans. Moreover, in the case of Federal Home Loan Bank borrowing approvals, an S&L had to show that 65% of its assets were invested in residential mortgages and other consumer-related assets. Commercial banks not subject to these types of limitations.

19. According to the Savings and Loans Institution Databook published by FDIC, about 4600 savings and loans institutions operated in 1980; in 1990, less than 2000 survived.

20. For example, between 1950 and 1993, U.S. financial assets held by commercial banks fell from 50% to 25%, while the financial assets held by MMFs simultaneously grew from 1% to 10%.

year span from 1984 to 1998, the percent of U.S. households that owned mutual funds rose from 11.2% to 44.0%. Typical investors in mutual funds are middle class, and more than 80% of households with mutual fund holdings are headed by individuals in their primary (25-64) income-earning years, with the heaviest concentration in the 35-44 bracket. The quantitative increase in the savings demand does not necessarily mean that the increased demand is going into the shadow banking system. Workers with low income growth and low financial literacy would simply put their wage bills into their local commercial banks. In fact, statistics prepared by the Consumer Finance Survey reveal that the households that are contributing to the increased holdings in the shadow banking system are exactly those that have higher financial literacy and whose household income exhibited faster growth.²¹ All of the demographic changes explain the fundamental source on the supply side that led to the emergence of shadow banks or investment companies in the U.S. during the 1990s.

ii) Differences in the foreign investment behavior of the U.S. financial institutions

To understand how such a structural change in the U.S. money market would impact the rest of the world, we need to know if these players in the U.S. money markets behave any differently in their choice of assets and investments. In this part, we provide evidence that these distinct types of intermediaries indeed do drastic differences in choosing their asset portfolio, particularly whether or not they make oversea investments and if they do, how they make these investments.

Stringent legal restrictions constrain savings and loans institutions when they choose investment categories. To comply with these legal restrictions, S&L institutions must refrain from investing abroad. Shadow banking institutions, which have largely gained the market share that S&L institutions lost in the U.S. money market, do not face such restrictions

21. In 1998, the median before-tax household income of households whose household head had at least some college education was \$53,000 and the median household income of households that owned mutual funds in 1998 was \$55,000. The income of households whose head had a college degree increased by more than 24% from 1992 to 2001, while the growth rate of income in households whose heads had a high school degree or less was less than 7%. The median household financial assets of households whose head had a college degree was close to \$109,000, while the median household financial assets reported by the Mutual Fund Fact Book (1998) was close to \$88,000.

in their asset choices. Having a large volume of money to deploy, mutual funds in the U.S. started to expand their investment spectrum to pursue the most profitable projects, sometimes in foreign lands. This fact is reflected in the bottom panel of Figure 3.5. Starting at the end of the 1980s, the international asset holdings of U.S. funds started to increase dramatically. At the end of 1986, the international asset holdings of U.S. funds represented less than 1% of their total holdings. By 1996, that number had risen to more than 12% and exceeded 495 billions.

The differences between U.S. shadow banking institutions and commercial banks in their foreign investments are somewhat more subtle. Commercial banks, too, do not face the investing abroad constraints imposed on S&L institutions. In fact, as reported in the bottom panel of Figure 3.6, throughout the 1980s, cross-border lending accounted for a non-trivial portion of U.S. commercial banks' lending. Although both types of intermediaries shared a willingness and eligibility to invest abroad, how they did so differed drastically.

To examine the foreign asset portfolio structures of these intermediary types in developed economies we explore transaction-level data on U.S. dollar-denominated cross-border loans. Figure 3.6 visualizes the portfolio difference between U.S. shadow banking institutions (MMF and mutual funds) and U.S. commercial banks in the international syndicated loan market.²² The figure delivers two pieces of messages. First, starting about 1990, investors in shadow banking institutions sharply increased their investment portfolio share in the international market; in contrast, no such changes are observed in commercial banks. Second, commercial banks focused on making loans directly to emerging market non-financial corporations; these loans accounted for more than 70% of their cross-border syndicated loan portfolio. In contrast, MMFs and mutual funds allocate more than 80% of their cross-border syndicated loan portfolio towards banks and other financial intermediaries in foreign countries.

22. For two reasons, the syndicated loan market provides a lens that can be used to determine how MMFs and mutual fund investors distribute their portfolios. First, during early 1990s, financial innovation facilitated the active participation of institutional lenders (Nandy and Shao (2007) Nini (2013)), including, especially, the participation of lending banks in the international arena. Second, the data on syndicated loans provide information about lending and borrowing institutions. This information includes accurate identifications of investors' asset allocations. In the case of other asset types, such as bonds and equity, the data are not consistently available and, thus, are hard to track.

Figure 3.7 shows the composition of capital credit flows towards emerging market economies. Across all regions of the emerging market world, net bank and trade-related lending started to grow during the 1980s and then stabilized during the 1990s. In contrast, the net flow of portfolio bonds did not start to increase until the 1990s, while at the same time the shadow banking system in U.S. began to grow drastically. The aggregate volume of net bond flows to Latin American economies and Asia Pacific emerging market economies grew almost ten-fold. Coevally, the net bond flow in European emerging market economies' grew five fold, and even in African emerging market economies, where in the 1990s net banking and trade flows were negative, bond issuance grew quickly. Taking another look at issuance level data from the emerging market economies' side, which is shown in Figure 3.8, we decompose the receivers of the bond flows by financial sector and non-financial corporate sector. Consistent with World Bank country-level aggregate data, the total bond issuance volume did not start to increase until the 1990s, and, importantly, approximately 75% of the bonds flowed to financial sectors in the emerging market world. Our findings are also consistent with Kaminsky et al. (2001).

These differences between how U.S. shadow banking institutions and commercial banks made loans in the emerging market is not difficult to understand. Having developed the skills (screening and monitoring, etc.) needed to finance the operations of non-financial firms in their own countries, commercial banks in developed economies directly extended credit to real sectors in emerging markets. Shadow banking lenders, however, did not possess such skills. Instead, the MMF and mutual funds in the developed world that wished to invest in profitable projects in EMEs had to develop an additional institutional arrangement: the use of domestic financial institutions from credit-receiving countries, which borrowed from non-bank lenders in the developed world and transmitted the credit to their domestic real sectors.

3.3.3. *Rise of Domestic Global Banks in EMEs*

The structural change in the financial market of the U.S. translated into a structural change in the global funding market because the U.S. is the center economy of international finance. Prior to this transformation, the predominant player that channeled credit from the developed world to the emerging market economies had long been commercial banks in developed markets. The on-going expansion of shadow banking institutions in the U.S. money market gave rise to the emergence of a group of new players that brought credit to emerging economies: *globally funded domestic banks* in emerging markets.

In this subsection, we examine foreign-currency debt issuance behavior on the credit-receiving side. Consistent with the credit supply-side changes documented above, we find that commercial banks in the rest of the world started to borrow more and more frequently from the global funding market during the early 1990s. In the upper panel of Figure 3.9, we plot the time-variation of non-U.S. banks' USD wholesale liability as a share of their total wholesale liability. Prior to 1990, this ratio for non-U.S. banks from developed market economies (primarily European banks) stayed below 10%, while the ratio for non-U.S. banks from emerging market economies essentially stayed close to zero. Coinciding with the structural change in the U.S. money market, both series started to take off around 1990. By 2005, the U.S. dollar liability reliance of emerging market economies' banks had reached 25%, and in European banks it exceeded 30%.²³

Moreover, we find that as the U.S. shadow banking institutions expanded their international investment, banks from emerging market economies became more responsive to U.S. monetary policy changes. Figure 3.9 displays how EME banks' USD liability issuance responded to U.S. financial condition indices over time. The U.S. financial condition indices are NFCI (Chicago Fed National Financial Conditions Index) and IMF-index for the United

23. The wholesale funding activities of global banks and their reliance on MMFs is also documented in Ivashina et al. (2015), Baba et al. (2009).

States (2017 GFSR Chapter 3 Annex 3.1). The Figure 4.18(a) and 4.18(c) estimate:

$$\frac{\text{USD liability issuance}}{\text{Total issuance}}_{b,t,r} = \alpha_b + \mu_r + \sum_{r=06-10, r \neq 85-90}^{r=76-80} \beta_r D[t \in r] \times F_t^{U.S.} + \theta \mathbf{X} + \epsilon_{b,t,r}$$

while Figure 4.18(b) and 4.18(d) estimate:

$$1[\text{USD liability issuance}]_{b,t,r} = \alpha_b + \mu_r + \sum_{r=06-10, r \neq 85-90}^{r=76-80} \beta_r D[t \in r] \times F_t^{U.S.} + \theta \mathbf{X} + \epsilon_{b,t,r}$$

where b refers to bank, t refers to year, r refers to the year range, and \mathbf{X} is a vector of country-level control variables, including GDP growth rate, net export/GDP, FDI/GDP, the domestic deposit rate, REER, and the inflation rate. All four regressions transpire at the bank-year level and include 956 banks from 35 emerging market economies. Each bank in the regression has at least three times of issuance. All regressions in the figures include bank fixed effect, year range fixed effect. Standard errors are heteroskedastically robust and clustered at year level. In Figure 4.18(a) and 4.18(c), the LHS is the liability issuance denominated in USD (bond and loan) divided by the total liability issuance of a bank in a given year. In Figure 4.18(b) and 4.18(d), the LHS is a dummy variable that equals 1 if a bank issued USD liabilities in a given year.

As Figure 3.9 clearly indicate, prior to 1990, banks from EMEs essentially did not respond to changes in U.S. financial and monetary conditions. From early 1990s, when U.S. shadow banking institutions began to dabble in the international markets, accommodative financial and monetary conditions in United states (lower NFCI and IMF-index) start to generate substantial spillover to the EME banks: EME banks started to issue significant amount of USD liability in response to easing financial conditions in the U.S..

These EME banks did not issue USD liabilities in order to let them to sit idle. Instead, access to global funding markets allowed banks in EMEs to conduct more foreign credit lending. We run a bank-year level regression to examine the correlation between the USD lending and the USD liability issuance of EME banks. As shown in Table 3.22, changes in

a EME bank's USD liability issuance are followed by responses in its USD lending, the size of which is both statistically and economically significant. As such, the newly-gained access to the global funding market allowed EME banks to compete with and, thus, replace their developed economy counterparts, which, prior to these structural changes in the U.S. money market, had dominated the transmission of cross-border capital to EMEs.

As a summary of the findings we document above, the burgeoning of shadow banking institutions in the U.S. money market during the last decade of the 20th century gave banks in emerging markets more convenient access to the global financing market. In this way, changes in the money market of the center economy translated into changes in *how* cross-border capital was channeled to borrowers in emerging markets. Access to the global funding market enabled domestic banks in emerging markets to compete with and gradually replace foreign counterparts that previously had dominated the channeling of cross-border credit to firms in EMEs.

3.4. Preferences of Lending Bases: Foreign Banks v.s. Domestic Banks

In section 3, we have documented a global trend in the transmission of credit ow to emerging markets, wherein domestic banks from EMEs gradually took over the role of channeling cross-border credit, which originally had been played by foreign banks. A natural question arises: Do these two distinct groups of lenders allocate cross-border credit differently? In this section, we examine these differences.

We begin by identifying two types of corporate firm borrowing bases: those that are transparency-based and those that are tangibility-based. We find that the two groups of lenders differ drastically in their lending bases preferences. Specifically, foreign banks are considerably more reluctant to conduct collateralized lending against fixed assets. Exploiting cross-country variations, we provide evidence that this difference can be explained by the difficulty that foreign lenders face when monitoring and seizing physical collateral; among

domestic lenders, these tasks are less difficult. We then focus our attention on corporate lending in emerging markets; monitoring and seizing physical collateral in these markets is more costly. We also exploit within-firm variation to determine how the lending technologies of foreign and domestic lenders differ from one another.

3.4.1. Constituents of Firm Debt Capacity: Transparency and Tangibility

A borrower cannot borrow from a rational creditor an amount that exceeds what he can commit to pay back. Corporate debt capacity, a key concept in any corporate finance textbook, plays a pivotal role in the transmission of cross-border capital flow to emerging markets.

In the literature of corporate finance theory, non-financial firms have access to two major sources of debt capacity that they can rely on for borrowing. The first is the transparency (or pledgeability) of firms' cash flows and earnings (e.g. Stiglitz and Weiss (1981), Holmstrom and Tirole (1997)). The second is the tangibility (or redeployability) of firms' assets (e.g., Hart and Moore, 1994; Kiyotaki and Moore, 1997; Bernanke, Gertler, and Gilchrist, 1999.) Figure 3.11 illustrates these two major constituents of corporate firms' debt capacity and the relevant lending bases for each type of debt capacity source.

Transparency-based lending includes arms-length debt, unsecured bank loans, and bank loans backed by assets whose value is sensitive to the earning and cash flow of borrowing firms. As shown in Figure 3.11, the income and cash flows of firms such as Formosa Plastics Corp. and Tencent Holdings (paralleling Ineos in the U.K. and Apple Inc. in the U.S.) are highly transparent and trustworthy in their reporting. These qualities allows these firms to issue large sums of bonds and unsecured loans. Normally, a reputation-related lending base is not written into credit agreement documents. A second tier of borrowers explicitly pledges their future earnings and receivables to creditors in loan documents. The most common of these pledged lending bases are "Securities", "Agency Guarantees", "Account Receivables", and "Reserve and Inventories". Often such earning/cash flow-based lending is accompanied by EBITDA-related financial covenants.

In contrast, tangibility-based lending often is based on assets that have a value that is independent of a firm's operating conditions. This type of lending is exclusively carried out by commercial banks in the form of collateralized loans secured by physical fixed assets. Should borrowers fail to make the promised payment, the creditors are granted the right to seize the collateralized fixed assets and sell those assets at market prices. Examples of fixed assets in collateralized lending include aircraft, vehicles and vessels, commercial lands, properties, machines, and real estate.

Which lending base a credit agreement would rely upon is obviously determined (at least in part) by the borrowers' characteristics. As documented in a large literature, only borrowers that have a strong reputation and financial sophistication can base their borrowing on transparency (e.g. Diamond (1991)). Other borrowers, such as newly established corporations, usually have to rely on their tangible assets for borrowing before they become ready and qualified for transparency-based borrowing. In table 3.13, we report the frequency of corporate lending base reliance in both developed markets (DME) and emerging markets (EME).²⁴ In emerging market economies, which often feature a large fraction of newly established and less financially sophisticated firms, lending is often based on fixed value assets.

3.4.2. Lender Identity and Insolvency Resolving Easiness

In addition to its obvious contingency on borrower-side characteristics, the debt capacity of a corporate firm is also determined by who is conducting the lending. In this part, we show that a particular dimension of lender identity— whether the lender is domestic or foreign— affects corporate lending bases. Specifically, we provide evidence that foreign banks behave very differently from domestic ones when, under certain circumstances, they choose their lending base.

A well-documented feature of emerging market economies is their relatively weak protection of creditor control rights when the debtor encounters insolvency conditions. According to the World Bank Doing Business, the average period of time needed to deal with insolvency

24. The calculation is based on loans recorded in Dealscan, LoanConnector and Datastream.

in our sample's 62 emerging market economies is greater than 3 years, and the average cost as a share of the borrowers fixed assets is about 20%.²⁵ In the developed market group, in contrast, the average length of time spent dealing with insolvency is 1.7 years and the average cost as a share of the borrowers fixed assets is 9.3%.

In economies that provide weak general creditor protection and debt enforcement, lenders must conduct more frequent and timely monitoring and be skillful at dealing with a variety of insolvency-related situations. The following cases of “ghost collateral” in China vividly illustrate how domestic and foreign lenders approach the problem of dealing with misbehaving borrowers differently. Hanning Iron and Steel Co. and Decheng Mining Ltd. are Chinese companies in similar industries. Both companies have proposed fraudulent collateral when they have reached for loans; the former, for example, pledged the same pile of 291-ton steel to multiple lenders, while the latter faked warehouse receivables. In the Hannings case, the lender was CITIC, and its inspector, assigned to a local branch in Shanghai, discovered the fraud unexpectedly during a regular inspection. Eventually CITIC won the court order and recovered a significant part of its losses. But in the Deching Minings case, the main lenders are Standard Chartered and HSBC, both of which are foreign banks. The banks failed to uncover the fraud carried out by the company, and eventually they faced a potential loss of several billion dollars.²⁶

Indeed, the extra difficulty that foreign lenders face when they conduct a close monitoring of the physical assets being pledged as collateral prevents them from extending credit on the basis of tangibility. Figure 3.13 compares the lending bases of foreign and domestic banks that extend loans to borrowers in the two economies. In both panels, the orange-shaded bars represent the dollar amount proportion of loans that were based on fixed-value assets extended by either domestic or foreign banks.²⁷ The left part of panel (a) reports the lending

25. Detailed information can be found at: <https://www.doingbusiness.org/en/data/exploretopics/resolving-insolvency>

26. The link to the relevant case: <https://www.reuters.com/investigates/special-report/china-collateral-fake/>.

27. Foreign bank participation is defined as the loans with at least one foreign bank in the syndication.

base compositions of loans extended to emerging market borrowers. A drastic difference can be seen: over 60% of the loans extended by domestic banks are backed by fixed-value assets as collateral, but only 20% of foreign bank extended loans are tangibility-based. Yet when we examine the loans received by borrowers from developed markets, we see no such distinctions, as is illustrated in the right part of panel (a).

We propose, then, that the different lending base preferences of domestic and foreign banks are driven by the relatively higher costs associated with insolvency resolution in emerging markets. To justify this, we direct our attention to emerging markets and sort them according to their debt enforcement conditions.²⁸ As shown in the Panel (b) of Figure 3.13, the difference between the lending base preferences of domestic and foreign lenders is much more pronounced in emerging market countries that have relatively high insolvency resolution costs.

To formally test the relations illustrated in Figure 3.13, we run a panel regression with the deal-level data that contains detailed information on the lender-borrower pair and lending bases. Specifically, for each deal we regress the lending base on a set of proxies for the ease with which to liquidate fixed assets in the borrower’s country and whether the lender is a foreign lender or domestic lender:

$$\begin{aligned}
 1[\text{Fixed assets}]_{b,c,t} &= \alpha_{b,t} + \beta I_{\text{Liquidation cost}}^c \\
 &+ 1[\text{Foreign bank}] + 1[\text{Foreign bank}] \times I_{\text{Liquidation cost}}^c + \gamma X + \epsilon_{b,t}
 \end{aligned}$$

where b indexes bank, c indexes the borrower’s country, and t indexes year, $1[\text{Foreign bank}]$ is a dummy variable that equals to 1 if the lending bank is a foreign bank relative to the borrower’s home country, and $I_{\text{Liquidation cost}}^c$ is the measure of the ease with which fixed assets in the borrower’s home country c can be liquidated. We use four measures to capture this liquidation cost. The first is Year resolve, which is the average number of years it takes to resolve insolvency in the borrower’s country; the second is the average cost of resolving

28. The classification of higher and lower debt enforcement strength are based on the World Banks’ Doing Business Debt Enforcement Index overall score. Details about each country are provided in the appendix.

an insolvency (in percentage of the borrowing firm's fixed assets); the third is the number of days it takes to register property; and the fourth is the number of steps it takes to register property in the borrower's country.²⁹ All four measures are intended to measure difficulty or relatively higher cost for foreign lenders of dealing with fixed-asset-based lending, either at the contracting stage or when a borrowing firm in EME runs into insolvency conditions.

Table 3.20 reports the results of the above regression. In column (1), we find that the longer it takes in the borrower country's to resolve insolvency, the less likely it is that any bank will lend on the basis of fixed value assets to firms in that country. While foreign lenders on average are 16.3% less likely than domestic lenders to lend on the basis of fixed assets, the difference will widen by another 5.3% if in the borrower's economy it takes 1 more year to resolve insolvency. The longer it takes on average to resolve insolvency, the more costly it is for lenders to make sure that the collateral's value is preserved; to do this lenders must periodically be able to monitor and evaluate the value of the collateral— a process that is generally more costly for foreign lenders than domestic banks.

Similarly, in column (2) we interact the foreign bank dummy with the average cost of resolving insolvency as a percentage of the borrower's fixed assets. The pattern is similar to that seen in column (1): A 10% higher cost associated with resolving insolvency in terms of seizing borrower's fixed assets is associated with 5.8% increase in the difference between foreign banks and domestic banks in the likelihood that they will accept fixed assets as lending bases. In column (3) and (4) of Table 3.20, we conduct the same set of investigations, but here we interact the foreign bank dummy with the number of years and procedures it takes to register property in the borrower's country. The longer the time it takes and the more complex it is to register property, the more costly it is and the more uncertain it becomes for foreign banks (relative to domestic banks) to ensure that the value of the borrower's fixed assets can be maintained and, thus, the less likely it is that foreign banks will accept the borrower's fixed assets as a lending base. For every additional year that it

29. The four variables in the regression come from World Bank Doing Business's "Resolving Insolvency" series and "Registering Property" series.

takes to register property, the likelihood that a foreign bank will accept the borrower's fixed assets as a lending base decreases by 3.3%—relative to the likelihood that a domestic bank from the borrower's country will accept the same terms. For every 2 additional steps that it takes to register property, the likelihood that a foreign bank will loan funds decreases by 5%—relative to the likelihood that a domestic bank from the borrower's country will do so.

3.4.3. With-in Firm Analysis: Lending Base Differences between Foreign and Domestic Lenders

Based on the categorizations of the lending bases and having documented the source of the differences in domestic and foreign banks, we now examine how these two distinct types of lenders behave differently when they extend credits to EME borrowers. Our goal is to conduct a with-in firm analysis based on our loan-level data in order to establish causal inferences about how the underwriting of credit agreements is affected by foreign bank participation. Specifically, we examine how collateral usage and covenant inclusion in foreign-currency dominated loans are affected by the degree of foreign lender participation. We start by specifying the empirical framework and sample construction for our tests.

Empirical Specifications

A major issue with simply running a cross-sectional analysis is that selection biases could potentially happen on both the lender's or the borrower's side. On the lenders' side, banks could choose to enter into certain loan contracts for reasons other than how much friction they expect to encounter when they need to liquidate or monitor. For example, foreign banks might be systemically more familiar than domestic banks in EMEs with lending to technology or communication industries. But firms in these industries intrinsically feature an intangible asset structure and, thus, they are unlikely to borrow against physical assets. In this case the fact that foreign banks conduct less tangibility-based lending should not be attributed to their distinctive preference on lending base from domestic banks.

Similarly, on the borrower's side, even within a single firm, the availability of fixed assets

and the prosperity of future earnings might differ at different points in time. Simply controlling for firm fixed effects and time fixed effects does not solve the problem. It could be possible that in one year, a firm issues a loan with domestic lenders in order to buy some physical inputs (e.g., commercial land) and pledges the purchased assets as collateral. In a different year, this same firm issues another loan with foreign banks to finance its exporting, in which case the firm pledges its export receivable to the creditors. In this scenario, domestic and foreign lenders finance this same firm against different lending bases because the specific purposes of the loans differ at different points in time in the firm's operation. In other words, such differences do not always reflect differences in the capacity to lend against tangible assets as collateral.

To establish a causal correlation, we restrict our sample to firms that have issued at least one multi-tranche deal, with each tranche having different lender compositions (in terms of foreign bank participation). This allows us to investigate *within-firm* (and at the *same point* in time) whether two tranches of the same loan package that have different foreign bank participation rates will produce differences in the structure of lending bases.

Our tests examine two main aspects of the underwriting of corporate debt contracts. First, we study how the usage of fixed assets as collateral in loan contracting is affected by the participation of foreign lenders, as shown in the following equations:

$$1[\text{Fixed assets collateral}]_{i,d,tr} = \alpha_i + \mu_d + \beta(\text{Foreign bank share/participation}) + \gamma\mathbf{X} + FE's \quad (3.1)$$

$$[\% \text{Face value fixed assets}]_{i,d,tr} = \alpha_i + \mu_d + \beta(\text{Foreign bank share/participation}) + \gamma\mathbf{X} + FE's \quad (3.2)$$

where i stands for the firm i , d stands for deal, and tr stands for tranche of the deal. The physical collateral usage in each deal tranche is proxied by two measures: a dummy variable that equals to 1 if any fixed asset is being pledged as collateral; and the fraction (in terms of face value) of the tranche that is backed by physical collateral. Analogously, we apply two similar measures to proxy our main regressor, which is foreign lender participation in each loan tranche. The first of these is a dummy variable that equals 1 if the tranche involves the

participation of at least one foreign bank (1[Foreign bank participation]); the other is the share of the foreign banks in the total dollar amount of the tranche expressed in percentage terms (Foreign bank share %).

In parallel, we conduct the same set of analyses on the covenant inclusion in loan contracting. Specifically, we run the following tranche-level regression

$$1[\text{Covenant}]_{i,d,tr} = \alpha_i + \mu_d + \beta(\text{Foreign bank share/participation}) + \gamma\mathbf{X} + \epsilon_{i,d,tr} \quad (3.3)$$

where i indexes borrowing firms, d indexes deal, and t indexes the deal's tranche. Firm and deal fixed effects are captured by α_i and μ_d respectively. Foreign lender participation in each deal tranche is measured as described above, while covenant inclusion is measured by a dummy variable that equals 1 if the deal tranche includes covenants.

Baseline Results

In Table 3.4 to Table 3.7, we display our identification results, which reveal how foreign bank participation affects the physical collateral usage in the contracting of cross-border credit. In Table 3.4 and Table 3.5, the LHS variable is a dummy variable that equals 1 if and only if the tranche is secured by some fixed assets. We find that the degree of foreign bank participation has a significant impact on lending bases outcomes. As presented in column (1) of Table 3.4, foreign bank participation is associated with a 19.2% decrease in the probability that a tranche in a given deal is contracted based on fixed assets for any given firm. This effect remains stable after accounting for the time and industry-time fixed-effects, as shown in column (2). Similarly, in column (1) and (2) of Table 3.5, we see that a 15% increase in the share of foreign banks in the total tranche amount is associated with a 36% decrease in the likelihood that a firm's tranche in a deal is contracted on the basis of fixed value assets.

To account for the effect of tranche-specific characteristics on lending base outcomes, we add control variables that reflect tranche-specific properties. These variables include the natural log of the tranche's amount, the tranche's maturity, the tranche's purpose dummies, and tranche-type dummies. Results that combine tranche-level controls as well as all the

fixed effects are reported in column (3).³⁰ In column (4), we report results after controlling for a variable called Debt Enforcement. This variable captures how efficient it is on average for an insolvency case to be resolved in the borrower's country. The higher the score, the more efficient the procedures are that resolve insolvency issues in the borrowing firms' country. Notice that including this variable also absorbs the country fixed effects, which are country-specific variables.

We further take into consideration the possibility that macroeconomic conditions in borrowers' countries may distort the effect of foreign bank participation on lending base outcomes. For instance, macroeconomic conditions in the borrower country could potentially affect the favorability of specific types of lending bases, or it could induce foreign banks to extend corporate lending to certain types of firms. In both cases, the regression results are likely to be tilted. To deal with this concern, we add three key borrower-country macroeconomic controls variables: GDP growth, REER, and Domestic Credit/GDP. As can be seen in column (5) in both Table 3.4 and Table 3.5, adding these macro-level control variables barely changes the main coefficient of interest.

Finally, in column (6) and column (7), we further add dummy variable controls that reflect whether a borrowing firm is a multinational entrepreneur and whether it is jointly owned by foreign investors. Both MNE and firms with foreign ownership structures have a much higher probability than general firms in the domestic market of having non-domestic fixed assets. Controlling for these firm types ensures that the results are not affected by the presence of special ownership structures on the firms' side.

In Table 3.6 and Table 3.7, we run the same set of regressions that we run in Table 3.4 and Table 3.5. The difference here is that we focus on a sub-sample of tranches and deals that contain detailed information about the percentage of the tranche's face value that is secured by domestic fixed assets. This allows us to construct a measure of the degree of foreign lender participation in each deal tranche that is more refined than the dummy variable, which indicates whether domestic fixed assets are used in the lending base formation. After

30. There are three main categories of purposes, M& A, trade-related, and general purposes.

this restriction, our sample shrinks to a total of 5062 tranches in 2104 deals undertaken by 1762 firms. Consistent with the results in Table 3.4 and Table 3.5, foreign bank participation decreases by 18.8% the likelihood that domestic fixed assets will show up in lending bases, while a 15% increase in foreign bank share in the tranche value will result in a 33.5% decrease in the percentage of a loans' face value that is written against fixed assets. These results stay robust after adding industry-time, and time fixed effects do not alter the results, nor does adding country-level legal enforcement quality, country-level macroeconomic controls, and firm ownership characteristics.

The second part of our tests in this subsection examines the effect of foreign bank participation on the likelihood of covenant inclusion in debt contracts. In accordance with Table 3.4 to Table 3.7, we run the same set of regressions with main regressors being dummy variables that indicate whether there is foreign bank presence and the total share of the face value that is lent by foreign banks. Table 3.2 and Table 3.3 display the results for this part of test, which is based on equation (3). We find that foreign bank participation on average increases the likelihood of covenant inclusion in the contract, underwriting cross-border credit by 12.4%. A 15% increase in a foreign bank's share in the tranche total amount increases by 28.1% the likelihood of covenant inclusion. These results remain statistically significant and quantitatively similar after we add on industry-time and time fixed effects, as well as country-level debt enforcement strength, country-level macroeconomic controls, and firm ownership characteristics.

To summarize, by examining tranche-level observations in foreign-currency-denominated credit agreements in EMEs, we find that foreign and domestic banks differ drastically in their lending base preferences. Specifically, when they extend credit to borrowers from emerging markets, foreign banks show a significantly greater reluctance than domestic banks to conduct collateralized lending against fixed assets. Instead, cross-border credit extended by foreign banks is more likely to be transparency-based, an arrangement that often relies on the inclusion of covenants in credit agreements.

3.5. The Real Impact of the Rise of Domestic Global Banks

In Section 3 we document an ongoing change in how cross-border capital is channeled to emerging markets: globally-funded domestic banks in EMEs are replacing foreign banks as the primary source of foreign credit extended to firms in emerging markets. Section 3.4 further examines how the behavior of domestic banks would differ from that of foreign banks if they chose their lending base from emerging markets. In this section, we investigate the real impact that this rise in domestic global banks has on emerging markets around the world.

3.5.1. *Allocation of Cross-border Credit: Foreign Banks v.s. Domestic Banks*

In Section 3.4 we have shown that foreign banks and domestic banks employ different lending technologies when they evaluate whether to accept lending bases. In this subsection, we show that due to these differences in lending technologies, domestic and foreign banks produce different “outputs” in the cross-border credit market. Specifically, we are interested to study how differences in the lender composition would lead to differences in (1) who is more likely to receive the credit; and (2) the credit volume that a given borrower receives.

Because the differences in the lending technologies of the two groups hinge on their ability to seize fixed assets and their relative preference for transparent cash flows, we consider two particular aspects of firm characteristics: tangibility and transparency. Throughout the analysis that follows, we focus on characterizing whether or not credit is more likely to be allocated to firms in tangible/intangible industries (tangibility) or to firms that are listed/unlisted firms (transparency). To study the matching patterns of cross-border lending in EMEs, we examine our deal-level observations of foreign credit agreements established in various emerging markets.

To study matching patterns between distinct lenders and credit receiving firms, we run the following multinomial logit model based on deal-level data in Dealscan. Each deal can

be viewed as a matched pair of borrowers and lenders:

$$\text{Ln}\left(\frac{P(\text{High-tang/Low-trans})}{1 - P(\text{High-tang/Low-trans})}\right)_{i,c,t} = \alpha_i + \mu_{c,t} + \beta(\text{Domestic bank share}(\%)) + \gamma\mathbf{X} + \epsilon_{i,c,t} \quad (3.4)$$

where i indexes the firm, c indexes the country and t indexes the year. The main explanatory variable is the total face value share owned by domestic banks in the deal package. A borrower is from a high-tangibility industry if the average tangibility (defined by PPE/total assets) of the borrower's two-digit SIC industry is above the 75th percentile of all two-digit industries in its economy. A borrower is classified as a low-transparency firm if it is a private firm. α_i is the firm-level fixed effects and $\mu_{c,t}$ is the borrower country-time fixed effects. \mathbf{X} is a vector of control variables that includes the maturity of the loan deal, the total number of banks in the deal package and the dummy variables that control for the purpose of the loan.

Table 3.8 shows the results of the regression in equation 3.4. As reported by column (1) of the table, a 10% percent increase in the domestic bank share in a deal package leads to a 31.2% increase in the probability that the credit will go to a firm in tangible industries.³¹ Similarly, column (2) of the table shows that a 10% percent increase in the domestic bank share in a deal package is associated with a 21.5% increase in the likelihood that the credit is received by an unlisted firm.

The matching between a deal's lender composition and the characteristics of the credit receiving firm could be thought of as measuring the allocation of cross-border credit on the extensive margin. For a more refined measurement of cross-border credit allocation, we take an additional step to investigate the intensive margin of the credit allocation. We ask, in other words, do certain types of firms tend to receive a larger credit volume from domestic banks than from foreign banks, and, if so, do they receive larger volume of credit from domestic banks especially when they contract on the basis of their tangible assets? To this end, we focus on a sub-sample of firms for which there are at least two foreign currency loan

31. The borrower's industry tangibility is constructed using the corporate balance sheet data from Worldscope. Tangibility is defined as industry's average PPE/Assets over 1995-2015.

issuance observations, and we estimate the following two equations:

$$\begin{aligned} \ln(\text{Amount})_{i,c,t} = & \alpha_i + \theta_{c,t} + \beta_1(\text{Domestic bank share}\%) \\ & + \beta_2(\text{Domestic bank share}\%) \times 1[\text{High tang/Low trans}] + \gamma X + \epsilon_{i,c,t} \end{aligned} \quad (3.5)$$

$$\begin{aligned} \ln(\text{Amount})_{i,c,t} = & \alpha_i + \mu_{c,t} + \beta_1(\text{Domestic bank share}\%) \\ & + \beta_2(\text{Domestic bank share}\%) \times 1[\text{High tang/Low trans}] \\ & + \beta_3(\text{Domestic bank share}\%) \times 1[\text{High tang/Low trans}] \times 1[\text{Fixed-assets}] + \gamma X + \epsilon_{i,c,t} \end{aligned} \quad (3.6)$$

The results of these two regression equations are reported in Table 3.9 and Table 3.10. Columns (1)-(3) of Table 3.9 show that the domestic bank share in lender composition is not on average significantly correlated with the foreign credit package amount on average, but if the credit-receiving firm is privately traded, a 20% increase in the domestic bank share will be associated with a 3.5% increase in the total foreign credit volume. This result stays statistically and economically robust after we add deal-level control variables and cluster the standard errors at the year level. Similarly, and as shown in column (4)-(6), the domestic bank share in the package does not significantly predict the average foreign credit deal size, but conditional on the receiver being a firm from a high-tangibility industry, a 20% increase in the domestic bank share is associated with a 3.7% increase in the deal volume.

We take one more step to figure how and why firms that have high tangibility or low cash flow transparency receive more cross-border credit from domestic banks. In Table 3.10, we interact $(\text{Domestic bank share}\%) \times 1[\text{High tang/Low trans}]$ with the dummy variable to indicate whether the deal has fixed assets pledged as collateral. In columns (1) and (3) of Table 3.10, we find that this newly introduced term absorbs a large fraction of the coefficient on $(\text{Domestic bank share}\%) \times 1[\text{High tang/Low trans}]$. This fact implies that borrowers in high-tangibility industries or that have low cash flow transparency receive higher foreign credit from domestic lenders because they pledge their tangible assets as collateral.

A measure of cross-border capital allocation that is perhaps more direct is the fraction per

unit of credit that a lender would allocate to certain categories of borrowers. In Figure 3.19 and Figure 3.20, we show the credit allocation from the banks' point of view. We calculate the average share of USD-denominated credit allocated to EME firms in different industries and to private firms by foreign banks and domestic banks, respectively. Our calculation is based on 50 major global banks and all of the domestic banks that have at least 5 consecutive years of lending in the Dealscan.

In Figure 3.19, panel 3.20(a) and 3.20(b) display foreign banks' average share of lending volume to the eight major industries categorized by the 2-digit SIC code. Industries are sorted from left to right according to their tangibility. Specifically, panel 3.20(a) displays foreign banks credit allocation profiles during normal times, while panel 3.20(b) shows the allocation profile during periods when the U.S. financial condition is accommodative. Similarly, panel 3.20(c) and 3.20(d) display domestic banks' USD portfolio across industries during normal and expansion periods, respectively.

Two pieces of messages can be easily read from Figure 3.19. First, the distribution of the domestic banks' USD loan portfolio is much more left-tailed than that of foreign banks. In other words, for each unit of cross-border credit channeled by domestic banks, the fraction being allocated towards tangible industries is much larger than that channeled by a foreign bank. Indeed, as can be seen in panel 3.20(a), the amount of credit that foreign banks extend to tangible sectors such as agriculture, mining and construction, is very limited. Second, when U.S. financial conditions ease, the USD loan portfolios of domestic banks tend to shift leftwards and evenly toward the high-tangibility industries. By comparison, the distribution of foreign banks' loan portfolios across industries does not respond significantly to these credit supply side changes. Similarly, in Figure 3.20, we examine how the cross-border loan portfolios of foreign and domestic banks differ with regards to borrower transparency. Specifically, we calculate the average fraction of USD loans (in terms of face value) extended to private firms in EMEs by foreign banks and domestic banks. Consistent with the regression results of equations (5) and (6), in transmitting cross-border capital to emerging market borrowers, domestic banks allocate a much larger portion to private firms than foreign banks

do. Furthermore, during the expansion period of global financing cycles, domestic banks respond by allocating an even larger portion of cross-border credit to unlisted firms, while foreign banks barely change their credit allocation in this dimension.

The above micro-level evidence, revealed by either the scope of cross-border deals or the credit allocation profiles of banks, suggests that the replacement of foreign banks by domestic banks in the cross-border loan market in EMEs can have potentially important real outcomes. In particular, as domestic banks become more accessible to the global funding market and begin to penetrate into the cross-border loan market, firms in the high-tangibility sector or that are less transparent are likely to get the opportunity to receive foreign credit more often than before. Additionally, during the expansion phase of the global financing cycle, when domestic banks start to play a nontrivial role in cross-border credit transmissions, these borrowers can get an even larger share in the allocation of cross-border capital.

3.5.2. Real impact at the aggregate level: Time-trend analysis

In this part, we conduct a time-trend analysis to examine the aggregate real impact on emerging markets of the rise of domestic global banks in these economies. In particular, we investigate both 1) the long-run effect, or how the industry structure in EMEs is reshaped, and 2) the short/medium-run effect, or how EMEs' susceptibility to global financing cycle is affected.

A. Reshaped industry structure

As documented above, when foreign banks channel cross-border credit to emerging market borrowers, their allocation of credit differs drastically from that of domestic banks. Specifically, once they gain access to the global financing market, domestic banks in EMEs generally allocate a much larger fraction of the cross-border credit they bring to firms in tangible industries than foreign banks do. Thus, it is natural to expect that the rise of globally funded domestic banks in emerging markets will have important real impacts on the industry structure of these economies.

In panel 3.15(a) of Figure 3.14, we display the time trend of the share of the total face value of USD-denominated loans received by high-tangibility sectors to the total face value of USD denominated loans made to EMEs. Specifically, we calculate the average share for two five-year brackets—1986-1990 and 2011-2015—using data assembled from Dealscan. During the 1986-1990 period, less than 4.8% of the USD denominated loans flew to firms in high-tangibility industries. Since the 1991-1995 period, when domestic bank in EMEs started to access the global funding market, the share of USD-denominated credit allocated to high-tangibility industries has steadily grown. Prior to the 2011-2015 bracket, more than 20% of the cross-border USD-denominated credit was allocated to firms in the high-tangibility sector. In Appendix B Figure 3.22, we document the pattern at an annual frequency.

In a similar calculation shown in panel 3.15(b) of Figure 3.14, during the 1986-1990 period, only 5.6% of the USD-denominated cross-border credit was allocated to private firms in EMEs. By the 2011-2015 period, 37.6% of total value of USD-denominated cross-border credit was channeled to private firms. In Figure 3.22, we show the year-by-year distribution of the share of USD-denominated credit channeled to private firms in 65 EME's. The steepest increase in the reallocation happened during the 1990-1995 period, which coincided with the fast growth of institutional lenders in the developed economies and the burgeoning of globally-funded domestic banks in EMEs.

Starting in the early 1990s, then, the manner in which foreign credit was channeled from the global funding market to emerging market economies changed. Similarly, during the 10 years after 1995, the industrial structure of emerging markets was greatly reshaped. For example, in the tangible sector, the average output value added as a share of GDP (measured by the construction, mining, and manufacturing sectors' value added as a percentage of GDP) in emerging market economies increased from 15.13% to 24.33%. Also during the same period and thereafter, average employment in tangible industries (measured by the total share of employment in a country's construction, agricultural, and manufacturing sectors etc) increased from 14.67% to 23.12%. Moreover, an analysis of data for listed firms in emerging market economies suggests that, compared to the average level of long-term debt

before 1995, the average long-term debt (scaled by lagged total assets) of tangible industries during the 1995-2010 period increased by 16.2%. During the same period, the corporate annual investment rate (measured by capital expenditures scaled by lagged total assets) increased by 5.2%.

B. Increased susceptibility to global financing cycle

Another important difference between domestic and foreign banks in their allocation of cross-border capital lies in their distinct responses to global financing cycle. In contrast to foreign banks, which barely respond in their credit allocation to changes in global financing conditions, domestic banks exhibit a high sensitivity to global funding fluctuations in their allocation of cross-border capital. Given this difference, it is likely that the replacement of foreign banks by domestic banks in the cross-border loan market made these economies more susceptible to global financial conditions.

To investigate the time variation in emerging markets' susceptibility to global financial conditions, we consider the following regression specification and run the regression estimation for the pre-1995 period and the post-1995 period separately.

$$Y_{i,t} = \alpha_i + \theta F_t^{U.S.} + \phi X_{i,t} + \epsilon_{i,t} \quad (3.7)$$

where $Y_{i,t}$ is the outcome variable of interest for economy i in year t . We focus on three outcome variable, the annual Real GDP growth rate, and the annual Domestic credit growth rate and the annual tangible sector value-added growth rate. $F_t^{U.S.}$ stands for U.S. financial market conditions, for which we consider two measures. The first is "NFICI" (Chicago Fed National Financial Condition Index) and the second is "IMF-index", which is similar to the index constructed by IMF's GFSR -2017. Parameter α_i is the economy-level fixed effect that captures all time-invariant economy-specific characteristics that could affect differences in the level of outcome variables. $X_{i,t}$ is a set of economy-specific time-varying control variables that capture time-varying economy-specific trending factors which not directly related to the main regressor that could result in differences in the responses of outcome variables. We

include two major sets of control variables in $X_{i,t}$. The first set includes economy i 's Net export/GDP, FDI/GDP, and REER, which reflect the economy's demand from overseas; the second set includes inflation, unemployment rate and the domestic deposit rate, which reflect the economy's internal demand conditions. The sample in the regression spans 1975 to 2015.

The coefficient of interest is θ , which captures the average degree of susceptibility of real economic outcomes in EMEs to U.S. financial market conditions. We separately estimate θ for both the pre-1995 period ($\theta_{\text{before1995}}$) and the post-1995 period ($\theta_{\text{after1995}}$) for the three outcome variables and the two measures of U.S. financial conditions. Table 3.12 through Table 3.24 report the results of the regression in Equation 3.7. In columns (1) and (2) of Table 3.12, we find that before 1995, a 0.5 increase (decrease) in the NFCI index (about half of its standard deviation) was associated with an average of 13 basis point decrease (increase) in real GDP growth rate. After 1995, a same magnitude change in NCI was associated with an average 85 basis point change in the real GDP growth rate. The difference between $\theta_{\text{after1995}}$ and $\theta_{\text{before1995}}$ is statistically significant. This result remains robust after including control variables on time-varying factors and demand-side factors, as shown in column (3) to column (8).

In Table 3.11, we run the same set of regressions from column (1) to column (8) to estimate the susceptibility of the EME's domestic credit growth to the global financing cycle. The domestic credit of an EME is measured by the total currency-denominated credit to the private sector extended by domestic banks. We find that before 1995, a 0.5 increase (decrease) in NFCI was associated with only a 13 basis points decrease (increase) in domestic credit growth, whereas after 1995, the effect increased to over 50 basis points. Finally, we investigate how EME's tangible sector value-added growth co-moves with U.S. financial market conditions over time. As shown in Table 3.13, before 1995, a 0.5 unit decrease (increase) in the NFCI was only associated with an average 6 basis point increase (decrease) in the tangible sector's growth in the EME, whereas after 1995, this susceptibility increased to 1.6%. In Table 3.21 to Table 3.24, we run the same set of analysis but instead

replacing $F_t^{U.S.}$ with the IMF-index. The results remain statistically robust.

3.5.3. *Real impact at aggregate level: Cross-country analysis*

Despite the statistically and economically significant results documented above, it is difficult to claim that these real changes in emerging markets were driven by the rise of domestic global banks in these economies. In this subsection, we take an additional step that further exploits cross-country variation in the causal relationship. Given that the degree to which foreign banks are replaced by domestic banks can differ across countries, we ask whether such variations can result in differences in real outcomes. In what follows, we display the results of the baseline cross-country regression and turn to an IV analysis for identification.

A. Baseline Results

In emerging markets around the world, domestic banks are replacing foreign banks in cross-border capital transmissions, and the degree to which this replacement is occurring varies significantly across countries. To measure the country-specific degree of replacement, which can be thought of as the country's exposure to the global money market transformation since the early 1990s, we construct the following measure D_i :

$$D_i = \frac{\sum_b \sum_{t>1995} C_{b,t}^{USD} \times 1[\text{Domestic bank}_b]}{\sum_b \sum_{t>1995} C_{b,t}^{USD}}$$

where i indexes the economy, b indexes a bank, t indexes the year and $C_{b,t}^{USD}$ represents the amount of USD-denominated cross-border loans issued by bank b in year t that showed up in Dealscan. $1[\text{Domestic bank}_b]$ is a dummy variable that equals 1 if bank b is a domestic bank. D_i is thus a de facto measure of the actual percentage of foreign credit that is channeled by domestic banks into country i after the global funding market transformation that happened in the beginning of 1990s. The higher the D_i , the higher the exposure of the economy to the

global money market transformation, and in turn, the higher the share of domestic-channeled foreign credit in the upcoming years.

i) Reshaped industry structure

In section 5.2, we found that coincides with the rise of domestic global banks in emerging markets around the world, since early 1990s, tangible industries in these economies have undergone accelerated growth. Moving a step further, we exploit cross-country variation in the degree to which domestic banks replace foreign banks. Specifically, we test whether in countries that experience a relatively higher degree of replacement, industry structure, too, is reshaped.

Under our empirical setting, we examine how the share of domestic banks that channeled foreign credit D_i for country i affected the country's tangible sector growth conditions in the during the 15-year period since 1995. To formalize the analysis, we write down the following specification:

$$\Delta Y_{1996-2010,i} = \alpha + \beta D_i + \phi \mathbf{X} + \epsilon_i \quad (3.8)$$

where i indexes country. $\Delta Y_{1996-2010,c}$ is change in the (average) outcome real economic variables of interest of country i during 1996-2010 period compared to the outcome variable prior to 1995. In this specification, the variable of interest could be the tangible sectors' share of output value added in GDP, the annual growth of tangible sector's output value added, the share of employment in tangible sector, or the average investment rate of tangible sector firms.

The results of the baseline OLS regressions are reported in Table 3.14. Panel (A) reports the regressions without country-level control variables and panel, while panel (B) presents the table with control variables included. Column (1) shows that a 10% higher de facto cross-border credit lent directly by domestic banks is associated with 2.13% higher tangible sector value added to GDP compared to the pre-1995 period, a 3.7% higher average annual tangible sector growth compared to the pre-1995 period, a 2.98% higher employment employed in

tangible industrial sector compared to the pre-1995 period, and a 5.62% higher average annual investment rate of tangible sector compared to the pre-1995 period. The pattern is robust after we include in the regression the control variables reported in panel (B).

ii) Increased susceptibility to global financing cycle

Analogously, exploiting national variation, we conduct a cross-sectional analysis to determine how the rise of domestic global banks in EMEs affect economy’s susceptibility to changes in the global financial market. The baseline regression equation is specified as follows:

$$Y_{i,t} = \alpha + \beta_1 1[\text{Post 1995}] + \beta_2 F_t^{U.S.} + \gamma D_i \times 1[\text{Post 1995}] \times F_t^{U.S.} + \phi \mathbf{X} + \epsilon_{i,t} \quad (3.9)$$

$Y_{i,t}$ ’s are the economy-year level outcome variables of interest, including the real GDP growth rate, the domestic credit growth rate, and the growth rate of tangible sector value added. The global financial condition measurement variables $F_t^{U.S.}$ are as defined in equation (3.7). To account for other important factors that could have an impact on the dependent variables, we include in control variable \mathbf{X} the unemployment rate, Net export/GDP, and inflation. To tease out the effects that external shocks have on a country’s susceptibility—shocks that are driven simply by the volume of external credit—we control for the ratio of external debt to GDP for each country. The sample in the regression spans 1975 to 2015 and covers 65 emerging market economies.

The coefficient of interest is γ . The goal of our test is to see if including this interaction term in the regression equation would be able to absorb a non-trivial portion of the coefficient on the term $F_t^{U.S.}$ itself. As reported in Table 3.11 through Tale 3.21, negative and statistically significant coefficient estimates of γ imply that the structure of cross-border credit received by a country explains its susceptibility to global financial shocks. More specifically, economies in which domestic banks play a larger role in channeling cross-border capital also exhibit a higher real economic outcome susceptibility to the global financial cycle.

B. IV Analysis for Identification

As in most causal identification exercises, the channeled cross-border credit share of a country’s domestic bank does not emerge exogenously. Instead, for any country i , the fraction of the cross-border capital that is channeled by its domestic banks D_i is likely to be affected by internal characteristics of country i that may also have an impact on the country’s industry structure and how susceptible the country will be to external shocks. To identify the real impact that is driven only by the rise of domestic global banks in emerging markets, we conduct an IV analysis so as to distill the exogenous part of variation in D_i ’s across countries.

We consider two sets of instrumental variables. First is the domestic banking sector concentration, measured by the asset share of the five biggest banks (*Fivebank*) and the asset share of the three biggest banks (*Threebank*), respectively. The starting year of both measures is 1996. The second set of instruments measure the workforce education level. As documented by Philippon and Reshef (2013) and Philippon and Reshef (2012), employees working in the financial sector on average have a higher skill bias, and demand for skilled labor tends to grow faster when there is a transformation in the financial market. Since the worker education level is a relatively slow-moving variable, when the global financial market transformation occurred in the early 1990s, economies that had a relatively more educated workforce tended to evolve a more absorbed domestic banking sector in response. We utilize two measures along this line of reasoning: *Secondary_24*, which is the Barro-Lee average years of secondary education of workers age 20-24; and *Tertiary_25*, which is the Barro-Lee average years of tertiary education of workers of age 25+. ³²

First stage:

$$D_i = \mu + \beta_1 Z_i + \beta_2 \bar{X}_{i,1990-1995} + \epsilon_i \tag{3.10}$$

Second stage:

$$Y_{i,t} = \alpha + \beta_1 1[\text{Post 1995}] + \beta_2 F_t^{U.S.} + \gamma \widehat{D}_i \times 1[\text{Post 1995}] \times F_t^{U.S.} + \phi \mathbf{X} + \epsilon_{i,t}$$

32. Both the Barro-Lee *Tertiary_25* and *Secondary_24* start from the year of 1990 and are estimated every five years. We use as our instrumental variable construction the average of the 1990 and 1995 measures of the two variables.

where Z is the instrumental variable discussed in the paragraph above and \widehat{D}_i is the fitted value from the first-stage regression.

Table 3.16 shows the results of the first-stage regressions when the two sets of instrumental variables are used. The control variable vector \mathbf{X} is the averages of the unemployment rate, inflation, and Net export/GDP during the 1990-1995 period. As can be seen from the column (1) and column (2) of Table 3.16, in an emerging market economy, a 10% increase in the asset shares of the three largest banks is associated during the 1991-1995 period with a 1.2% lower incremental in the share of domestic bank-channeled foreign credit. Similarly, in an emerging market economy, a 10% increase in the asset shares of the five largest banks is associated during the 1991-1995 period with a 1.5% lower incremental in the share of domestic bank-channeled foreign credit. In columns (3) and (4), every 1 additional year of average secondary school education in the workforce aged 20-24 is associated with a 2.7% increase in the incremental of domestic bank-channeled foreign credit. Also during the 1991-1995 period, every 1 additional year of average tertiary school education in the workforce aged 25+ is associated with a 3.3% increase in the incremental of domestic bank-channeled foreign credit.

Table 3.17 to Table 3.19 demonstrate the equation 3.9 and the equation 4.5. Column (1) of Table 3.17 through Table 3.19 report the OLS regression equation 3.9, while column (2) to column (5) report the 2SLS regression using the four instrumental variables from the two categories. The negative and statistically significant coefficient indicates a higher susceptibility to real outcome variables in U.S. financial conditions if, after the transformation of the global funding market during the early 1990s, the economy's domestic banks were engaged more actively in cross-border credit channeling. On the basis of column (1)'s in Table 3.17 and 3.18 and 3.19, we estimate that the post-1995 real GDP susceptibility towards a 0.5-unit U.S. financial condition change (measured by NFCI) to be 39.3 basis points higher; and domestic credit growth susceptibility towards a 0.5-unit U.S. financial condition change to be 16.5 basis point higher if the incremental of domestic bank channeled foreign credit goes up by 6.5%; and the domestic tangible sector growth susceptibility towards a 0.5-unit

U.S. financial condition change to be 65 basis point higher if the incremental of domestic bank channeled foreign credit goes up by 6.5% (about one standard deviation across the distribution of D_i of the 65 economies). The results remain quantitatively robust if we turn to 2SLS estimations and remain qualitatively unchanged if we switch to the IMF-index as shown in Table 3.25, 3.26 and 3.27.

3.6. Conclusions

Over the last several decades, while the volume of cross-border credit flows relative to their economic size has not changed much, the manner in which foreign capital has been channeled to emerging markets has changed drastically. We document an ever-growing share of cross-border credit channeled by domestic banks from EMEs since the early 1990s. This trend—the rise in the importance of the role played by domestic banks in cross-border capital transmission is commonly observed in most EMEs around the world. We argue and provide evidence that this structural change in how capital from developed market is transmitted to developing economies is unlikely to be driven by credit demand-side factors. Instead, we find consistent evidence that the transformations taking place in the emerging market world can (at least partly) be explained by the compositional change in the U.S. money market. As the market share owned by shadow banking institutions has increased, especially since the fall of S&L institutions around 1990, the non-bank intermediaries have tapped into businesses outside the country. That U.S. non-bank intermediaries generally do not know how to deal with corporate firms in foreign countries gives banks from emerging markets a new source of access to the global funding market. Thanks to their newly gained access to the global funding market, domestic banks are thus able to compete with and gradually replace their foreign counterparts in the cross-border loan market.

The change in how cross-border credit is channeled to EMEs could make a difference, if there exists certain important distinctions between foreign banks and those that are replacing them—the domestic banks in EMEs. Indeed, we find that in extending credit to firms in emerging markets, foreign banks and domestic banks have drastically different preferences on

lending base. In particular, foreign banks are much more reluctant to extend credit against fixed assets as collateral than domestic lenders, especially in economies where the insolvency resolution process is costly and lengthy. Using tranche-level data on cross-border loans in EMEs, we find that higher foreign bank participation in a tranche deal is associated with a significantly lower use of physical collateral and a higher rate of covenant inclusion.

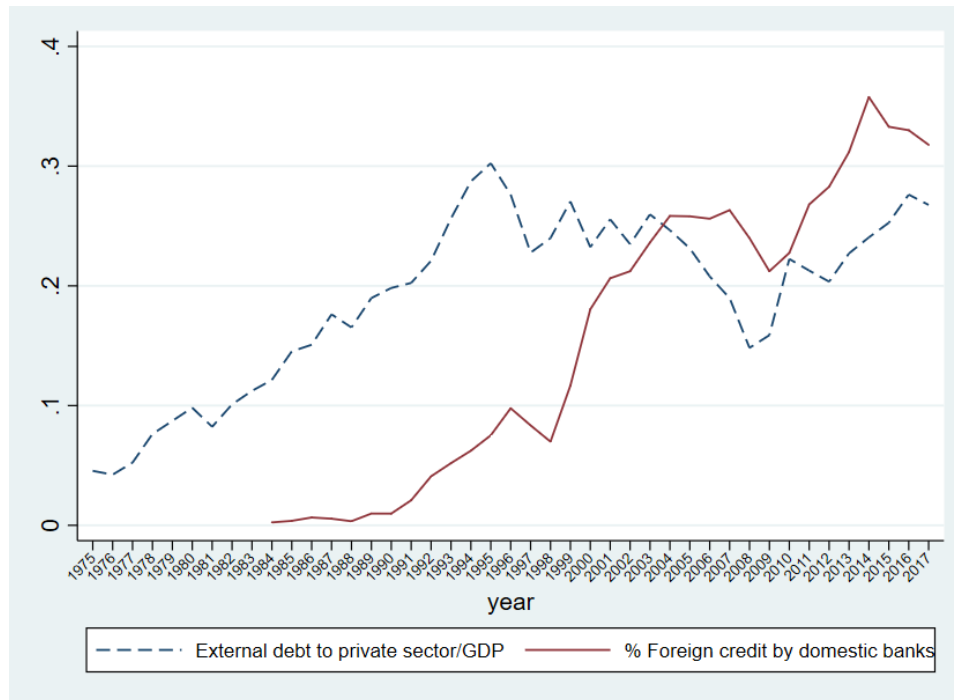
Just as the lending technologies that foreign banks and domestic banks employ to extend credit to firms in EMEs differ, so do the “products” that they produce also differ. Specifically, examining micro-level data on cross-border loan deals, we find that domestic banks tend to allocate a much higher portion of cross-border capital to tangible sector firms and unlisted firms than foreign banks. Furthermore, we find that domestic banks respond more in the credit allocation to changes in the global financial market condition than foreign banks. During the easing phase of the global financing cycle, the share of cross-border capital that domestic banks allocate toward tangible industries significantly increases, while the credit allocation of foreign banks barely changes.

Having documented the micro-level differences between foreign and domestic banks’ behavior in lending to EME borrowers, we then investigate the aggregate-level impact of the rise of domestic global banks in EMEs. In a time trend analysis, we find that along with upward trend in the share of domestic bank-channeled cross-border credit, emerging markets around the world become 1) more tilted toward tangible industries and 2) more susceptible to external shocks in the global financial market. The reshaped industry structure and increased sensitivity to the global financing cycle are consistently observed in many emerging markets around the world.

Finally, in a cross-country analysis we exploit country-wise heterogeneity in the share of cross-border capital channeled by domestic banks. Using measures of a country’s financial literacy as an IV to construct the exogenous components in country-wise variation, we find that the above aggregate real impacts are more pronounced if a larger fraction of cross-border credit is channeled by domestic banks. Our analysis suggests that the ongoing replacement of foreign lenders by domestic lenders in the cross-border loan market can have a profound

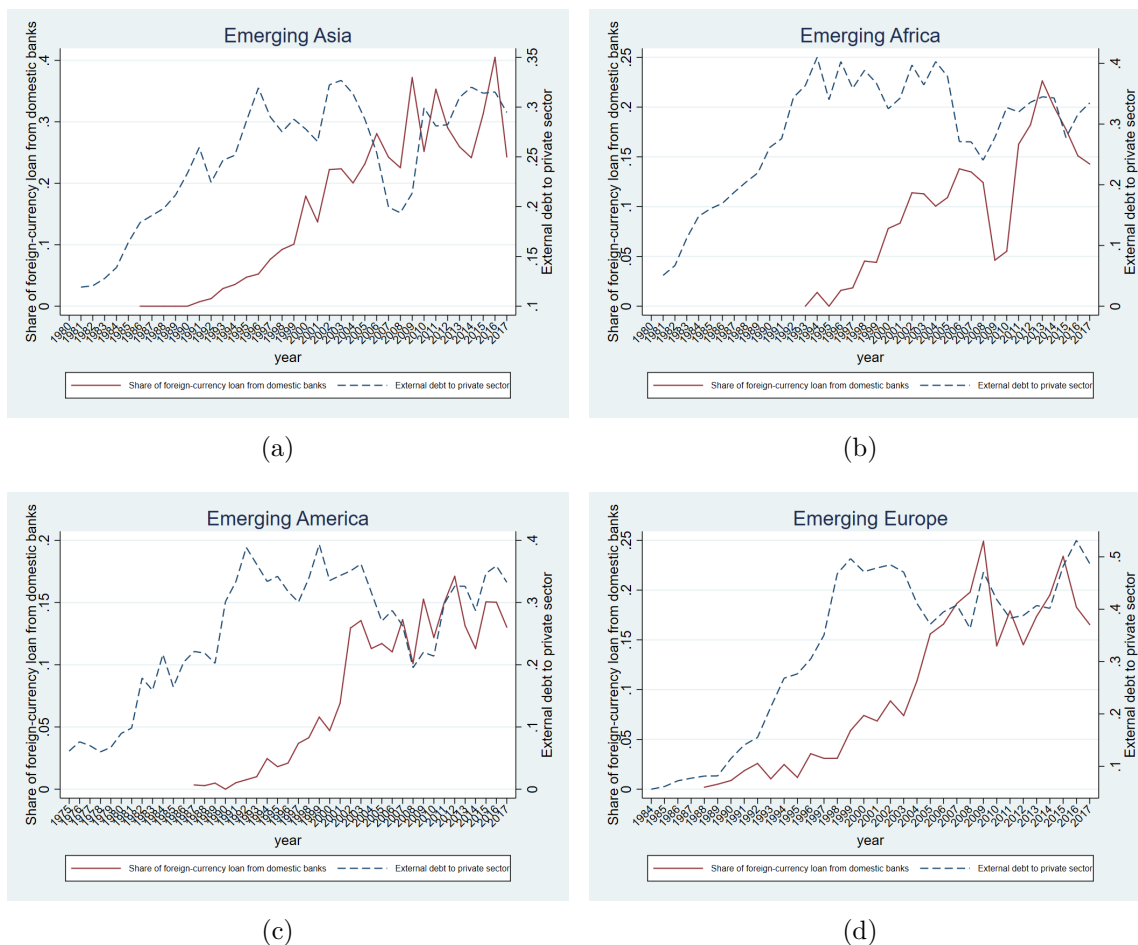
impact on emerging market economies.

Fig. 3.1. EME External Debt and FX Credit Intermediated by Domestic Banks



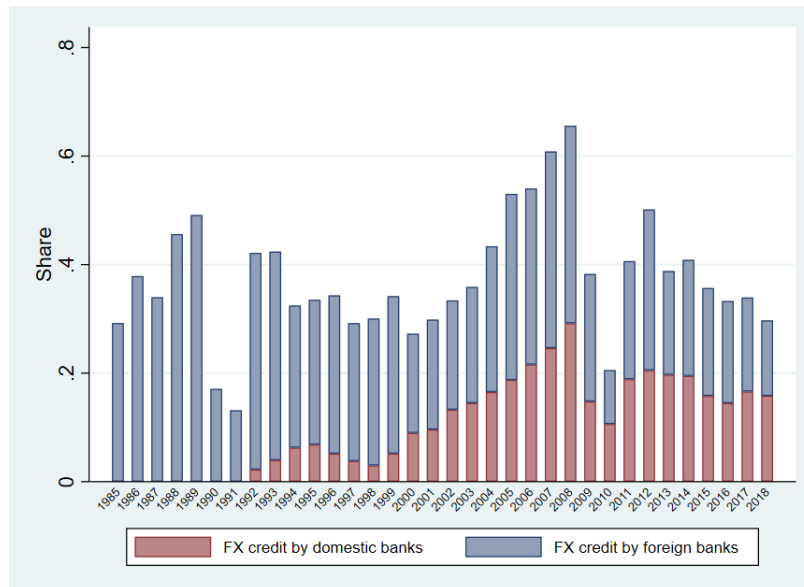
Source: IMF IFS and LPC Dealscan. The navy dashed line plots the external debt to non-financial sector as a proportion of GDP during 1975-2017. The red solid line plots the dollar amount of foreign currency bank credit that are lent by domestic global banks as a proportion of total amount of foreign credit over the span of years during 1990-2017. The compilation is the average of 50 emerging market economies.

Fig. 3.2. Rise of Domestic banks in cross-border lending all over the world



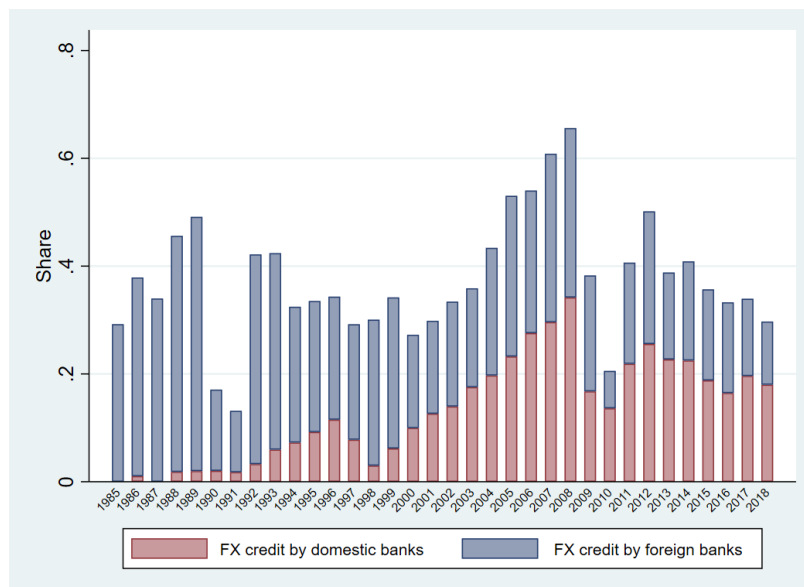
Source: IMF IFS and LPC Dealscan. For regional figure, the navy dashed line plots the external debt to non-financial sector as a proportion of GDP during 1975-2017. The red solid line plots the dollar amount of foreign currency bank credit that are lent by domestic global banks as a proportion of total amount of foreign credit over the span of years during 1990-2017. The compilation is the average of 50 emerging market economies.

Fig. 3.3. Domestic bank participated foreign-currency cross-border loans and foreign-bank only cross-border loans



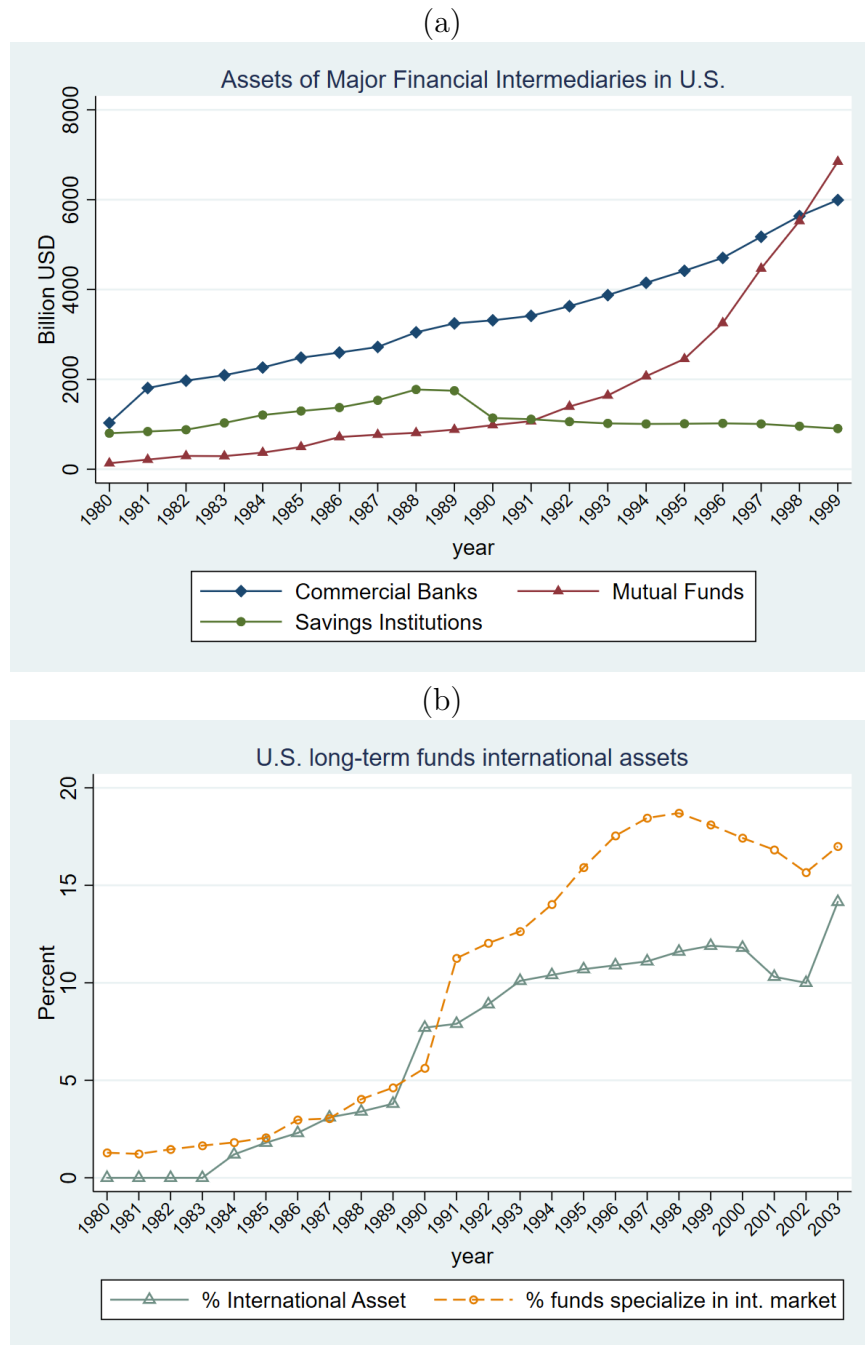
Source: LPC Dealscan. Figure shows the dollar amount of foreign-currency denominated loans to emerging market economies' non-financial corporate sector that are issued by domestic bank participated tranches and by foreign-bank-only tranches respectively. The share is calculated as the sum of loans in respective definitions scaled by total volume of loans to EME in a given year. The calculation is based on 50 major emerging market economies.

Fig. 3.4. Domestic bank foreign-currency cross-border loans volume and foreign-bank lent cross-border loans volume



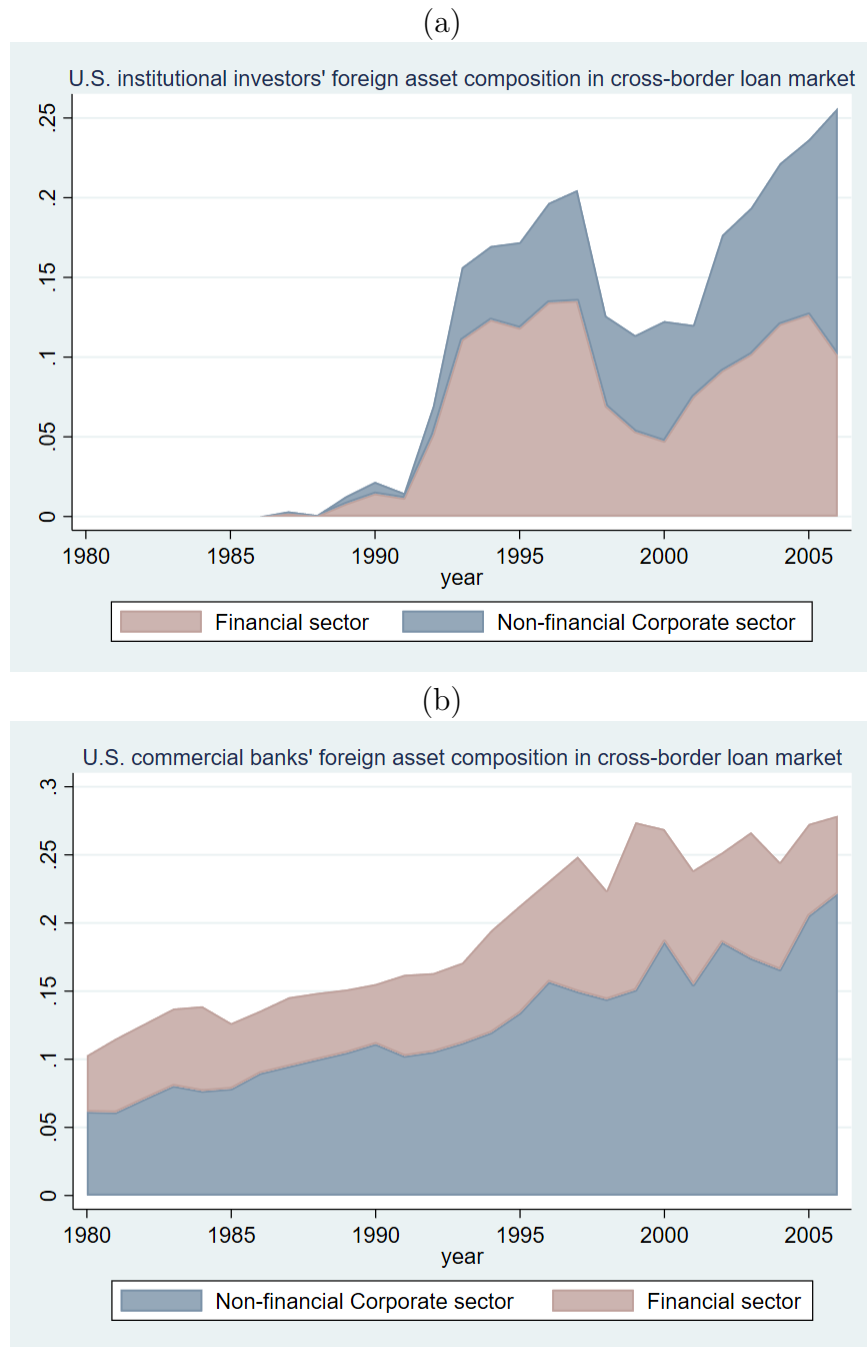
Source: LPC Dealscan. Figure shows the dollar amount of foreign currency denominated loans to emerging market economies' non-financial corporate sector that are lent directly by domestic bank-participated tranches and by only by foreign banks respectively. The share is calculated as the sum of loans in respective definitions scaled by total volume of loans to EME in a given year. The calculation is based on 50 major emerging market economies.

Fig. 3.5. Expansion of Mutual funds in the U.S. Financial Market and in international market



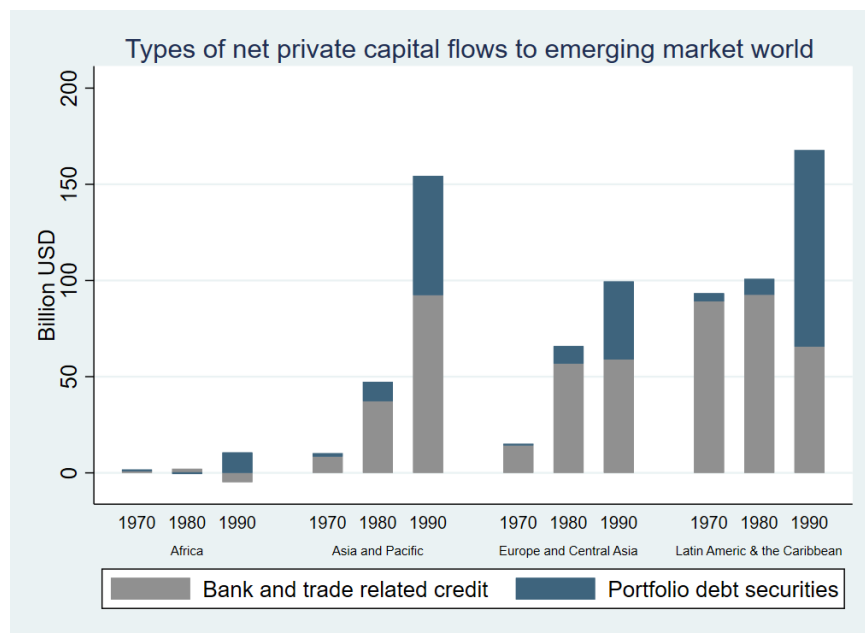
Notes: The source of the data in the above figure comes from *Mutual Fund Fact Book (1980-2000)*. In panel (a) "Savings Institutions" include all the mutual savings banks and savings & loans associations. Mutual funds include money market funds and bond funds. Panel (b) plots the share of total net assets that are classified as investment in the international market, the funds in this figure includes money market funds and bond funds.

Fig. 3.6. Mutual funds and commercial banks different investment strategy in international market



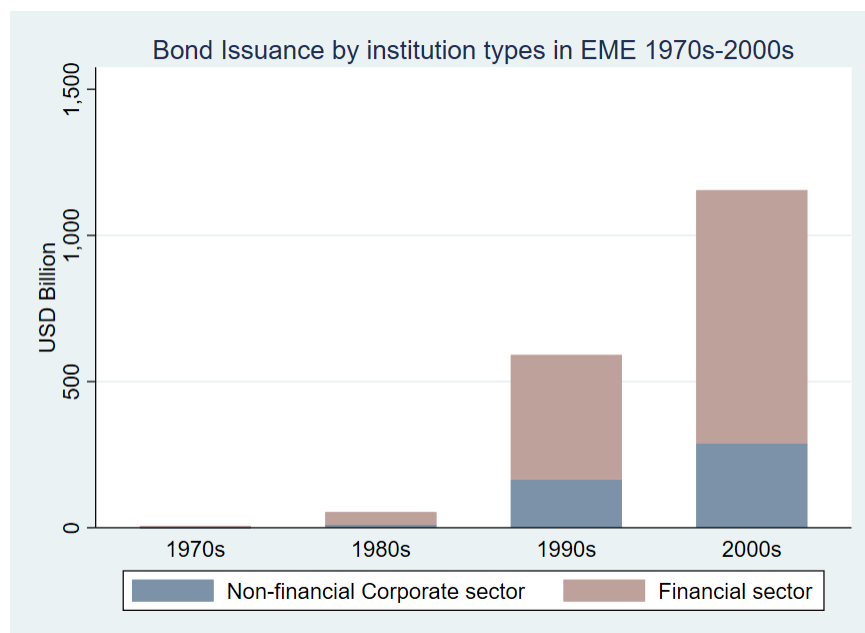
Source: Dealscan. The sum of blue and red area shows the proportion of total lending of U.S. non-bank financial institutions (panel (a))/commercial banks (panel (b)) total lending to foreign entities as of total lending; the blue area shows the proportion of lending to foreign borrowers of total lending amount in a given year, the red boundary shows the proportion of total lending to foreign banks, both are aggregate proportions. Mathematically, $\text{Blue} + \text{Red} = \frac{\sum_t \text{Loan amount}_t \times 1[[\text{EME borrower}]_t]}{\sum_t \text{Loan amount}_t}$, $\text{Blue} = \frac{\sum_t \text{Loan amount}_t \times 1[[\text{EME borrower}]_t] \times 1[[\text{Non-financial}]_t]}{\sum_t \text{Loan amount}_t}$, $\text{Red} = \frac{\sum_t \text{Loan amount}_t \times 1[[\text{EME borrower}]_t] \times 1[[\text{Financial}]_t]}{\sum_t \text{Loan amount}_t}$.

Fig. 3.7. Types of net private debt flows to emerging market economies



Source: Worldbank. The figure displays types of cross-border net debt flows to private sector of EMEs. Bank and trade related refers to bank debt, portfolio debt securities refers to portfolio bonds.

Fig. 3.8. Bond issuance by sector in EME



Source: Thomson One Banker. The figure displays the bond issuance volume by EME non-financial corporations and financial sector. From 1970s to 2000s.

Fig. 3.9. EME banks' dynamic responses to U.S. financial condition indices

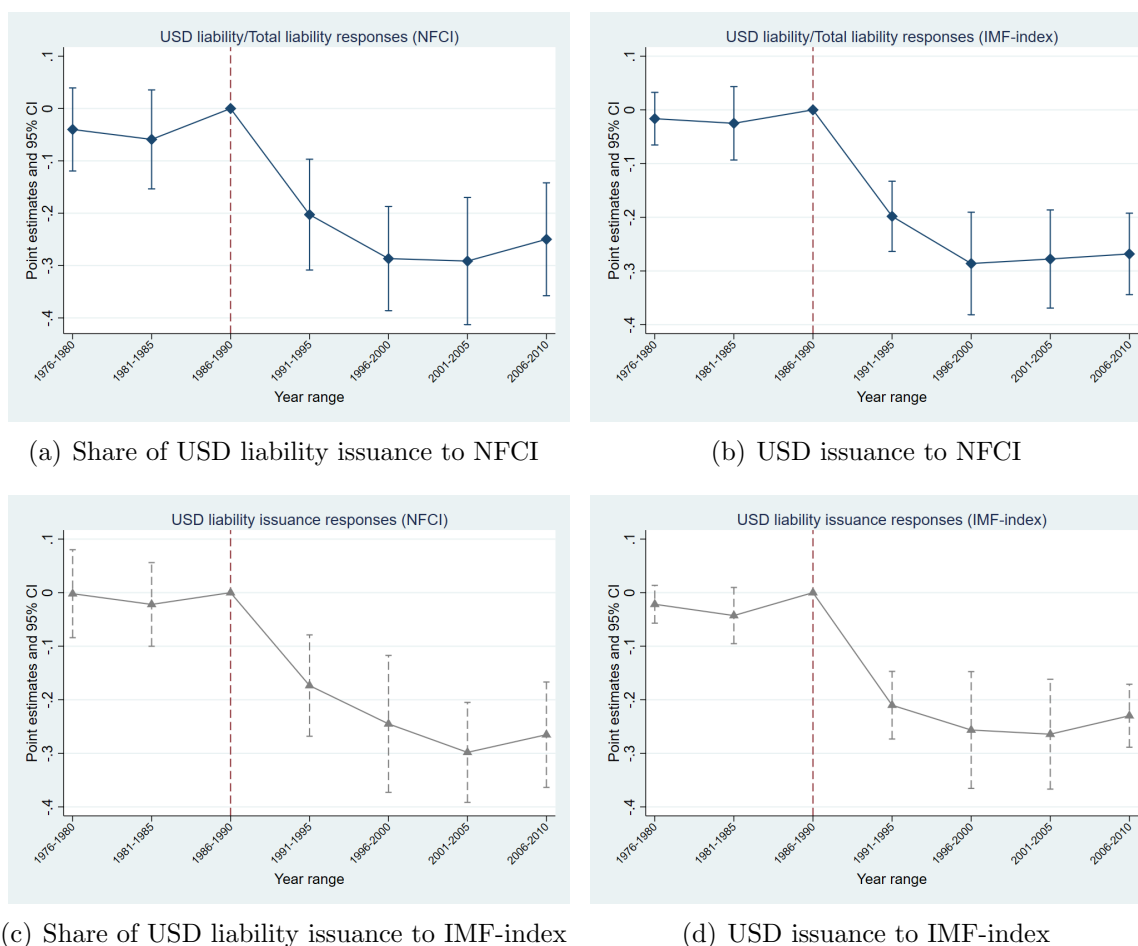


Figure 3.9 illustrates EME banks' USD funding issuance in response to U.S. financial condition indices over time. The U.S. financial condition indices are NFCI (Chicago Fed National Financial Conditions Index) and IMF-index for the United States (2017 GFSR Chapter 3 Annex 3.1). The Figure 4.18(a) and 4.18(c) estimate:

$$\frac{\text{USD liability issuance}}{\text{Total issuance}}_{b,t,r} = \alpha_b + \mu_r + \sum_{r=06-10, r \neq 85-90}^{r=76-80} \beta_r D[t \in r] \times F_t^{U.S.} + \theta \mathbf{X} + \epsilon_{b,t,r}$$

while Figure 4.18(b) and 4.18(d) estimate:

$$1[\text{USD liability issuance}]_{b,t,r} = \alpha_b + \mu_r + \sum_{r=06-10, r \neq 85-90}^{r=76-80} \beta_r D[t \in r] \times F_t^{U.S.} + \theta \mathbf{X} + \epsilon_{b,t,r}$$

where b refers to bank, t refers to year and r refers to the year range, \mathbf{X} is a vector of country-level control variables including GDP growth rate, net export/GDP, FDI/GDP, deposit rate, REER, and inflation rate. All four regressions are at bank-year level, and include 956 banks from 35 emerging market economies, each bank in the regression has at least three times of issuance. All regressions in the figures include bank fixed effect, year range fixed effect, standard errors are heteroskedastically robust and clustered at year level. In Figure 4.18(a) and 4.18(c), the LHS is the liability issuance denominated in USD (bond and loan) divided by total liability issuance of a bank in a given year; in Figure 4.18(b) and 4.18(d), the LHS is dummy variable that equals to 1 if a bank issued USD liabilities in a given year.

Table 3.1. Loan Characteristics

Panel A: Summary Statistics (Tranche-level, Overall sample)						
Tranche Information	N	Mean	Sd.	p(25)	p(50)	p(75)
Maturity(years)	11788	5.8	3.9	3.0	5.0	7.0
All In Spread Drawn (bps)	11788	190.2	197.0	90.0	140.0	240.0
Loan amount (m)(USD)	11788	102.7	482.6	24.6	60.2	167.6
1[Foreign banks participation]	11788	0.54	0.29	0	1	1
Foreign banks share	11788	0.45	0.36	0.08	0.41	0.77
Total number of lenders	11788	7.84	8.61	3	5	9
1[Term loan]	11788	0.65	0.33	0	1	1
1[Lead bank domestic bank]	11788	0.42	0.47	0	0	1
1[Multinational firm]	11788	0.29	0.45	0	0	1
1[Foreign ownership/Joint venture]	11788	0.12	0.28	0	0	1
<hr/>						
Deal's Currency	No.	%				
Domestic currency	2901	24.6				
Euro	940	8.0				
USD	7893	67.0				
Yen	54	0.5				
<hr/>						
Loan Purpose	No.	%				
General corporate purpose	10479	88.9				
M&A	306	2.6				
Trade and export	1001	8.5				
<hr/>						
# Firms	4490					

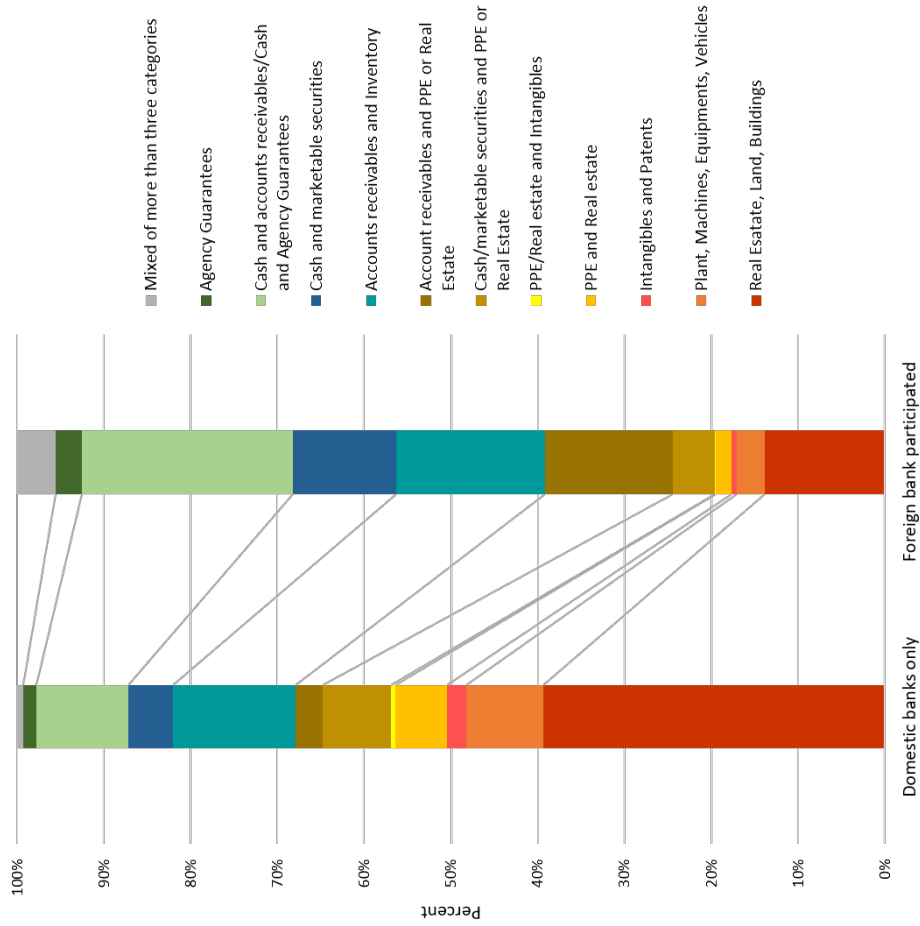
Notes: The above table presents the summary statistics of the sample of observations that serve as our baseline regression sample as shown in equation 3.1. 1[Foreign banks participation] is a dummy variable that equals 1 if the tranche has at least one foreign bank participated, foreign bank share is the total contribution of foreign banks in the tranche's face value scaled by the total amount of the tranche value, Total number of lenders is the total number of all lenders in a tranche. 1[Term loan] is a dummy variable that equals 1 if the loan is a term loan with bullet type of repayment. 1[lead bank domestic bank] is a dummy variable that equals 1 if the lead arranger is a domestic bank with the same parent country as the borrower, 1[multinational firm] is a dummy variable that equals 1 if the firm is a multinational firm, 1[foreign ownership/ joint venture] is a dummy variable that equals 1 if the firm has foreign ownership.

Fig. 3.11. Categorization of lending bases

Debt capacity						
Transparency				Tangibility		
Earnings/cash flow based				Fixed-value assets		
	Securities	Agency guarantee	Account receivables	Reserves & Inventories	Internationall y-deployable	Domestic-based
<i>Tencent, Formosa Plastic, Batik Asam, Philip Morris, etc</i>	"Stock shares of a listed subsidiary in.XY"	"Standby LC"	"Assignments of leasing income"	"Oil inventories"	"Boeing 777 air-craft"	"Plant and equipment of a subsidiary.XXX"
	"Floating charge over securities"	"Promissory notes specifying XXX from parent company.XXX"	"Toll income of Express No.XY"	"Sillables in XXXX-quarters."	"Vessel.XXX"	"Mortgage over land and properties"
					"Ship.XXX"	"Mortgage over new extension of shopping mall"
Unsecured				Secured		

Notes: The above table provides an exhaustive categorization of all types of assets that firms the database have borrowed against as lending bases. We also demonstrate here how different types of assets are related to firms' debt capacity. In general, firms have two sources of debt capacity: first is transparent cash flows or earnings ("Transparency"), and the second is through offering tangible assets up-front to lenders ("Tangibility"). Similar categorizations of debt capacity is also demonstrated by Lian and Ma (2018).

Fig. 3.12. Detailed types of lending bases in documentation



Notes: The above figure shows the full spectrum of the categories of lending bases of domestic-bank-only loans and foreign-bank participated loans that have shown up in the sample. The height of each colored block represents the total amount of loans based on a specific category of assets as a share of total secured loan amount.

Table 3.2. Covenant inclusion and foreign bank participation

	1[Covenant Inclusion]						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1[Foreign bank participation]	0.124** (0.0456)	0.113** (0.0355)	0.135*** (0.0342)	0.185*** (0.0552)	0.136** (0.0565)	0.118** (0.0377)	0.122*** (0.0267)
Ln[Loan amount]			0.287* (0.155)	0.284** (0.0944)	0.309** (0.101)	0.288* (0.122)	0.312** (0.103)
Maturity			-0.0166 (0.0155)	-0.0188 (0.0172)	-0.0201 (0.0198)	-0.0101 (0.0133)	-0.0122 (0.0145)
1[LBO]			-0.255 (0.262)	-0.225 (0.272)	-0.282 (0.266)	-0.265 (0.253)	-0.248 (0.269)
1[Trade finance]			0.0201* (0.00982)	0.0121 (0.0179)	0.0113 (0.0165)	0.0103* (0.00522)	0.0141 (0.126)
1[Term loan]			-0.0187 (0.0232)	-0.0192 (0.0212)	-0.0179 (0.0203)	-0.0222 (0.0232)	-0.0252 (0.0268)
Resolving Insolvency Score				0.0309** (0.0102)			
GDP growth					3.118 (2.334)		
REER					0.0655 (0.0448)		
Domestic credit/GDP					2.332 (1.176)		
1[Multinational Entrepreneur]						0.0912* (0.0365)	
1[Foreign ownership/J.V.]							0.119** (0.0395)
Observations	22782	22782	22782	18762	18762	18762	18762
Adjusted R^2	0.233	0.276	0.443	0.482	0.498	0.452	0.466
Lead bank country FE	Y	Y	Y	Y	Y	Y	Y
Industry-Year FE	N	Y	Y	Y	Y	Y	Y
Deal FE	Y	Y	Y	Y	Y	Y	Y

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The table presents results on the baseline regression equation:

$$1[\text{covenant inclusion}]_{i,d,t} = \alpha_i + \mu_d + \beta(1[\text{Foreignbankparticipation}]) + \gamma\mathbf{X} + FE's$$

Ln(loan amount) is the log of tranche amount, maturity is maturity in years, 1[LBO], 1[Trade finance] are indicator variables that equal to 1 if the loan is for M&A purpose or trade financing respectively. Resolving insolvency score is the borrower country's overall score of resolving insolvency defined by WorldBank Doing Business. GDP growth is the real GDP growth of the borrower's economy in year t , REER is real effective exchange rate, Domestic credit/GDP is the total credit to private sector lent by domestic financial intermediaries. 1[Multinational Entrepreneur] and 1[Foreign ownership/J.V.] are indicator variables that equals 1 if the firm is an MNE or J.V.

Table 3.3. Covenant inclusion and foreign bank participation

	1[Covenant Inclusion]						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Foreign bank share (%)	1.872** (0.587)	1.763*** (0.502)	1.902*** (0.543)	1.776*** (0.489)	1.553** (0.515)	1.287*** (0.349)	1.366*** (0.355)
Ln[Loan amount]			0.166** (0.0546)	0.124** (0.0418)	0.177** (0.0581)	0.165** (0.0576)	0.182** (0.0583)
Maturity			-0.0233 (0.0176)	-0.0302* (0.0147)	-0.0334 (0.0203)	-0.0298* (0.0143)	-0.0276* (0.0135)
1[LBO]			-0.0872 (0.0622)	-0.0762 (0.0679)	-0.0988 (0.0853)	-0.0923 (0.0872)	-0.121 (0.0877)
1[Trade finance]			0.0337* (0.0166)	0.0421* (0.0203)	0.0403 (0.0282)	0.0377* (0.0172)	0.0382* (0.0167)
1[Term loan]			-0.0423 (0.0366)	-0.0394 (0.0309)	-0.0388 (0.0315)	-0.0323 (0.0432)	-0.0562* (0.0244)
Resolving Insolvency Score				0.0203* (0.00663)			
GDP growth					2.772 (1.993)		
REER					0.0452* (0.0203)		
Domestic credit/GDP					3.109 (2.093)		
1[Multinational Entrepreneur]						0.0766** (0.0365)	
1[Foreign ownership/J.V.]							0.123** (0.0257)
Observations	22782	22782	22782	18762	18762	18762	18762
Adjusted R^2	0.209	0.302	0.339	0.402	0.488	0.426	0.438
Lead bank country FE	Y	Y	Y	Y	Y	Y	Y
Industry-Year FE	N	Y	Y	Y	Y	Y	Y
Deal FE	Y	Y	Y	Y	Y	Y	Y

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The table presents results on the baseline regression equation:

$$1[\text{covenant inclusion}]_{i,d,tr} = \alpha_i + \mu_d + \beta(\text{Foreign bank share}\%) + \gamma\mathbf{X} + FE's$$

Ln(loan amount) is the log of tranche amount, maturity is maturity in years, 1[LBO], 1[Trade finance] are indicator variables that equal to 1 if the loan is for M&A purpose or trade financing respectively. Resolving insolvency score is the borrower country's overall score of resolving insolvency defined by WorldBank Doing Business. GDP growth is the real GDP growth of the borrower's economy in year t , REER is real effective exchange rate, Domestic credit/GDP is the total credit to private sector lent by domestic financial intermediaries. 1[Multinational Entrepreneur] and 1[Foreign ownership/J.V.] are indicator variables that equals 1 if the firm is an MNE or J.V.

Table 3.4. Baseline results: I

	1[Fixed assets collateral]						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1[Foreign bank participation]	-0.192** (0.0655)	-0.194** (0.0642)	-0.195*** (0.0551)	-0.225*** (0.0642)	-0.236** (0.0775)	-0.228** (0.0756)	-0.213*** (0.0602)
Ln[Loan amount]			0.104* (0.0501)	0.115* (0.0506)	0.109* (0.0509)	0.108* (0.0511)	0.112* (0.0509)
Maturity			-0.0163 (0.0174)	-0.0173 (0.0204)	-0.0164 (0.0329)	-0.0222 (0.0180)	-0.0203 (0.0176)
1[LBO]			-0.255 (0.262)	-0.225 (0.272)	-0.282 (0.266)	-0.265 (0.253)	-0.248 (0.269)
1[Trade finance]			0.0137 (0.146)	-0.0142 (0.149)	-0.0167 (0.152)	-0.0143 (0.143)	-0.0139 (0.126)
1[Term loan]			0.109 (0.112)	0.116 (0.117)	0.122 (0.179)	0.121 (0.132)	0.135 (0.128)
Resolving Insolvency Score				0.0480* (0.0241)			
GDP growth					-7.092 (4.181)		
REER					-0.0443 (0.0319)		
Domestic credit/GDP					9.332 (5.176)		
1[Multinational Entrepreneur]						0.175 (0.148)	
1[Foreign ownership/J.V.]							0.261* (0.122)
Observations	11788	11788	11788	10652	10652	10652	10652
Adjusted R^2	0.329	0.477	0.534	0.542	0.404	0.539	0.541
Lead bank country FE	Y	Y	Y	Y	Y	Y	Y
Industry-Year FE	N	Y	Y	Y	Y	Y	Y
Deal FE	Y	Y	Y	Y	Y	Y	Y

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The table presents results on the baseline regression equation:

$$1[\text{Fixed-assets collateral}]_{i,d,tr} = \alpha_i + \mu_d + \beta 1[\text{Foreign bank participation}] + \gamma \mathbf{X} + FE's$$

Ln(loan amount) is the log of tranche amount, maturity is maturity in years, 1[LBO], 1[Trade finance] are indicator variables that equal to 1 if the loan is for M&A purpose or trade financing respectively. Resolving insolvency score is the borrower country's overall score of resolving insolvency defined by WorldBank Doing Business. GDP growth is the real GDP growth of the borrower's economy in year t , REER is real effective exchange rate, Domestic credit/GDP is the total credit to private sector lent by domestic financial intermediaries. 1[Multinational Entrepreneur] and 1[Foreign ownership/J.V.] are indicator variables that equals 1 if the firm is an MNE or J.V.

Table 3.5. Baseline Results: II

	1[Fixed assets collateral]						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Foreign bank share (%)	-2.413*** (0.501)	-2.443*** (0.516)	-2.793*** (0.503)	-2.744*** (0.527)	-2.685*** (0.412)	-2.527*** (0.488)	-2.811*** (0.407)
Ln[Loan amount]			0.122* (0.0501)	0.132* (0.0487)	0.131* (0.0628)	0.119* (0.0500)	0.123* (0.0503)
Maturity			-0.0211 (0.0172)	-0.0231 (0.0192)	-0.0281 (0.0540)	-0.0259 (0.0176)	-0.0241 (0.0182)
1[LBO]			-0.264 (0.266)	-0.253 (0.276)	-0.262 (0.281)	-0.278 (0.265)	-0.282 (0.268)
1[Trade finance]			-0.0376 (0.162)	-0.0386 (0.144)	-0.0424 (0.157)	-0.0597 (0.145)	-0.0386 (0.156)
1[Term loan]			0.0831 (0.114)	0.0923 (0.135)	-0.0799 (0.153)	0.0675 (0.124)	0.0752 (0.122)
Resolving Insolvency Score				0.127** (0.453)			
GDP growth					-7.311 (4.223)		
REER					-0.0493 (0.0350)		
Domestic credit/GDP					9.697 (5.322)		
1[Multinational Entrepreneur]						0.168 (0.145)	
1[Foreign ownership/J.V.]							0.421** (0.142)
Observations	11788	11788	11788	10652	10652	10652	10652
Adjusted R^2	0.337	0.485	0.541	0.524	0.408	0.547	0.542
Lead bank country FE	Y	Y	Y	Y	Y	Y	Y
Industry-Year FE	N	Y	Y	Y	Y	Y	Y
Deal FE	Y	Y	Y	Y	Y	Y	Y

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The table presents results on the baseline regression equation:

$$1[\text{Fixed-assets collateral}]_{i,d,tr} = \alpha_i + \mu_d + \beta(\text{Foreign bank share}\%) + \gamma\mathbf{X} + FE's$$

Ln(loan amount) is the log of tranche amount, maturity is maturity in years, 1[LBO], 1[Trade finance] are indicator variables that equal to 1 if the loan is for M&A purpose or trade financing respectively. Resolving insolvency score is the borrower country's overall score of resolving insolvency defined by WorldBank Doing Business. GDP growth is the real GDP growth of the borrower's economy in year t , REER is real effective exchange rate, Domestic credit/GDP is the total credit to private sector lent by domestic financial intermediaries. 1[Multinational Entrepreneur] and 1[Foreign ownership/J.V.] are indicator variables that equals 1 if the firm is an MNE or J.V.

Table 3.6. Baseline Results III

	% of loan value secured fixed assets						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1[Foreign bank participatoin]	-0.188*** (0.0403)	-0.196** (0.0355)	-0.201** (0.0422)	-0.179*** (0.0389)	-0.192*** (0.0401)	-0.203*** (0.0378)	-0.186** (0.0398)
Ln[Loan amount]			0.0163 (0.0145)	0.0172 (0.0198)	0.0219 (0.0181)	0.0129 (0.0199)	0.0212 (0.0211)
Maturity			-0.00403 (0.00492)	-0.00455 (0.00474)	-0.00488 (0.00419)	-0.00804 (0.00652)	-0.00507 (0.00679)
1[LBO]			-0.0809 (0.112)	-0.0942 (0.114)	-0.0913 (0.123)	-0.0925 (0.132)	-0.0933 (0.127)
1[Trade finance]			-0.0205* (0.0102)	-0.0299* (0.0144)	-0.0298* (0.0127)	-0.0276* (0.0139)	-0.0293* (0.0133)
1[Term loan]			0.0286 (0.0477)	0.0289 (0.0469)	0.0321 (0.114)	0.0203 (0.0453)	0.0299 (0.0333)
Resolving Insolvency Score				0.0332** (0.0113)			
GDP growth					1.344 (1.762)		
REER					-0.00879 (0.0166)		
Domestic credit/GDP					1.106 (1.503)		
1[Multinational Entrepreneur]						0.152* (0.0624)	
1[Foreign ownership/J.V.]							0.477** (0.145)
Observations	5062	5062	5062	4496	4219	5062	5062
R^2	0.499	0.553	0.617	0.688	0.692	0.703	0.711
Lead bank country FE	Y	Y	Y	Y	Y	Y	Y
Industry-Year FE	N	Y	Y	Y	Y	Y	Y
Deal FE	Y	Y	Y	Y	Y	Y	Y

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table shows the results The table presents results on the baseline regression equation:

$$1[\% \text{ face value secured by fixed assets}]_{i,d,tr} = \alpha_i + \mu_d + \beta(1[\text{Foreign bank participation}]) + \gamma\mathbf{X} + FE's$$

Ln(loan amount) is the log of tranche amount, maturity is maturity in years, 1[LBO], 1[Trade finance] are indicator variables that equal to 1 if the loan is for M&A purpose or trade financing respectively. Resolving insolvency score is the borrower country's overall score of resolving insolvency defined by WorldBank Doing Business. GDP growth is the real GDP growth of the borrower's economy in year t , REER is real effective exchange rate, Domestic credit/GDP is the total credit to private sector lent by domestic financial intermediaries. 1[Multinational Entrepreneur] and 1[Foreign ownership/J.V.] are indicator variables that equals 1 if the firm is an MNE or J.V.

Table 3.7. Baseline Results IV

	% of loan value secured fixed assets						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Foreign bank share (%)	-2.223*** (0.427)	-1.924** (0.392)	-2.303** (0.401)	-2.335*** (0.361)	-2.209*** (0.353)	-2.229*** (0.363)	-2.453** (0.327)
Ln[Loan amount]			0.0152 (0.0220)	0.0152 (0.0220)	0.0349 (0.0671)	0.0134 (0.0215)	0.0152 (0.0220)
Maturity			-0.00487 (0.00754)	-0.00487 (0.00754)	0.0157 (0.0216)	-0.00804 (0.00759)	-0.00487 (0.00754)
1[LBO]			-0.0930 (0.117)	-0.0930 (0.117)	-0.0908 (0.125)	-0.0983 (0.114)	-0.0930 (0.117)
1[Trade finance]			-0.00255 (0.0632)	-0.00255 (0.0632)	-0.227 (0.223)	-0.0165 (0.0623)	-0.00255 (0.0632)
1[Term loan]			0.0279 (0.0498)	0.0279 (0.0498)	0.0370 (0.117)	0.0177 (0.0490)	0.0279 (0.0498)
Resolving Insolvency Score				0.0307** (0.0102)			
GDP growth					-1.278 (1.690)		
REER					-0.00757 (0.0140)		
Domestic credit/GDP					1.106 (2.130)		
1[Multinational Entrepreneur]						0.111** (0.0324)	
1[Foreign ownership/J.V.]							0.536* (0.224)
Observations	5062	5062	5062	4496	4219	5062	5062
R ²	0.529	0.654	0.708	0.702	0.810	0.726	0.705
Lead bank country FE	Y	Y	Y	Y	Y	Y	Y
Industry-Year FE	N	Y	Y	Y	Y	Y	Y
Deal FE	Y	Y	Y	Y	Y	Y	Y

Standard errors in parentheses

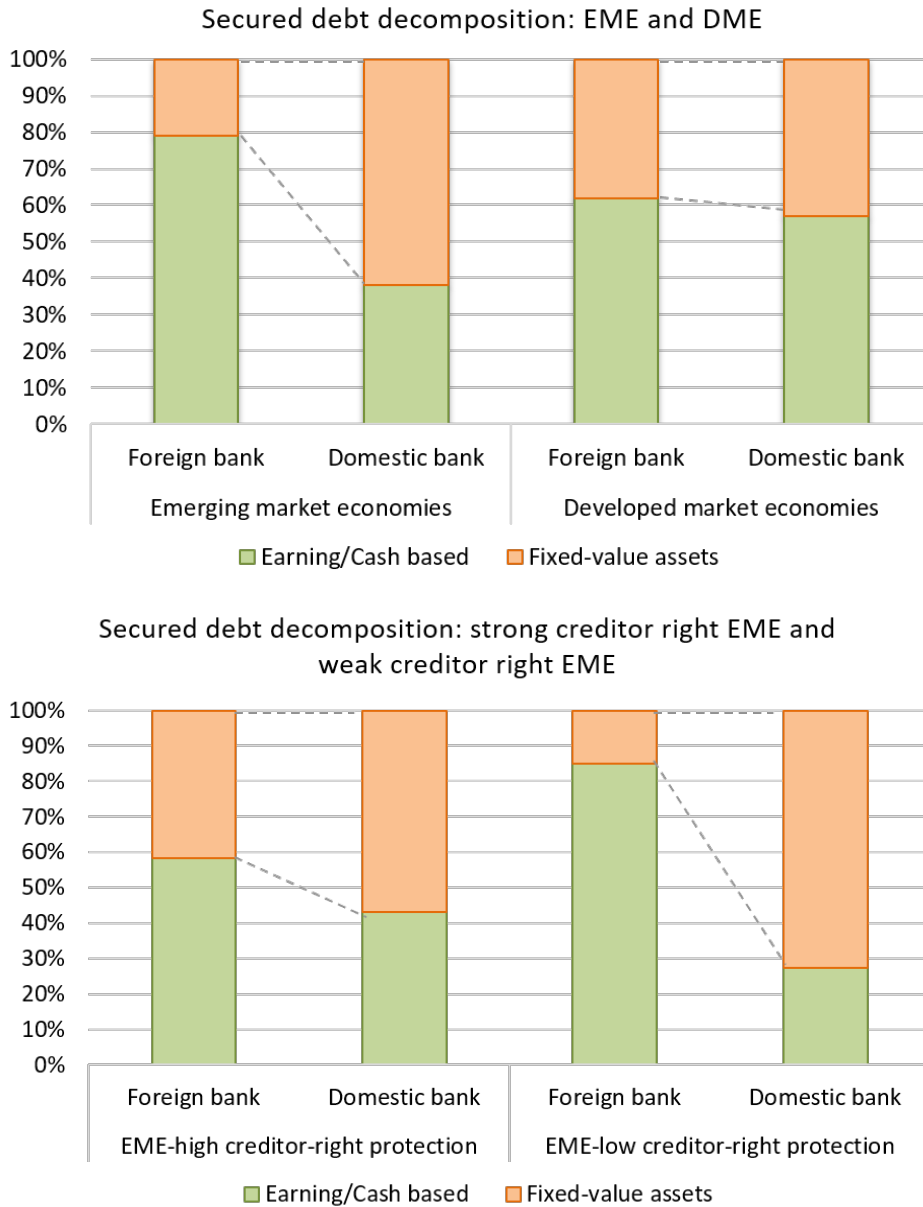
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: The table shows the results The table presents results on the baseline regression equation:

$$1[\% \text{ face value secured by fixed assets}]_{i,d,t,r} = \alpha_i + \mu_d + \beta(\text{Foreign bank share}\%) + \gamma\mathbf{X} + FE's$$

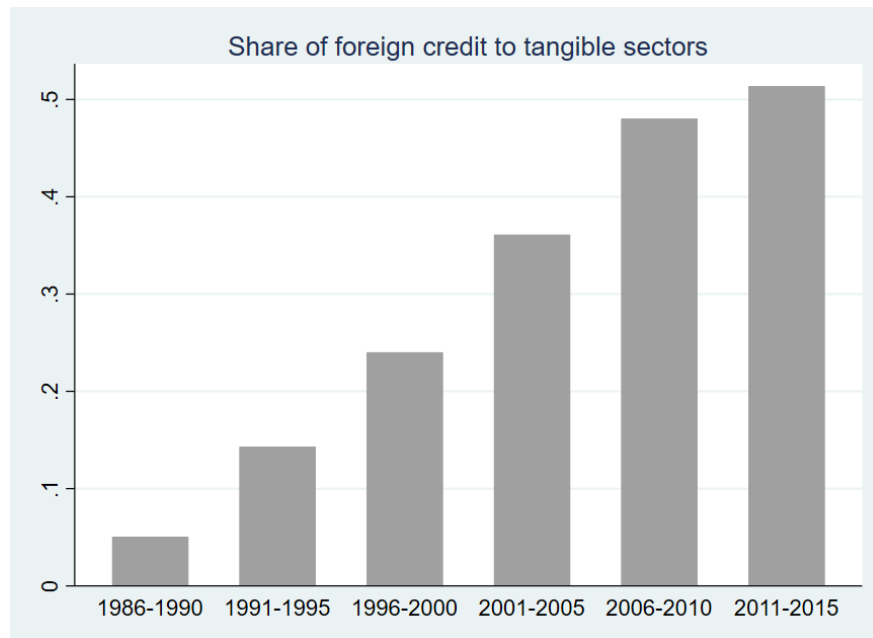
Ln(loan amount) is the log of tranche amount, maturity is maturity in years, 1[LBO], 1[Trade finance] are indicator variables that equal to 1 if the loan is for M&A purpose or trade financing respectively. Resolving insolvency score is the borrower country's overall score of resolving insolvency defined by WorldBank Doing Business. GDP growth is the real GDP growth of the borrower's economy in year t , REER is real effective exchange rate, Domestic credit/GDP is the total credit to private sector lent by domestic financial intermediaries. 1[Multinational Entrepreneur] and 1[Foreign ownership/J.V.] are indicator variables that equals 1 if the firm is an MNE or J.V.

Fig. 3.13. Foreign and domestic bank participation in Developed market and Emerging market



Notes: The above figure shows the differences between domestic banks and foreign banks in lending base choices in developed countries and emerging markets and in emerging market with high score of property registration. Developed Market Economies include United States, United Kingdom, Canada, Germany, Netherlands and Switzerland. Authors' calculation based on Datastream, Thomson One Banker and Loanconnector. The shaded bars represent the proportion of dollar amount of secured loans using different categories of lending bases. High resolving insolvency score EME's include South Africa, Malaysia and Czech Republic, and Low credit score EME's include Peru, Colombia and Mexico.

Fig. 3.14. Over-time trend: Foreign currency cross-border credit to High-tangibility industries and to unlisted firms

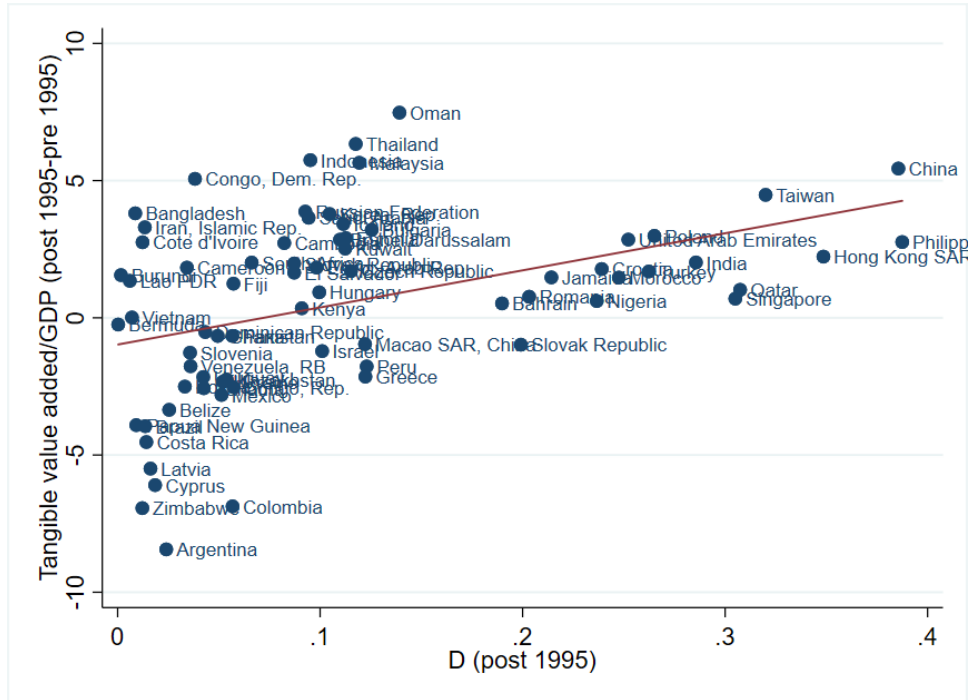


(a) Share of USD cross-border credit to tangible sectors



(b) Share of USD cross-border credit to private firms

Fig. 3.15. Reshaping of Industrial Structure: Cross-sectional Evidence



The figure shows the cross-sectional correlation between changes in EME's tangible sector value-added/GDP (post 1995-pre 1995) and the proportion of cross-border credit that was channeled by domestic banks post 1995. $D(\text{post } 1995)$ is defined as $\frac{\sum_b \sum_{t>1995} C_{b,t}^{USD} \times 1[\text{Domestic bank}_b]}{\sum_b \sum_{t>1995} C_{b,t}^{USD}}$, where $C_{b,t}^{USD}$ is the amount of a USD cross-border loan by bank b .

Table 3.8. Matching between banks and firms

	High-tangibility	Low-transparency
	(1)	(2)
% Domestic bank share	3.127*** (0.0211)	2.153*** (0.0342)
Maturity	1.003*** (0.000232)	1.005*** (0.000238)
1[Secured]	1.179*** (0.0378)	1.354*** (0.0438)
1[Takeover]	0.991 (0.0616)	1.258*** (0.0798)
1[Trade finance]	0.959 (0.0469)	2.204*** (0.111)
No. of lenders	0.988*** (0.00179)	0.985*** (0.00204)
Observations	77596	77596
Firm FE	Yes	Yes
Country-time FE	Yes	Yes

Exponentiated coefficients; Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table estimates the following regression equation:

$$\text{Ln}\left(\frac{P(\text{High tangibility}/\text{Low-transparency})}{1 - P(\text{High tangibility}/\text{Low-transparency})}\right)_{i,c,t} = \alpha_i + \theta_{c,t} + \beta(\text{Domestic bank share}(\%)) + \gamma X + \epsilon_{i,c,t}$$

A borrower is from a high-tangibility industry if the average tangibility (defined by PPE/total assets) of borrower's two-digit SIC industry is above the 75th percentile of all the two-digit industries in its economy. A borrower is classified as low-transparency firm if it is a private firm. A 10% percent increase in domestic bank share leads to increase in the probability of the credit going to high-tangibility firm/ low-transparency firm by around 30%/20%.

Table 3.9. Lender types and firm characteristics

	Ln[Loan amount]					
	(1)	(2)	(3)	(4)	(5)	(6)
% Domestic bank share	-0.157*	-0.111	-0.111	-0.179*	-0.114*	-0.114
	(0.0616)	(0.0652)	(0.0684)	(0.0890)	(0.0544)	(0.0591)
% Domestic bank share × 1[Low-transparency]	0.175***	0.116***	0.116***			
	(0.0261)	(0.0256)	(0.0314)			
% Domestic bank share × 1[High-tangibility]				0.186***	0.120***	0.120***
				(0.0285)	(0.0279)	(0.0267)
Maturity		0.00204***	0.00204***		0.00204***	0.00204***
		(0.000144)	(0.000296)		(0.000152)	(0.000292)
1[Secured]		-0.0210	-0.0210		-0.0214	-0.0214
		(0.0209)	(0.0257)		(0.0209)	(0.0260)
No. of lenders		0.0322***	0.0322***		0.0322***	0.0322***
		(0.000961)	(0.00168)		(0.000961)	(0.00170)
1[Takeover]		0.609***	0.609***		0.609***	0.609***
		(0.0406)	(0.0684)		(0.0406)	(0.0681)
1[Trade finance]		-0.0566	-0.0566		-0.0567	-0.0567
		(0.0311)	(0.0495)		(0.0311)	(0.0493)
Observations	41684	41684	41684	41684	41684	41684
Adjusted R^2	0.590	0.607	0.607	0.590	0.607	0.607
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Deal FE	Yes	Yes	Yes	Yes	Yes	Yes
Clusters (year)			34			34

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The table presents the following regression equation:

$$\ln(\text{Amount})_{i,c,t} = \alpha_i + \theta_{c,t} + \beta_1(\text{Domestic bank share}\%) + \beta_2(\text{Domestic bank share}\%) \times 1[\text{High tangibility/Low transparency}] + \gamma X + \epsilon_{i,c,t}$$

No. of lender is the total number of lending banks in a tranche, 1[Takeover] is a dummy variable that equals 1 if the purpose of the deal is for merger and acquisition. 1[Trade finance] is a dummy variable that equals 1 if the purpose of the deal is trade finance. 1[secured] is a dummy variable that equals 1 if the tranche is secured. A firm is defined to be of high-tangibility if its industry's above the top 25-th percentile of tangibility measured by PPE/Total assets in its country. And a firm is low-transparency if it is unlisted.

Table 3.10. Matching between banks and firms

	Ln[Loan amount]			
	(1)	(2)	(3)	(4)
% Domestic bank share	-0.110*	-0.108	-0.119*	-0.122
	(0.0511)	(0.0584)	(0.0489)	(0.0589)
% Domestic bank share×1[Low-transparance]	0.0246***	0.0375***		
	(0.00444)	(0.00423)		
% Domestic bank share× 1[Low transparency× 1[Fixed-value asset]	0.156***	0.172***		
	(0.0358)	(0.0376)		
% Domestic bank share×1[High-tangibility]			0.0368***	0.0354***
			(0.0109)	(0.0105)
% Domestic bank share× 1[High tangibility]× 1[Fixed-value asset]			0.116***	0.124***
			(0.0325)	(0.0331)
Maturity	0.00211***	0.00211***	0.00413***	0.00414***
	(0.000144)	(0.000304)	(0.000144)	(0.000303)
No. of lenders	0.0322***	0.0303***	0.0314***	0.0325***
	(0.000958)	(0.00166)	(0.000959)	(0.00167)
1[Takeover]	0.605***	0.612***	0.609***	0.614***
	(0.0406)	(0.0685)	(0.0406)	(0.0680)
1[Trade finance]	-0.0563	-0.0498	-0.0568	-0.0535
	(0.0311)	(0.0494)	(0.0311)	(0.0493)
Observations	31684	31684	31684	31684
Adjusted R^2	0.607	0.610	0.605	0.611
Firm FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Deal FE	Yes	Yes	Yes	Yes
Clusters (year)		34		34

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: The table shows the OLS The table presents the following regression equation:

$$\begin{aligned}
 \text{Ln}(\text{Amount})_{i,c,t} &= \alpha_i + \mu_{c,t} + \beta_1(\text{Domestic bank share}\%) \\
 &+ \beta_2(\text{Domestic bank share}\%) \times 1[\text{High tang/Low trans}] \\
 &+ \beta_3(\text{Domestic bank share}\%) \times 1[\text{High tang/Low trans}] \times 1[\text{Fixed-value}] + \gamma X + \epsilon_{i,c,t}
 \end{aligned}$$

No. of lender is the total number of lending banks in a tranche, 1[Takeover] is a dummy variable that equals 1 if the purpose of the deal is for merger and acquisition. 1[Trade finance] is a dummy variable that equals 1 if the purpose of the deal is trade finance. 1[secured] is a dummy variable that equals 1 if the tranche is secured. A firm is defined to be of high-tangibility if its industry's above the top 25-th percentile of tangibility measured by PPE/Total assets in its country. And a firm is low-transparency if it is unlisted.

Table 3.11. Overtime susceptibility to global financial condition: Real GDP

	GDP growth							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
NFCI	-0.275 (0.162)	-1.693*** (0.260)	-0.490 (0.253)	-1.892*** (0.300)	-0.435 (0.482)	-1.741*** (0.374)	-0.452 (0.517)	-1.985*** (0.345)
REER			-0.00323* (0.00128)	-0.0126 (0.00683)			-0.0299 (0.0314)	-0.0119 (0.0133)
Net Export/GDP			0.0538 (0.0382)	0.0152 (0.0125)			0.0487 (0.0550)	0.0204 (0.0158)
FDI			0.142 (0.144)	0.0148 (0.0134)			0.0466 (0.0241)	0.0435 (0.0305)
Unemployment					-0.771** (0.251)	-0.160 (0.0815)	-0.803** (0.250)	-0.128 (0.0795)
Inflation					-0.000867 (0.000877)	-0.00787 (0.0255)	0.000624 (0.00329)	-0.0451 (0.0231)
Deposit rate					0.000261 (0.000898)	-0.117** (0.0386)	-0.000149 (0.00113)	-0.0781 (0.0437)
Observations	998	1203	353	707	262	584	195	424
R^2	0.031	0.035	0.055	0.066	0.088	0.089	0.260	0.156
Economy FE	✓	✓	✓	✓	✓	✓	✓	✓
Year range	before 1995	after 1995	before 1995	after 1995	before 1995	after 1995	before 1995	after 1995

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: The table shows the OLS regression of annual GDP growth rate of emerging market economies to NFCI, which is Chicago Fed's National Financial Conditions Index (NFCI) and also a set of economy-level control variables. The coefficient on the NFCI after 1995 is tested to be significantly more negative than before 1995.

Table 3.12. Overtime susceptibility to global financial condition: Domestic Credit Growth

	Domestic credit growth							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
NFCI	-0.263 (0.166)	-1.002*** (0.187)	-0.278 (0.203)	-1.172*** (0.235)	-0.307 (0.262)	-1.062*** (0.263)	-0.421 (0.295)	-1.236*** (0.249)
REER			0.00401 (0.00491)	0.00579 (0.00531)			-0.0251 (0.0180)	-0.0885 (0.0967)
Net Export/GDP			0.0305* (0.0148)	0.0254* (0.00985)			0.0625 (0.0314)	0.0348** (0.0114)
FDI			0.162** (0.0557)	0.0214* (0.0104)			0.367** (0.138)	0.0573** (0.0220)
Unemployment					-0.511*** (0.140)	-0.126* (0.0592)	-0.569*** (0.149)	-0.0910 (0.0594)
Inflation					-0.00112 (0.00476)	0.00837 (0.0200)	0.00222 (0.00188)	-0.00836 (0.0186)
Deposit rate					0.00672 (0.00487)	-0.0701* (0.0289)	0.00129 (0.00648)	-0.0312 (0.0333)
Observations	800	1104	305	676	256	580	190	420
R^2	0.021	0.027	0.103	0.154	0.161	0.158	0.179	0.127
Economy FE	✓	✓	✓	✓	✓	✓	✓	✓
Year range	before 1995	after 1995	before 1995	after 1995	before 1995	after 1995	before 1995	after 1995

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: The table shows the OLS regression of annual domestic credit growth rate of emerging market economies to NFCI, which is Chicago Fed's National Financial Conditions Index (NFCI) and also a set of economy-level control variables. The coefficient on the NFCI after 1995 is tested to be significantly more negative than before 1995.

Table 3.13. Overtime susceptibility to global financial condition: Industrial Value Added Growth

	Industrial value-added growth							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
NFCI	-0.135 (0.272)	-3.217*** (0.440)	0.103 (0.483)	-3.695*** (0.549)	-0.933 (0.680)	-4.031*** (0.602)	0.857 (0.909)	-3.856*** (0.635)
REER			-0.0117 (0.00979)	-0.0124 (0.0128)			-0.113 (0.0615)	-0.0275 (0.0258)
Net Export/GDP			0.0981 (0.0747)	0.0532* (0.0249)			-0.0223 (0.0908)	0.0664* (0.0323)
FDI			0.115 (0.367)	0.0301 (0.0245)			0.934* (0.410)	0.0670 (0.0563)
Unemployment					-0.381 (0.338)	-0.114 (0.132)	-0.0568 (0.425)	0.0769 (0.150)
Inflation					-0.00194 (0.00159)	-0.0346 (0.0451)	-0.0916 (0.0653)	-0.0769 (0.0472)
Deposit rate					0.00240 (0.00324)	-0.105 (0.0657)	0.0538 (0.0375)	-0.0395 (0.0861)
Observations	571	1023	227	641	226	531	172	391
R^2	0.023	0.052	0.029	0.081	0.075	0.109	0.240	0.142
Economy FE	✓	✓	✓	✓	✓	✓	✓	✓
Year range	before 1995	after 1995	before 1995	after 1995	before 1995	after 1995	before 1995	after 1995

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: The table shows the OLS regression of annual annual industrial sector's value added growth rate of emerging market economies to NFCI, which is Chicago Fed's National Financial Conditions Index (NFCI) and also a set of economy-level control variables. The coefficient on the NFCI after 1995 is tested to be significantly more negative than before 1995.

Table 3.14. Trend change in tangible sector growth in EME: OLS

Panel A: Baseline				
	Δ Tang. value added/GDP	Δ Tang. growth	Δ Tang. Emp	Δ Tang investment
	(1)	(2)	(3)	(4)
ΔD	0.213** (0.0738)	0.377** (0.133)	0.298* (0.116)	0.562** (0.179)
Observations	65	48	62	59
R^2	0.015	0.021	0.034	0.033
Panel B: With controls				
	Δ Tang. value added/GDP	Δ Tang. growth	Δ Tang. Emp	Δ Tang investment
	(1)	(2)	(3)	(4)
ΔD	0.199** (0.0598)	0.309** (0.109)	0.376** (0.127)	0.467** (0.167)
Observations	65	48	62	59
R^2	0.114	0.122	0.144	0.165

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The table presents the results of the following regression:

$$\Delta Y_{1996-2010,i} = \alpha + \beta D_i + \phi \mathbf{X} + \epsilon_i$$

$\Delta Y_{1996-2010,c}$ is change in (average) outcome real economic variables of interest of country i during 1996-2010 compared with the (average) outcome variable before 1995. In this specification, it could be industrial sectors' share of output value added in GDP, the annual growth of industrial sector's output value added, the share of employment in industrial sector, and the average investment rate of tangible sector firms.

Table 3.15. Trend change in tangible sector growth in EME: 2SLS

Panel A: Baseline				
	<u>Δ Tang. value added</u>	<u>Δ Tang. growth</u>	<u>Δ Tang. Emp</u>	<u>Δ Tang investment</u>
	(1)	(2)	(3)	(4)
D	0.258**	0.407**	0.392*	0.702**
	(0.0883)	(0.123)	(0.141)	(0.234)
Observations	65	48	62	59
R^2	0.017	0.013	0.025	0.022

Panel B: With controls				
	<u>Δ Tang. value added</u>	<u>Δ Tang. growth</u>	<u>Δ Tang. Emp</u>	<u>Δ Tang investment</u>
	(1)	(2)	(3)	(4)
D	0.201**	0.336**	0.424**	0.655**
	(0.0652)	(0.113)	(0.136)	(0.223)
Observations	65	48	62	59
R^2	0.102	0.112	0.123	0.142

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The table presents the results of 2SLS the following regression equations:

$$D_i = \mu + \beta_1 Z_i + \beta_2 \bar{X}_{i,1990-1995} + \epsilon_i$$

$$\Delta Y_{1996-2010,i} = \alpha + \beta \hat{D}_i + \phi \mathbf{X} + \epsilon_i$$

The instrumental variable is "Ave. secondary edu (20-24)". $\Delta Y_{1996-2010,c}$ is change in (average) outcome real economic variables of interest of country i during 1996-2010 compared with the (average) outcome variable before 1995. In this specification, it could be industrial sectors' share of output value added in GDP, the annual growth of industrial sector's output value added, the share of employment in industrial sector, and the average investment rate of tangible sector firms.

Table 3.16. First-stage regression

	IV-1		IV-2	
	(1)	(2)	(3)	(4)
Three-bank concentration	-0.121**			
	(0.0326)			
Five-bank concentration		-0.152**		
		(0.0501)		
Ave. secondary edu (20-24)			0.0276***	
			(0.00669)	
Ave. tertiary edu (25+)				0.0327***
				(0.00625)
Unemployment	0.00360	0.00381	0.00278	0.00346
	(0.00266)	(0.00263)	(0.00263)	(0.00272)
Net export/GDP	0.000837*	0.000908*	0.000388	0.000779*
	(0.000349)	(0.000363)	(0.000318)	(0.000348)
Inflation	-0.00112	-0.00337	-0.000393	-0.00103
	(0.00160)	(0.00286)	(0.00137)	(0.00160)
Observations	65	65	65	65
R^2	0.256	0.249	0.238	0.245

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The table shows the first-stage regression for the 2SLS analysis.

$$D_i = \mu + \beta_1 Z_i + \beta_2 \bar{X}_{i,1990-1995} + \epsilon_i$$

The left-hand side variable D_i is the fraction of cross-border foreign currency loan to economy i that's lent by domestic banks. Three-bank concentration and five-bank concentration are the market share of the biggest three banks or five banks of an economy i . *Secondary_24* is the Barro-Lee average years of secondary education of workers of age 20-24; and *Tertiary_25* the Barro-Lee average years of tertiary education of workers of age 25+.

Table 3.17. Second-stage regression: GDP-1

	OLS	IV			
	(1)	(2)	(3)	(4)	(5)
1[Post 1995]	-1.330*** (0.324)	-1.616*** (0.336)	-1.664*** (0.344)	-1.598*** (0.333)	-1.636*** (0.344)
NFCI	-0.454* (0.208)	-0.184 (0.229)	-0.172 (0.232)	-0.140 (0.230)	-0.210 (0.225)
1[Post 1995] × D × NFCI	-0.0887** (0.0303)				
1[Post 1995] × $\widehat{D}_{\text{Secondary } 24}$ × NFCI		-0.186*** (0.0381)			
1[Post 1995] × $\widehat{D}_{\text{Tertiary } 25}$ × NFCI			-0.191*** (0.0414)		
1[Post 1995] × $\widehat{D}_{\text{3-bank}}$ × NFCI				-0.218*** (0.0453)	
1[Post 1995] × $\widehat{D}_{\text{5-bank}}$ × NFCI					-0.193*** (0.0409)
D	7.114 (6.190)				
\widehat{D}		11.85 (8.268)	12.15 (7.206)	12.33 (9.395)	12.40 (9.511)
Net Export/GDP	0.00264 (0.00363)	0.00683 (0.00411)	0.00754 (0.00500)	0.00470 (0.00358)	-0.0105* (0.00471)
Inflation	-0.00240*** (0.000517)	-0.00260*** (0.000523)	-0.00257*** (0.000524)	-0.00254*** (0.000516)	-0.00247*** (0.000507)
Unemployment	-0.251*** (0.0279)	-0.235*** (0.0282)	-0.237*** (0.0282)	-0.240*** (0.0276)	-0.204*** (0.0283)
Observations	1107	1101	1101	1107	1029
R^2	0.130	0.126	0.123	0.130	0.147
Economy controls	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The table presents the OLS and 2SLS of the following regression:

$$D_i = \mu + \beta_1 Z_i + \beta_2 \bar{X}_{i,1990-1995} + \epsilon_i$$

$$Y_{i,t} = \alpha + \beta_1 1[\text{Post 1995}] + \beta_2 F_t^{U.S.} + \gamma \widehat{D}_i \times 1[\text{Post 1995}] \times F_t^{U.S.} + \phi \mathbf{X} + \epsilon_{i,t}$$

The left-hand side variable is GDP growth rate. NFCI is the National Financial Condition Index constructed by Chicago Fed. Control variables include net export/GDP, inflation rate and unemployment rate.

Table 3.18. Second-stage regression: Domestic Credit Growth-1

	OLS	IV			
	(1)	(2)	(3)	(4)	(5)
1[Post 1995]	-0.231 (0.265)	-0.378 (0.269)	-0.366 (0.271)	-0.420 (0.273)	-0.556* (0.265)
NFCI	-0.607*** (0.146)	-0.311 (0.159)	-0.362* (0.162)	-0.418* (0.163)	-0.422** (0.153)
1[Post 1995] × D × NFCI	-0.0502*** (0.0128)				
1[Post 1995] × $D_{\widehat{\text{Secondary}} 24}$ × NFCI		-0.129*** (0.0254)			
1[Post 1995] × $D_{\widehat{\text{Tertiary}} 25}$ × NFCI			-0.118*** (0.0277)		
1[Post 1995] × $D_{\widehat{3\text{-bank}}}$ × NFCI				-0.108*** (0.0308)	
1[Post 1995] × $D_{\widehat{5\text{-bank}}}$ × NFCI					-0.102*** (0.0268)
D	9.308 (8.218)				
\widehat{D}		12.98 (9.376)	13.32 (8.121)	12.67 (8.872)	12.15 (9.339)
Net Export/GDP	0.0246** (0.00806)	0.0200* (0.00822)	0.0201* (0.00826)	0.0251** (0.00804)	0.0263*** (0.00793)
Inflation	-0.000119 (0.000350)	-0.0000841 (0.000349)	-0.0000824 (0.000350)	-0.0000754 (0.000349)	-0.000106 (0.000331)
Unemployment	-0.246*** (0.0363)	-0.239*** (0.0359)	-0.239*** (0.0360)	-0.243*** (0.0360)	-0.217*** (0.0346)
Observations	1021	1001	1001	1009	931
R^2	0.118	0.129	0.131	0.133	0.135
Economy controls	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The table presents the OLS and 2SLS of the following regression:

$$D_i = \mu + \beta_1 Z_i + \beta_2 \bar{X}_{i,1990-1995} + \epsilon_i$$

$$Y_{i,t} = \alpha + \beta_1 1[\text{Post 1995}] + \beta_2 F_t^{U.S.} + \gamma \widehat{D}_i \times 1[\text{Post 1995}] \times F_t^{U.S.} + \phi \mathbf{X} + \epsilon_{i,t}$$

The left-hand side variable is domestic credit growth rate. NFCI is the National Financial Condition Index constructed by Chicago Fed. Control variables include net export/GDP, inflation rate and unemployment rate.

Table 3.19. Second-stage regression: Industrial Growth

	OLS	IV			
	(1)	(2)	(3)	(4)	(5)
1[Post 1995]	-3.854*** (0.646)	-4.325*** (0.648)	-4.519*** (0.650)	-4.735*** (0.654)	-4.873*** (0.663)
NFCI	-0.874** (0.337)	-0.252 (0.367)	-0.127 (0.371)	-0.0995 (0.372)	-0.249 (0.368)
1[Post 1995] × \widehat{D} × NFCI	-0.200*** (0.0491)				
1[Post 1995] × $\widehat{D}_{\text{Secondary } 24}$ × NFCI		-0.340*** (0.0573)			
1[Post 1995] × $\widehat{D}_{\text{Tertiary } 25}$ × NFCI			-0.391*** (0.0619)		
1[Post 1995] × $\widehat{D}_{\text{3-bank}}$ × NFCI				-0.461*** (0.0694)	
1[Post 1995] × $\widehat{D}_{\text{5-bank}}$ × NFCI					-0.429*** (0.0633)
D	8.877 (7.677)				
\widehat{D}		10.89 (7.533)	11.99 (8.565)	12.37 (9.102)	11.78 (8.563)
Net Export/GDP	0.0165 (0.0202)	0.0204 (0.0204)	0.0199 (0.0204)	0.0188 (0.0197)	0.0139 (0.0207)
Inflation	-0.00210** (0.000777)	-0.00203** (0.000771)	-0.00200** (0.000769)	-0.00194* (0.000768)	-0.00202** (0.000768)
Unemployment	-0.199* (0.0811)	-0.175* (0.0784)	-0.176* (0.0782)	-0.173* (0.0785)	-0.173* (0.0791)
Observations	947	942	942	948	884
R^2	0.113	0.151	0.165	0.139	0.141
Economy controls	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The table presents the OLS and 2SLS of the following regression:

$$D_i = \mu + \beta_1 Z_i + \beta_2 \bar{X}_{i,1990-1995} + \epsilon_i$$

$$Y_{i,t} = \alpha + \beta_1 1[\text{Post 1995}] + \beta_2 F_t^{U.S.} + \gamma \widehat{D}_i \times 1[\text{Post 1995}] \times F_t^{U.S.} + \phi \mathbf{X} + \epsilon_{i,t}$$

The left-hand side variable is industrial value added growth rate. NFCI is the National Financial Condition Index constructed by Chicago Fed. Control variables include net export/GDP, inflation rate and unemployment rate.

Fig. 3.16. Foreign and Domestic Bank Participation Industry in EME and Developed Market Economies

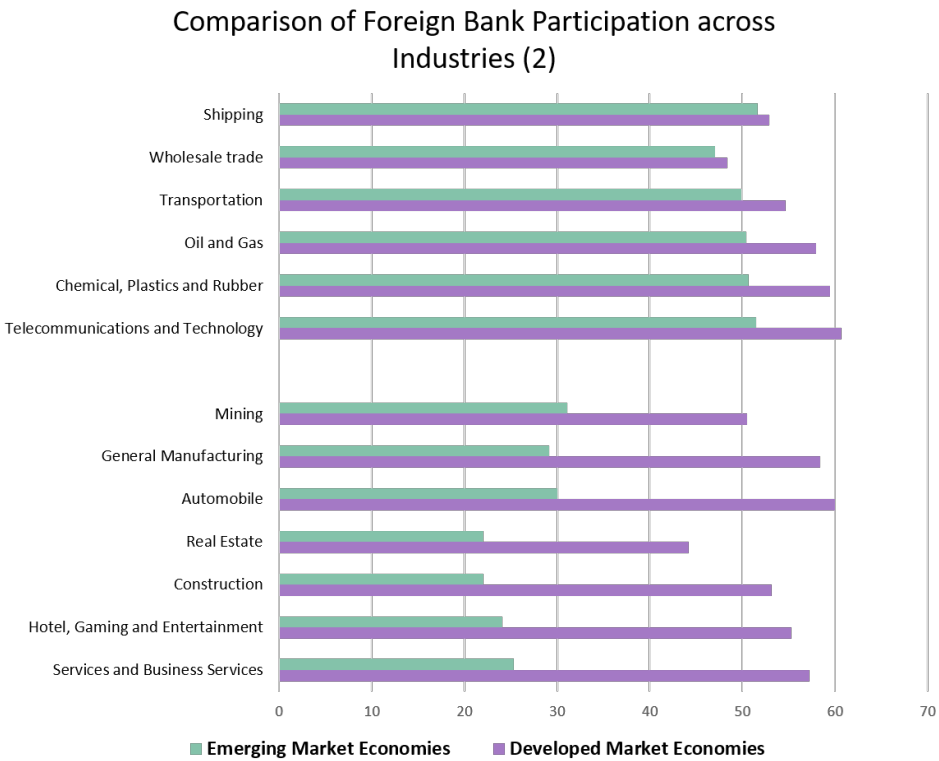
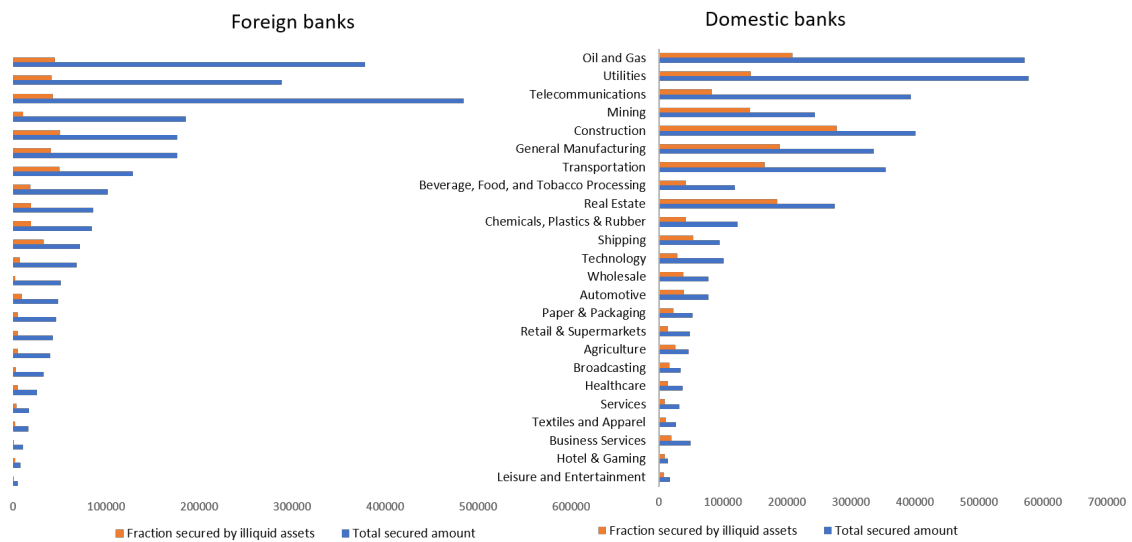


Fig. 3.17. Foreign and Domestic Bank Lending Bases across Industry in EME and Developed Market Economies



2-digit SIC	Industry	Tangibility
00-09	Agriculture, Forestry, & Fishing	0.468
10-14	Mining	0.425
15-17	Construction	0.405
40-49	Transportation & Public Utilities	0.357
20-39	Manufacturing	0.336
70-89	Services	0.263
52-59	Retail Trade	0.251
50-51	Wholesale Trade	0.198

Fig. 3.18. Foreign and Domestic Bank Lending Bases across Industry in EME and Developed Market Economies

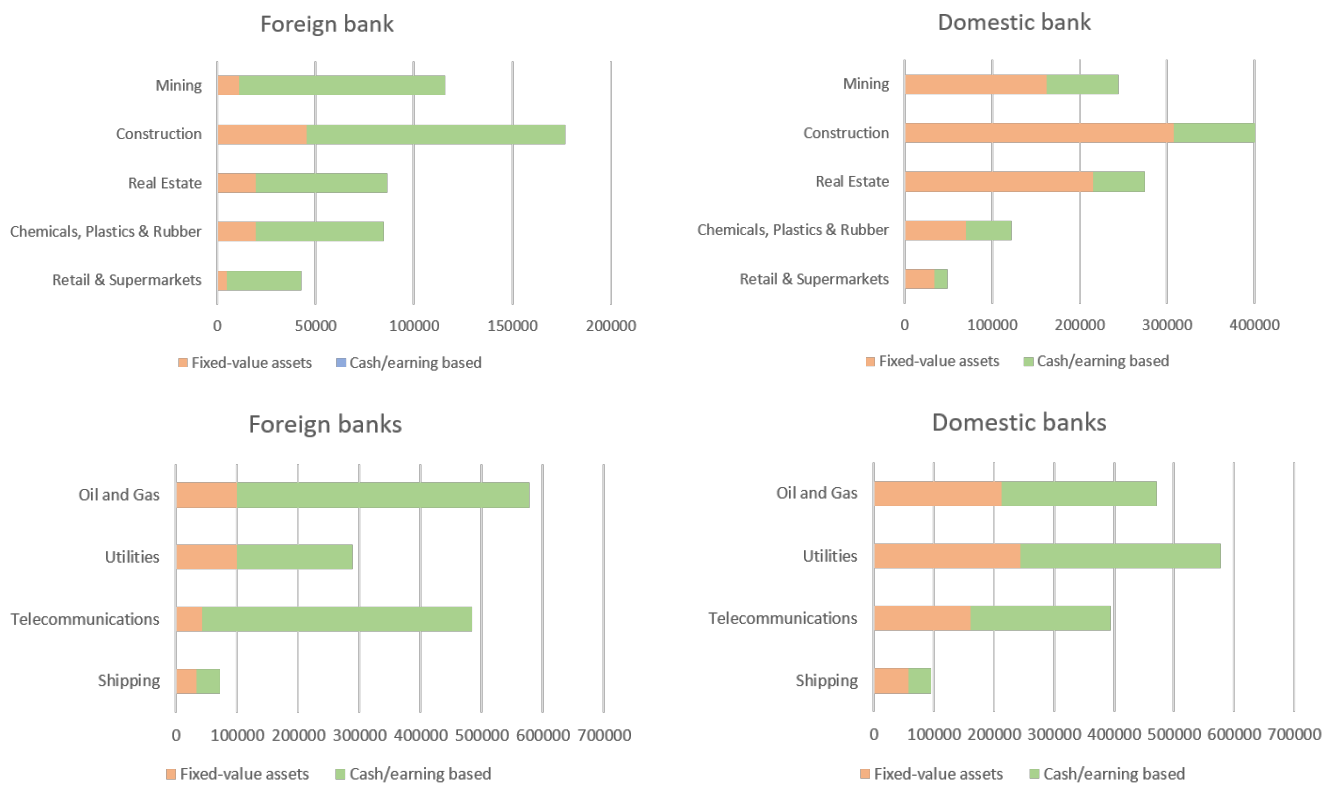
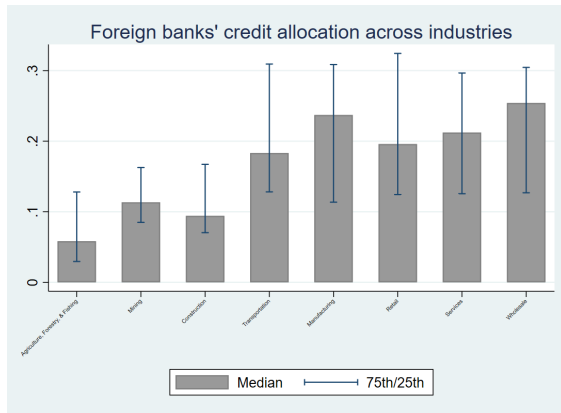
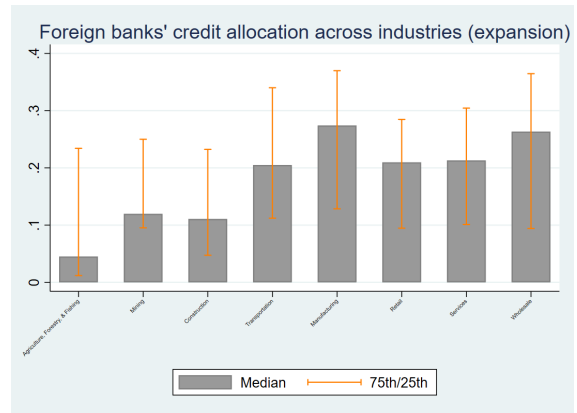


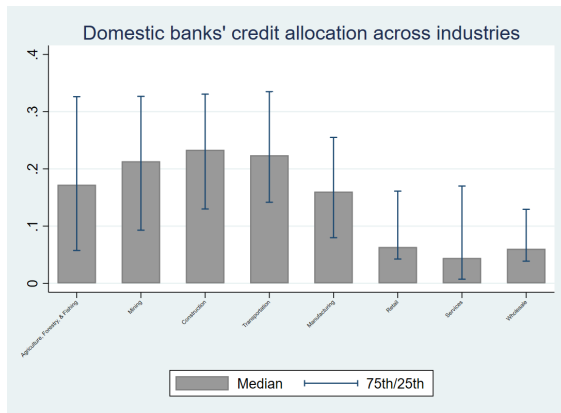
Fig. 3.19. Foreign and domestic banks' USD credit portfolio and industry tangibility



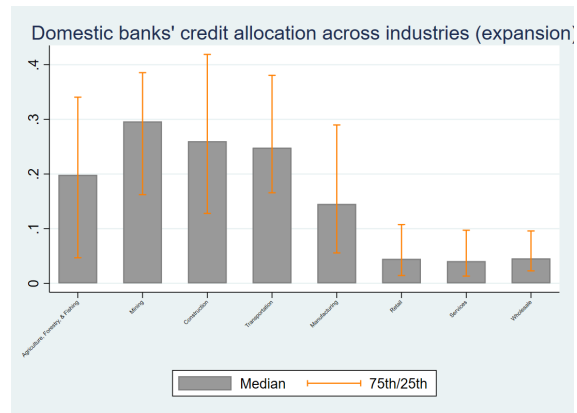
(a) Foreign bank portfolio across industries



(b) Foreign bank portfolio

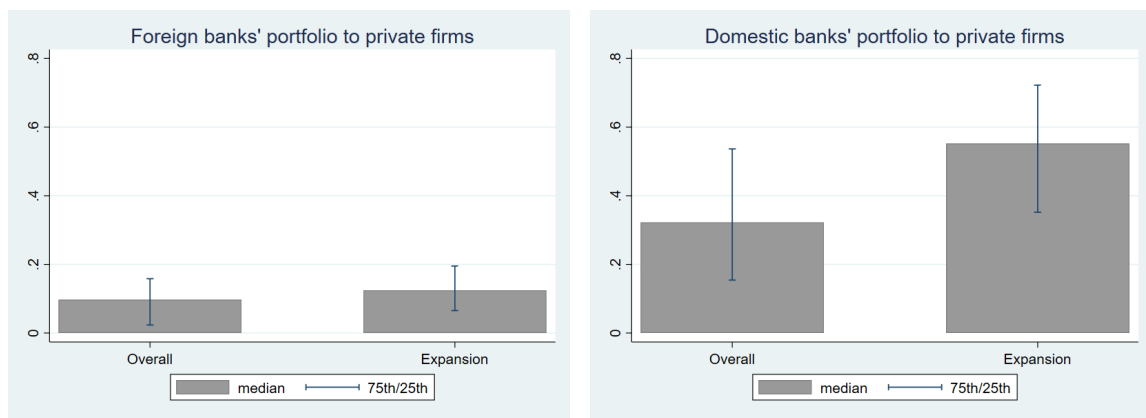


(c) Domestic bank portfolio across industries



(d) Domestic bank portfolio across industries

Fig. 3.20. Foreign and domestic banks' USD credit portfolio and firm transparency



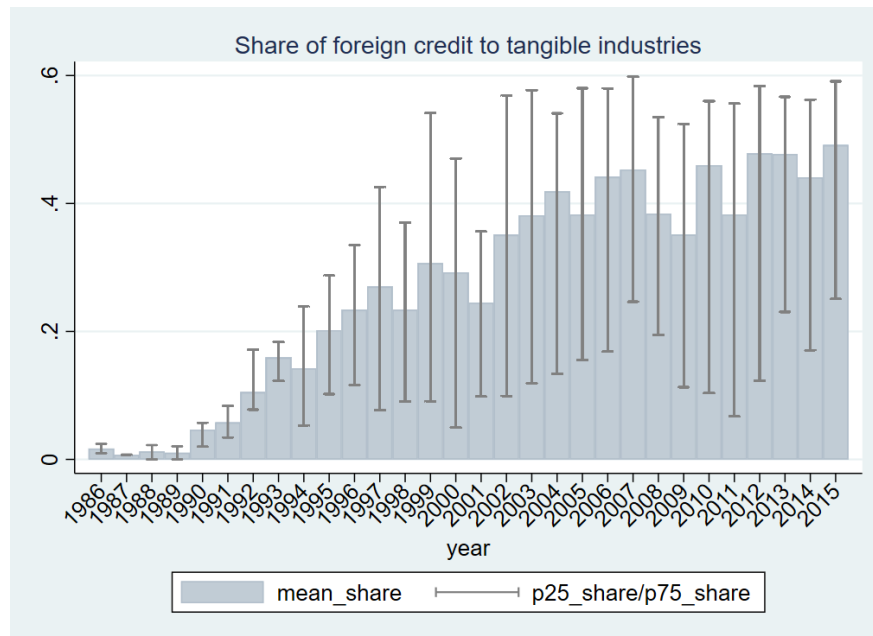
(a) Foreign bank portfolio allocating to private firms (b) Domestic bank portfolio allocating to private firms

Fig. 3.21. Snap-shot of domestic bank channeled foreign credit in cross-border market by selective countries

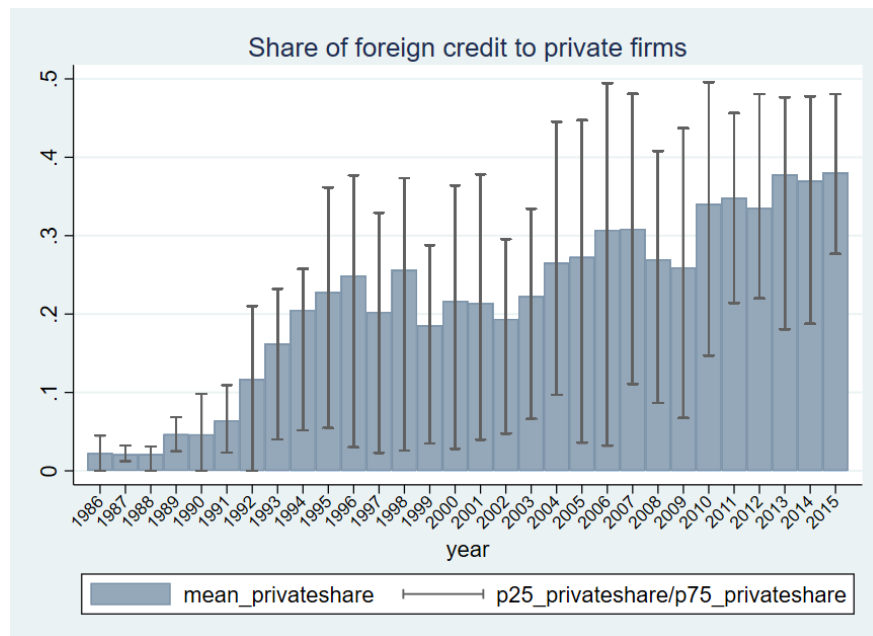


Source: LPC Dealscan. Figure shows the share of foreign currency denominated credit to emerging market economies' non-financial corporate sector that are lent directly by domestic banks, taken from three snapshot years.

Fig. 3.22. Allocation of foreign credit



(a) Share of USD cross-border credit to tangible sectors



(b) Share of USD cross-border credit to private firms

Table 3.20. Bank-level regression of lending bases choices

	1[Fixed assets secured]			
	(1)	(2)	(3)	(4)
Year resolve	-0.0193***			
	(0.00455)			
1[Foreign Lender]× Year resolve	-0.0527***			
	(0.0121)			
Cost (% of estate)		-0.00290**		
		(0.00103)		
1[Foreign bank]×Cost (% of estate)		-0.00578**		
		(0.00167)		
Time register			-0.0140***	
			(0.00295)	
1[Foreign bank]×Time register			-0.0325***	
			(0.00391)	
Procedures				-0.0127***
				(0.00321)
1[Foreign bank]× Procedure				-0.0252***
				(0.00555)
1[Foreign bank]	-0.163***	-0.155***	-0.201***	-0.204***
	(0.0330)	(0.0358)	(0.0432)	(0.0378)
Observations	249277	249277	250147	250147
Adjusted R^2	0.259	0.257	0.260	0.264
Bank FE	✓	✓	✓	✓
Bank role FE	✓	✓	✓	✓
Industry-year FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Industry FE	✓	✓	✓	✓
Bank country FE	✓	✓	✓	✓
Bank Type FE	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.21. Cross-country susceptibility to global cycle: Over time

	GDP growth							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IMF index	-0.461 (0.585)	-0.729*** (0.135)	-0.482 (0.601)	-0.841*** (0.158)	-0.463 (0.564)	-0.855*** (0.195)	-0.447 (0.402)	-0.784** (0.184)
REER			0.0112 (0.0294)	-0.0133 (0.00736)			0.0359 (0.0632)	-0.0157 (0.0146)
Net Export/GDP			0.0308 (0.0964)	0.00490 (0.0139)			-0.0261 (0.0876)	0.0144 (0.0171)
FDI			-0.142 (0.176)	0.0178 (0.0149)			0.357 (0.238)	0.0500 (0.0333)
Unemployment					-1.408 (0.788)	-0.118 (0.0873)	-2.067* (0.747)	-0.0786 (0.0875)
Inflation					-0.0144 (0.0213)	-0.0145 (0.0264)	-0.0198 (0.0267)	-0.0503* (0.0245)
Deposit rate					0.00815 (0.0124)	-0.0932* (0.0406)	0.0114 (0.0153)	-0.0581 (0.0474)
Observations	745	1103	326	654	268	554	139	401
R^2	0.016	0.027	0.011	0.028	0.085	0.073	0.614	0.109
Country FE	✓	✓	✓	✓	✓	✓	✓	✓
year range	before 1995	after 1995	before 1995	after 1995	before 1995	after 1995	before 1995	after 1995

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.22. EME banks' USD borrowing and lending behavior

Panel A: USD Lending and Funding Comovement				
	Ln[USD lending]			
	(1)	(2)	(3)	(4)
Ln[USD liability]	0.189***	0.188***	0.189***	0.188***
	(0.0331)	(0.0360)	(0.0473)	(0.0467)
U.S. Interest rate	0.723	0.720	0.723	0.720
	(1.703)	(1.703)	(1.352)	(1.359)
Δ GDP	0.342	0.342	0.342	0.342
	(1.134)	(1.134)	(0.302)	(0.302)
REER	-0.00551	-0.00549	-0.00551	-0.00549
	(0.00405)	(0.00405)	(0.00421)	(0.00430)
Ln[USD liability] \times 1[US expansion]		0.0239***		0.0239***
		(0.0275)		(0.0174)
Observations	3832	3832	3832	3832
Adjusted R^2	0.950	0.950	0.950	0.950
Bank FE	Yes	Yes	Yes	Yes
Cluster			21	21
Panel B: USD Funding and U.S. Monetary Condition				
	Ln[USD Liabilities]		%USD Liabilities	
	(1)	(2)	(3)	(4)
U.S. Interest rate	0.748***	0.747**	0.0344**	0.0342**
	(0.221)	(0.237)	(0.0109)	(0.0112)
Δ GDP	-0.382	-0.198	-0.0173	-0.0231
	(0.330)	(0.183)	(0.0229)	(0.0113)
REER	-0.0763*	-0.00752	-0.0117	-0.00536
	(0.0346)	(0.0317)	(0.00842)	(0.00355)
VIX	-0.00135	-0.00878	-0.00545	-0.00560*
	(0.00100)	(0.00755)	(0.00880)	(0.00260)
Observations	65611	65611	65122	65122
Adjusted R^2	0.982	0.989	0.038	0.666
Bank FE	Yes	Yes	Yes	Yes
Clusters		21		21

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.23. Cross-country susceptibility to global cycle: Over time

	Domestic credit growth							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IMF index	-0.247 (0.370)	-0.465*** (0.0963)	-0.130 (0.519)	-0.366** (0.123)	-0.222 (0.322)	-0.536*** (0.135)	-0.330 (0.325)	-0.524*** (0.131)
REER			0.00605 (0.0102)	0.00655 (0.00569)			-0.0249 (0.0660)	0.00773 (0.0104)
Net Export/GDP			0.00958 (0.0363)	0.0191 (0.0109)			0.0202 (0.0639)	0.0317** (0.0122)
FDI			-0.0297 (0.0599)	0.0207 (0.0115)			0.158 (0.194)	0.0611* (0.0237)
Unemployment					-0.658* (0.319)	-0.0919 (0.0626)	-0.910 (0.614)	-0.0578 (0.0646)
Inflation					-0.00877 (0.00913)	0.00186 (0.0204)	-0.0574 (0.0829)	-0.0140 (0.0195)
Deposit rate					0.00626 (0.00530)	-0.0470 (0.0301)	0.0340 (0.0474)	-0.00827 (0.0358)
Observations	799	1012	307	625	266	550	137	397
R^2	0.032	0.024	0.050	0.029	0.226	0.156	0.195	0.109
Economy FE	✓	✓	✓	✓	✓	✓	✓	✓
Year range	before 1995	after 1995	before 1995	after 1995	before 1995	after 1995	before 1995	after 1995

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.24. Cross-country susceptibility to global cycle: Over time

	Industrial sector growth							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IMF index	-0.790 (0.731)	-1.159*** (0.237)	-0.0736 (1.096)	-1.241*** (0.289)	-0.0839* (1.108)	-1.450*** (0.338)	-0.0928 (1.682)	-1.344*** (0.353)
REER			0.00205 (0.0214)	-0.00923 (0.0200)			-0.0288 (0.0655)	-0.0474 (0.0347)
Net Export/GDP			0.0840 (0.0898)	0.0736* (0.0310)			0.0836 (0.117)	0.0743 (0.0381)
FDI			0.262 (0.296)	0.0203 (0.0260)			0.514 (0.382)	0.0765 (0.0607)
Unemployment					0.212 (0.326)	-0.0523 (0.179)	0.00814 (0.387)	0.184 (0.200)
Inflation					-0.0243 (0.0148)	-0.0243 (0.0938)	-0.0541* (0.0211)	-0.160 (0.0960)
Deposit rate					0.0167 (0.00893)	-0.189 (0.118)	0.0342** (0.0124)	-0.131 (0.188)
Observations	317	755	207	468	241	410	193	306
R^2	0.004	0.033	0.012	0.064	0.069	0.076	0.135	0.131
Economy FE	✓	✓	✓	✓	✓	✓	✓	✓
Year range	before 1995	after 1995	before 1995	after 1995	before 1995	after 1995	before 1995	after 1995

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.25. Second-stage regression: GDP-2

	OLS	IV			
	(1)	(2)	(3)	(4)	(5)
after1995	-0.602 (0.359)	-0.437 (0.366)	-0.445 (0.366)	-0.449 (0.361)	-0.576 (0.367)
IMF_index	-0.315* (0.129)	-0.145 (0.145)	-0.143 (0.147)	-0.136 (0.147)	-0.135 (0.146)
1[Post 1995]×D× IMF_index	-0.0335*** (0.0102)				
1[Post 1995]× $\widehat{D}_{\text{Secondary } 24}$ × IMF_index		-0.0654** (0.0203)			
1[Post 1995]× $\widehat{D}_{\text{Tertiary } 25}$ × IMF_index			-0.0687** (0.0220)		
1[Post 1995]× $\Delta\widehat{D}_{3\text{-bank}}$ × IMF_index				-0.0776** (0.0243)	
1[Post 1995]× $\widehat{D}_{5\text{-bank}}$ × IMF_index					-0.0815*** (0.0222)
D	6.983 (6.544)				
\widehat{D}		10.31 (8.655)	12.88 (8.993)	13.14 (8.763)	12.65 (9.272)
Net Export/GDP	-0.0115 (0.0115)	-0.0157 (0.0117)	-0.0151 (0.0117)	-0.0164 (0.0114)	-0.0136 (0.0117)
Inflation	-0.00206*** (0.000520)	-0.00202*** (0.000525)	-0.00202*** (0.000526)	-0.00203*** (0.000518)	-0.00204*** (0.000517)
Unemployment	-0.286*** (0.0512)	-0.297*** (0.0506)	-0.292*** (0.0507)	-0.285*** (0.0501)	-0.275*** (0.0506)
Observations	1065	1061	1061	1066	993
R ²	0.119	0.133	0.131	0.142	0.149
Economy controls	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.26. Second-stage regression: Domestic Credit Growth-2

	OLS	IV			
	(1)	(2)	(3)	(4)	(5)
1[Post 1995]	0.103 (0.265)	0.300 (0.269)	0.273 (0.270)	0.196 (0.269)	0.0876 (0.259)
IMF_index	-0.339*** (0.0926)	-0.143 (0.105)	-0.172 (0.107)	-0.211 (0.108)	-0.159 (0.101)
1[Post 1995]×D× IMF_index	-0.0760*** (0.0137)				
1[Post 1995]×D _{Secondary 24} × IMF_index		-0.0477*** (0.0143)			
1[Post 1995]×D _{Tertiary 25} × IMF_index			-0.0433** (0.0155)		
1[Post 1995]×D _{3-bank} × IMF_index				-0.0396* (0.0174)	
1[Post 1995]×D _{5-bank} × IMF_index					-0.0503*** (0.0150)
D	8.521 (6.533)				
\widehat{D}		11.32 8.213)	11.93 (7.984)	12.59 (9.092)	13.14 (9.415)
Net Export/GDP	0.0206* (0.00839)	0.0147 (0.00859)	0.0156 (0.00859)	0.0195* (0.00839)	0.0227** (0.00820)
Inflation	-0.0000980 (0.000357)	-0.0000490 (0.000357)	-0.0000587 (0.000358)	-0.0000724 (0.000356)	-0.0000744 (0.000337)
Unemployment	-0.240*** (0.0377)	-0.234*** (0.0375)	-0.232*** (0.0376)	-0.234*** (0.0376)	-0.205*** (0.0360)
Observations	981	963	963	968	895
R ²	0.117	0.122	0.124	0.135	0.138
Economy FE	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.27. Second-stage regression: Industrial Growth

	OLS	IV			
	(1)	(2)	(3)	(4)	(5)
1[Post 1995]	-3.063*** (0.652)	-2.835*** (0.656)	-2.796*** (0.655)	-2.712*** (0.657)	-2.770*** (0.658)
IMF_index	-0.483* (0.212)	-0.149 (0.239)	-0.0740 (0.243)	-0.0755 (0.247)	-0.0548 (0.242)
1[Post 1995] × $D \times$ IMF_index	-0.0540 (0.0276)				
1[Post 1995] × $D_{\widehat{\text{Secondary}} 24} \times$ IMF_index		-0.123*** (0.0321)			
1[Post 1995] × $D_{\widehat{\text{Tertiary}} 25} \times$ IMF_index			-0.146*** (0.0350)		
1[Post 1995] × $D_{\widehat{3\text{-bank}}} \times$ IMF_index				-0.162*** (0.0395)	
1[Post 1995] × $D_{\widehat{5\text{-bank}}} \times$ IMF_index					-0.180*** (0.0357)
D	10.092 (8.763)				
\widehat{D}		12.03 (9.662)	12.87 (9.792)	13.15 (9.033)	13.77 (9.236)
Net Export/GDP	0.00750 (0.0213)	0.00639 (0.0215)	0.00757 (0.0214)	0.00168 (0.0209)	0.00263 (0.0217)
Inflation	-0.00201* (0.000798)	-0.00194* (0.000793)	-0.00194* (0.000792)	-0.00195* (0.000793)	-0.00194* (0.000790)
Unemployment	-0.192* (0.0853)	-0.174* (0.0826)	-0.164* (0.0825)	-0.150 (0.0828)	-0.153 (0.0831)
Observations	908	905	905	910	850
R^2	0.123	0.137	0.136	0.128	0.129
Economy controls	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

CHAPTER 4

DOMESTIC BANK-CHANNELED FOREIGN CREDIT— ABLESSING OR A CURSE: EVIDENCE FROM CHINA

4.1. Introduction

Over the past three decades, emerging market economies (EMEs) around the world have been witnessing a deepening integration of their banking sector with the international funding market.¹ Along with the increasingly important role that domestic banks from EMEs play in transmitting cross-border capital, increased real economic co-movements with cycles in the global funding market and susceptibility to external shocks are widely seen in many EMEs around the world, as illustrated in Figure 4.1.²

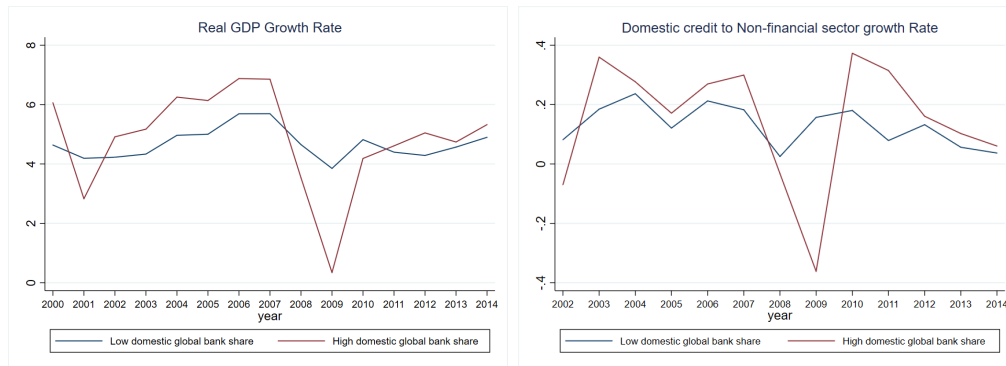


Fig. 4.1. Banking Globalization and Macroeconomic Volatility

Many research and policy works have paid attention to the increasing degree of interconnectedness in the global economy (Miranda-Agrippino and Rey (2015b)). Some have expressed concerns that the financial inter-connection between an emerging market economy's banking sector and the global funding market could be a mixed blessing (Martin

1. See detailed documentation in Jiang and Xu (2019).

2. The fast and slow domestic banking sector globalization is defined based on the percentage of cross-border foreign currency credit that was lent by domestic banks after 1995. The fast banking globalization emerging market economies in the figure include Czech Republic, China, South Korea, Poland, Turkey, and Indonesia; and the slow banking globalization emerging market economies include Brazil, Chile, South Africa, Vietnam, Iran, and Ukraine.

and Rey (2006), Bekaert et al. (2005), Prasad et al. (2004), Edison et al. (2002), Mishkin (2007)). A common theme, for example, is that the potential extra volatility and fragility could outweigh the benefits of more credit.³ However, very few of the previous works have been able to determine whether a greater involvement of domestic banks in the intermediation of cross-border credit could lead to more volatile real economic conditions, and very few have identified the exact channels through which the greater involvement of an EME's own banking sector in the cross-border credit intermediation could bring about real economic outcomes. Without a comprehensive understanding of the potential benefits and pitfalls of allowing domestic banks to play a more significant role in the transmission of cross-border capital, policies that regulate domestic banks' access to foreign capital cannot be completely justified.

This paper proposes and empirically identifies a novel channel through which structural differences in cross-border credit translate into real outcomes to EMEs. Exploiting a unique cross-region heterogeneity in the domestic global bank distribution in China, from which exogenous variations in the structure of cross-border credit are extracted, we find that regions in which a larger share of foreign credit was channeled by domestic banks was associated with more volatile real outcomes during the 2003-2009 global financing cycle. We further find that a more susceptible domestic credit intermediation is behind the excess real fluctuations—the evidence suggests that the global financing cycle gets localized. An examination of disaggregated firm-level data reveals that channeling a higher share of foreign credit by domestic banks has a mixed effect; specifically, it brings more flexibility to cross-border debt contracting and greater the efficiency to foreign and credit allocation, but at the same time, it might expose the domestic economy towards a collateral externality. We now elaborate.

One salient feature of emerging market economies is their relatively weak legal infras-

3. As an illustration, Figure 1 compares two groups of economy's GDP and domestic banking sector credit volatility. One group of economies has a low domestic bank loan making share in the cross-border market, while the other group has a high domestic bank loan share in the cross-border loan market. While the group with the higher domestic global bank presence tends to grow faster when the global financing cycle is in the easing phase, this group also dips deeper during the tightening phase. The high cyclicity of the real economic outcomes in EMEs is also seen in various works, including Aguiar and Gopinath (2007).

structure and low average corporate transparency. Foreign banks and domestic banks employ drastically different lending technologies in extending credit to borrowers from EMEs, as documented by Jiang and Xu (2019). In particular, while domestic banks often accept domestic fixed-value assets (primarily land and properties) as collateral for credit extension, foreign banks rarely conduct collateralized lending against physical assets in emerging markets, presumably due to extra difficulties in monitoring and seizing these assets. Instead, the credit extended by foreign banks to EME borrowers is largely covenant-based and earning transparency-based.

Differences in lending technologies map onto different contingency spaces of cross-border debt contracts when foreign credit is being channeled into an EME by distinctive types of lenders. The replacement of foreign banks by domestic lenders from EMEs in the cross-border credit transmission marks the completion of one crucial dimension of the contracting space: it allows credit agreements to be written against domestic hard assets as collateral. Thus, the increased contingency in cross-border debt contracting offers additional flexibility in how borrowers from EMEs can get access to credit in the global funding market.

The main insights of this paper rest on a mixed effect of this newly added flexibility in cross-border debt contracting. In particular, this flexibility in the contracting of cross-border credit agreement can help the economy achieve a more efficient allocation of credit during easing phase of the global financing cycle. Yet it can also induce domestic industrial firms to over-stretch their debt capacity by acquiring excessive tangible collateralizable assets, which would dampen asset prices and impair the intermediation of domestic credit during the tightening phase.

During the easing phase of a global financing cycle, if an economy's cross-border credit is only transmitted by foreign banks, which offer limited contracting space, only the high cash flow transparency firms will get the foreign credit. This often means that the marginal social value of the last dollar of global credit could have been higher than the marginal productivity of the firm that actually received it. Thus, the economy is not reaping the full benefit of the abundant foreign credit supply. Yet in an economy whose cross-border credit flows are all

channeled by domestic banks (and because of the enlarged flexibility in contracting), more firms that have domestic fixed assets can get financed from their lenders. This helps the economy reap the benefits of easy money, boosting real economic growth.

Increased flexibility in cross-border credit contracting, however, could induce firms to stretch their debt capacity by piling up too much land during the easing phase. When the increased demand for industrial land as collateral drives up the economy's industrial land prices, the higher value of the domestic collateral generates a multiplier effect, enabling firms borrowing *domestic* credit to also enlarge their debt capacity. But when the global financial condition suddenly reverses, firms find it no longer necessary to maintain a high debt capacity and hence high asset tangibility is no longer needed. Downward pressure is suddenly placed on the domestic collateral price, impairing firms that borrow domestic credit based on the same set of domestic collateral. As such, the global financing cycle gets localized in EMEs, through this collateral channel.

However, empirically identifying the exact channel through which the structure of cross-border credit could affect real outcomes is not an easy task. The most convenient variation to deploy would be differential shares of cross-border credit channeled by domestic banks across countries; through these one could investigate how this difference correlates with real economic outcomes at the country level. But claims made by cross-country exercises that use only aggregate variables are often limited. Greater involvement of domestic banking sector in cross-border credit market could be driven by unobserved country-specific factors that may simultaneously affect real outcomes. In these cases, the channel underneath a correlation is obscured.

Our empirical identification leverages a unique within-country cross-city heterogeneity of China's domestic global bank distribution and disaggregated data at different scales to identify this channel, over one single global financing cycle: 2003-2009. The global financial cycle pushed a large volume of foreign credit from global funding market towards China. What's more, domestic banks are replacing foreign banks in the intermediation of foreign

credit towards the non-financial corporate sector during this episode.⁴ In 2000, foreign banks' total lending balance in China's domestic banking market reached as high as 16%.⁵ By 2007, the total lending balance of foreign banks in the entire banking industry had declined to less than 6.7%.

The key institutional setting that makes this episode a perfect laboratory for studying our research question is one particular domestic bank, the Bank of China, which plays a unique and dominant role in international capital intermediation in China. It plays this role because of its special institutional and political background. For a long time the Bank of China was the country's only authorized bank, and within China's economy it was also the only bank specializing in intermediating foreign credit. Because its branching network is sticky and uncorrelated with the global financial cycle, we can construct exogenous variation in the exposure (or access) of industrial companies to the foreign credit that is channeled by domestic global banks.

We first examine aggregate patterns at the city level. Our findings suggest that *conditional on the same level of foreign credit*, cities that have a higher fraction of foreign credit flowing into their industrial firms channeled by local domestic banks experienced faster growth in real GDP, a faster growth of employment in industrial sectors, and a faster industrial firm TFP growth during the period 2003-2007. This episode of the global financing cycle features a drastic inflow of hot money. Yet these cities also experienced a more severe slowdown in their real GDP, industrial employment, and firm TFP growth during the 2008-2009 episode, when global funding markets tightened and hot money suddenly left.

Empirically, we find that when the volume of foreign credit is controlled, a 10% increase in the share of domestic bank-channeled foreign credit is associated with a 2.6% faster real GDP growth at the city level, a 5.57% higher growth in industrial sector employment growth,

4. In Jiang and Xu (2019), we show that this replacement of foreign banks by domestic lenders from EMEs in cross-border credit transmission could be related to the growing market share of shadow banking institutions in the U.S. money market.

5. The percentage is calculated among all types of commercial bank assets, including loans to the household sector and to the agricultural sector, conditional on the percentage of the credit balance to the industrial sector, the percentage will be more than 30%.

and a 2.08% increase in local firms' TFP growth rate during the 2003-2007 easing period. However, when the global financing condition suddenly tightened in 2008-2009, a 10% higher share of domestic bank-channeled foreign credit during the easing phase (2003-2007) of the global financing cycle was associated with a 2.20% slower real GDP growth, a 1.12% slower industrial sector employment growth, and a 2.47% slower TFP growth during the downturn, holding the level of total foreign credit flow controlled. Overall, all else being equal, cities that received a higher de facto percentage of foreign credit channeled by domestic banks were associated with a higher real economic volatility during the 2003-2009 global financial cycle.

To obtain a causal claim from the correlation, we instrument for the de facto percentage of foreign credit that local industrial firms received from local domestic banks with the pre-cycle market share of the Bank of China in the local area. The existence of a single dominant domestic global bank in China, the Bank of China, gives us an ideal source of within-country regional heterogeneity in firms' access to domestic bank-channeled foreign credit during the 2003-2009 global financial cycle. We find that the pre-cycle presence of BOC across cities in China strongly predicts the de facto percentage of foreign credit that was channeled by local domestic banks during the 2003-2009 cycle, but is less significantly correlated with the level of total foreign credit received by firms in the city.⁶ Furthermore, we provide multiple checks on the exclusion restriction and find that pre-cycle market share of BOC across cities does not exhibit significant correlations with pre-cycle firm- and city-levels characteristics that were likely to affect real economic outcomes during the 2003-2009 cycle. Adopting this IV strategy, we find that the structure of foreign credit had an economically and statistically significant effect – the share being channeled by domestic banks – on the real outcomes in each local economy during the 2003-2009 global financing cycle.

Having documented that cities that had a higher share of foreign credit channeled by

6. A 10% increase in the pre-cycle BOC lending balance market share is associated with a 22.7% increase in the domestic channeled foreign credit during the easing phase of the cycle. and a 10% increase in the number of branches in the city's commercial bank branches is associated with a 6.31% higher domestic channeled foreign credit during the easing phase of the financial cycle.

domestic banks experienced higher volatility in their real economic outcomes during the global financing cycle, we now go one step further to examine how the allocation of credit varied across cities. Using disaggregated firm-level data, we find that the aforementioned impact on aggregate economic outcomes of the structural difference in foreign credit flow across cities is likely to be driven by its impact on the allocation of credit across firms. In particular, we find that when a higher share of foreign credit is channeled by domestic banks, an increased fraction of credit is received by firms in high-tangibility industries, young firms, and firms with high a pre-cycle ROA during the easing phase (2003-2007) of the global financing cycle.⁷ Thanks to a more efficient allocation of the hot money, this distortion in the allocation of credit contributes to a higher growth rate in the local real outcomes. However, when global financing tightens, these types of firms also suffer more in cities, where a higher fraction of foreign credit is channeled by domestic banks. This outcome is reflected in a larger cut in credit and a more severe slowdown in TFP and output growth.

If one city experiences a considerably higher volatility in its real outcomes than another city that has the same amount of hot money, then the explanation must lie in the intermediation of domestic credit.⁸ Inspired by this intuition, we probe the underlying source of the amplification effect of domestic bank-channeled foreign credit on local economic fluctuations. We find that underneath the excess volatility in the local real economy is a more affected domestic credit intermediation. To this end, we examine a 1999-2013 firm-bank pair lending panel that provides detailed information about the borrowing firm, its relationship bank, all of the loans the firm gets from a given relationship bank, the collateral it pledged for the loans, and the location of borrowers. Importantly, we focus on the lending relationship of banks that lacked access to the international financing market. For a better measure of debt

7. We find that a 10% increase in the city-level domestic bank-channeled foreign credit is associated with an average 3.6% increase in credit (compared with these types of firms in other cities) that is allocated to firms in high-tangibility industries; an average of 1.45% in credit that is allocated to firms whose age is less than 7 years; and an average increase of 1.06% in credit that is allocated to firms that have a high pre-cycle ROA.

8. This is particularly true during the tightening phase of the global financing cycle, when hot money leaves and the intermediation and allocation of domestic credit becomes particularly relevant.

capacity, we also conduct a sub-sample analysis that focuses on revolving credit loans and examines changes in the limits of these credit line facilities.

We find that during the global financial cycle, lending relationships in cities that experienced higher industrial land price volatility tended to display more drastic expansion and shrinkage in the volume of credit issuance. Moreover, this expansion and shrinkage in borrowing limits was especially severe for firms that relied on commercial and industrial land and properties to get financing. Empirically, we find that while on average the borrowing capacity of firms increased 2.3% during the easing phase of the global financing cycle, firms from the high-tangibility sector that were located in cities that underwent significant commercial land price appreciation saw an additional 13.2% increase in the borrowing capacity of their relationship lenders. Similarly, during the tightening phase, while the borrowing capacity of firms shrank 12.1% on average, firms from the high-tangibility sector located in cities that experienced a steeper decline in local land prices saw an extra 36.9% reduction in their borrowing capacity.

In the next part of our analysis, we examine the behavior of firms over the global financing cycle. In particular, we investigate changes in firms' tangible asset holdings during the easing phase of the credit cycle. We find that holding the total volume of foreign credit to a city controlled, firms located in cities that received a higher share of domestic bank-channeled foreign credit significantly increase their asset tangibility (measured by PPE/Total assets), make more investments in cumulative fixed assets, and become more levered, as measured by their total debt.⁹ Moreover, we show that within the same city, the differences in asset structure change are more substantial for firms in high-tangibility industries and that have a lower cash flow transparency ex-ante.

To make the identification cleaner, we conduct a time-dependent Diff-in-Diff analysis, which uses the firms' city-level 2002 BOC presence before the initiation of the cycle to measure the local exogenous exposure of firms to domestic bank-channeled foreign credit

9. Empirically, we find that although all firms on average increase their tangibility by 2.1% during the easing phase of the global financial cycle, a 10% higher domestic bank-channeled foreign credit in the local city is associated with a 13.7% higher tangibility growth in the local firms' balance sheet.

and estimate the year-by-year coefficient. Consistent with the channel depicted in the cross-sectional analysis, we find that compared to a low-BOC presence city, a high local presence of BOC does not explain differences in local firms' tangibility, fixed asset investment rate, and total debt, until the cycle happened.

Next, we conduct an empirical test of changes in local land prices and local land transaction dynamism. We find that variations in the share of domestic bank-channeled foreign credit can explain the cross-sectional difference in the volatility of C&I land prices across cities throughout the entire cycle. Furthermore, we find that from 2003 to 2007, cities that had a high pre-cycle BOC presence experienced a larger appreciation in industrial land prices and higher growth in annual commercial mortgage issuance. Moreover, when the global financing cycle suddenly reversed in 2008 - 2009, the cities that featured high pre-cycle exposure to BOC experienced a particularly pronounced drop in industrial land prices and commercial mortgage issuance dynamism.

Related Literature This paper studies how completion of contracting space by domestic banks when intermediating cross-border credit flows during a global financial cycle could translate the global financial cycle into a local financial cycle. This issue is closely related to and related and contributes to several strands of literature.

First, on the macroeconomics side, this study is broadly related to works that examine financial sector development and real macroeconomic and asset price volatility. Focusing on the international macroeconomic setting, Wei (2018) and Kose et al. (2009) provide a survey of literature that examines the correlation of financial account liberalization and real economic growth. ? make the point that international resource liquidity should be more seriously taken into concern. Numerous previous works, including McKinnon and Pill (1997), Prasad et al. (2004), Mishkin (2007) have demonstrated that financial globalization or banking globalization could introduce risk to emerging market economies. Moreover, a large set of recent works has documented that spillovers of the center economy's monetary policy affect emerging market economies through bank lending, risk-taking, asset price volatility and exchange rate pass-through: Miranda-Agrippino and Rey (2015b), Bruno and Shin

(2014), Rey (2013), Bruno and Shin (2015), Ivashina et al. (2015), Brauning and Ivashina (2017), Kalemli-Ozcan et al. (2018), Baskaya et al. (2017), Alfaro et al. (2019), Morais et al. (2019), etc. Our work contributes to this strand in literature through making the point in an EME, the global financial cycle can be transmitted to a local financial cycle using a within-country event-study framework and we provide a novel channel through which the cycle is transmitted by domestic banks.

Second, this paper is closely related to corporate finance works that examine incomplete contracting, pecuniary externality, and collateralized lending and its real implications in an emerging market setting. In theoretical frameworks, Stulz (2005) and Broner and Ventura (2016) have shown that the effectiveness and scope of financial globalization is crucially dependent on the emerging market economies' institutional strength, corporate ownership structure, and debt enforcement quality. Farhi et al. (2009), Caballero and Krishnamurthy (2001), Caballero and Krishnamurthy (2003), Lorenzoni (2008a), and Bianchi (2011) qualitatively and quantitatively study how over/under collateralized borrowing due to contracting frictions can lead to amplified financial cycles. More recently, Diamond et al. (2020) and Diamond et al. (2018) demonstrate that easing financing conditions can systemically tilt firms towards their debt capacity resource to the asset-sale-based financing and neglecting the cash-flow-based borrowing. More broadly, our paper is also related to theoretical research that stresses that, in contrast to a first-best benchmark in which financial frictions are absent, such frictions can amplify macroeconomic shocks: Aoki et al. (2007), Kiyotaki and Moore (1997a), Bernanke and Gertler (1989), etc. Our paper empirically joins this strand of literature by concretely illustrating how completing contracting space by domestic banks' intermediating of cross-border credit flows could result in more volatile real local economic outcomes throughout the cycle.

A third strand in the literature to which our paper is relevant is applied macroeconomics and applied microeconomics work that aims to identify the real effect on the economy of structural change or shocks to the banking sector. These papers include Khwaja and Mian (2008b), Mian et al. (2020), Mian and Sufi (2014), Chodorow-Reich (2014), Calomiris et al.

(2017), etc. Calomiris et al. (2017) finds that weak movable collateral laws create distortions in the allocation of resources that favor immovable-based production and investment, and they verify the finding in an experimental setting following Slovakia’s collateral law reform. Mian et al. (2020) shows that credit supply expansion boosts non-tradable sector employment and the price of non-tradable goods, thus amplifying local business cycle through the household demand channel. Our paper enriches this strand of literature by using detailed firm-level data to determine how pure financial market differences across cities—here differences in the ease with which firms can reach hot money from domestic banks that can write debt contracts based on physical assets—could result in drastically different real economic outcomes.

The rest of the paper is organized as follows. Section 4.2 discusses the empirical and institutional background. Section 4.3 describes data construction and summary statistics. Section 4.4 lays out the theoretical framework and the relevant empirical hypothesis to be tested. Section 4.5 conducts a cross-sectional analysis of the real impact of domestic bank-channeled foreign credit at the city level. In Section 4.6 we show that impaired domestic credit intermediation underlies the cross-sectional high volatility. Section 4.7 conducts analysis of local firm behavior during the global financial cycle. Section 4.8 concludes.

4.2. Empirical and Institutional Background

4.2.1. A Natural Experiment: The 2003-2009 Global Financing Cycle

In this paper, we explore the real economic effect of having domestic bank-channeling foreign credit from the international money market during the global financial cycle of 2003-2009; during which 2003-2007 was the easing period of the global financing cycle and 2008-2009 was the tightening period of the cycle. The cycle has been documented in several studies that have focused on the international financial cycle and banking (Miranda-Agrippino and Rey (2015b) and Borio (2013), Lane (2012) etc.). Following the loosening of monetary policy in the U.S, economic conditions in various advanced economies started to go through

a large-scale expansion in 2002 (Calomiris (2011)). The expansion was driven largely by the households sector (Mian et al. (2013)), which was strengthened by borrowing against rising house prices. The burgeoning debt-financed economic boom pushed up asset prices and fueled the decrease in global risk aversion in global banks and institutional investors. These forces jointly pushed investment towards the emerging market economies (Bruno and Shin (2015), ?).¹⁰

This financial cycle, which originated in developed economies, was soon widely transmitted to emerging market economies, resulting in a fast accumulation of cross-border debt, climbing asset prices, and corporate leverage. When the house price suddenly plummeted in 2008-2009 period, the sudden contraction in the credit supply also transmitted to the emerging market world, leading to a "sudden stop" in the cross-border capital flow and a drop in asset prices there. This drastic reversal in global funding market conditions even impaired many emerging market economies' domestic credit intermediation, even though the occurrence and ending of the cycle had purely external origins and was largely uncorrelated to emerging market economies' own real economic conditions.

Figure 4.2 depicts the initiation and ending of the entire global financial cycle. The solid grey line plots the Global Financial Condition Index (FCI), which is constructed from IMF's GFSR 2018, and the scale is shown on the right-axis. Higher values in the Financial Condition Index means tighter financial conditions, and vice versa. Starting in 2003, the FCI decreased to below zero. Synchronizing this loosening in financial conditions, we see that EME's cross-border credit/GDP ratio increased by nearly 20%. In 2008-2009, when the FCI suddenly tightened from below zero to more than 4, the cross-border credit flow/GDP to the whole emerging market world suddenly dropped to below 35%. This push-factor-driven global financial cycle provides a natural experimental setting in which to explore two issues: how a cycle that is initiated externally (relative to any single emerging market economy) is transmitted to an emerging market economy; and how its leaving affects the emerging market economy afterwards.

10. The real monetary policy rate stayed negative over the period of 2002-2005.

Figure 4.3 and Figure 4.5 depict the growth of foreign credit in China and the evolution of the total percentage share of the foreign credit balance of the total credit balance in China, respectively, against the backdrop of the global financial cycle. We measure the total volume of foreign credit in China using the sum of two variables. The first variable is the foreign-currency denominated loan balances issued by all financial intermediaries within the border of China. This variable is available annually from the Almanac of China's Banking and Finance. The second variable is the total cross-border loan balances of the intermediaries that are located outside of China. This variable is available from BIS's Locational Banking Statistics. The total domestic currency-denominated loan balances are also available from the Almanac of China's Banking and Finance. As illustrated in Figure 4.5, starting in 2003, the total amount of the foreign credit balance in China grew faster than domestic credit. And Figure 4.3, between 2003 and 2007, the total foreign credit balance divided by the sum of the total foreign and the domestic credit balance increased from 6.5% to over 13%. The evolution of foreign credit in China not only conforms to the external driven global financial cycle, it also indicates that foreign credit was quantitatively important for the Chinese economy during that period. Similarly, during the 2008-2009 period, the foreign credit balance decreased dramatically to less than 7.5%, marking the left of hot money.

4.2.2. Institutional Background in China during this Cycle

Aside from the aggregate financial condition changes in the global financing market that function as the external engine that pushes credit from the global market towards emerging market economies, China for two reasons provides an ideal environment for studying the role that domestic banks play in channeling foreign credit and for studying the real impact of that role. First, China's financial market has gone through a big wave of financial globalization since its admission into the WTO. In fact, domestic banks have started to replace foreign banks and become the major role players in channeling foreign credit to domestic firms. Second, for a long time in China only the Bank of China—among the four big state-owned banks—has specialized in foreign currency lending, and this can be attributed to certain

political factors. The geographic distribution of Bank of China's branches and its lending market share are pre-determined and sticky relative to the global financing cycle, this gives us exogenous variation in the accessibility of foreign credit that domestic banks provide to local industrial corporations, and that, in turn, allows us to investigate the real impact on local economic outcomes of having access to more domestic bank-channeled foreign credit.

The post-WTO financial opening-up not only includes the further opening-up of foreign banks' operations in China; more importantly, during this process major domestic banks obtained significantly greater access to the global financing market (Garcia-Herrero et al. (2006), Leng (2006), and Branstetter and Lardy (2008)). In 2003, Bank of China became the first state-owned Chinese commercial bank to be selected by the government to be transformed into a publicly-listed shareholding commercial bank. Its transformation into a shareholding company greatly broadened the its funding channels, enabled it to gain ratings and acquire funding in the international market.^{11 12} More importantly, due this wave of financial globalization, during the 2001-2007 episode, domestic banks in China started to replace foreign banks in the foreign currency lending business. Figure 4.6 compares the percentage of domestic banks and foreign banks' foreign currency lending foreign currency commercial and industrial lending in China. The sum of the dashed and the solid line represent total share of foreign currency lending balance in total commercial and industrial lending balance. At the end of the 1990s, total foreign currency lending balance was around 22% in total C&I lending balance, and nearly 80% of the FX C&I lending was done by foreign bank. Starting in 2000, the lending balance of foreign banks started to gradually decrease, while the foreign currency lending of domestic banks quickly moved to replace it.

11. Accounting information disclosure at international standard was first employed by Bank of China in 2003, detailed information about the balance sheet and income statements by regions, employees compensation plan, investment plans by industry and asset holdings etc.

12. In 2003, domestic banks' foreign funding balance was only around 0.26 billion USD, when it came to the end of 2007, the foreign funding balance reached 66.8 billion USD. With the public listing, major domestic banks speed up their overseas funding paces through bond and loan issuance. during the episode of 2003-2007, the growth rate of USD bond and loan issuance by domestic commercial banks reached an average of 15.6%.

By 2003, even foreign banks were overrun.¹³

Moreover, this pattern is also true for second-tier cities and for local firms that are associated with multinational entrepreneurs. Research in 2004 carried out by People's Bank of China, Lianyungang branch, investigated borrowing behavior of 580 joint-ventures in the city (Dong (2004)). Joint ventures are firms that are jointly funded by foreign and domestic partners. These firms are naturally tied to foreign banks at their founding, and, thus, they are more likely to borrow from foreign banks than other firms. Consistent with the situation reviewed by aggregate-level data, the new loan issuance from foreign banks to local joint-ventures decreased by 32.4% in 2003, while the new loan issuance from local domestic banks to these local joint ventures increased by 15%. Among the 68 new joint-ventures established in 2003, none borrowed from foreign banks as their initiation founding. The reason for this replacement is exactly consistent with the findings presented in Jiang and Xu (2019). While foreign banks were only able to take the guarantee of the parent firms of foreign partners—a guarantee normally issued in the form of promissory notes that assign future earnings to the lender—domestic banks can accept many more categories of collateral, including land, plants, and equipment. Before domestic banks obtained adequate access to the global funding market, this contracting flexibility was not deployable. As domestic banks became more and more globalized, this flexibility became available and Local firms quickly adopted it.

4.2.3. Specialty of China: A Single Dominant Domestic Global Bank

The dominance of the Bank of China in the country's foreign exchange market was driven by special political and institutional background. The Bank of China is the only bank in China that has been operated for more than one hundred years.

Established in 1912, the BOC initially functioned China's central bank under the approval of the provisional president, Mr. Sun Yat-Sun. At that time, the main task of the Bank of

13. Foreign banks' declining business in foreign currency lending was not compensated by their RMB lending business during the same period, even though China lifted the restrictions on foreign banks' RMB and deposit taking in China when admitted to WTO, data from Almanac of China's Banking and Finance show that foreign currency lending is still the major lending currency of foreign banks.

China was to transfer and maintain public funds, print money, and act as a fiscal agency. From 1928 to 1949, China went through a series of social revolutions as well as two world wars and internal wars, and the Bank of China was designated to be China's special foreign exchange bank. The bank opened branches in international financial centers, such as London, Singapore, New York, and this greatly helped the Bank of China accumulate experience in foreign exchange and market management. Since 1949, due to its special expertise in foreign exchange trading and loan making, which it accumulated following its establishment and during the war period, the Bank of China began to serve as China's only authorized foreign exchange bank.

By 2003, the Bank of China had opened branches in 27 countries with a total of 549 overseas branches, which makes it the most globalized bank in China. Due to the institutional and historical formation of the Bank of China, its dominant role in external funding and the channeling of foreign credit to Chinese firms has been unparalleled among China's commercial banks. The total foreign currency lending balance of the Bank of China reached an historical high of 51.37 billion USD. In 2003, the Bank of China's foreign currency lending balance was about 45.7% of its total lending balance (RMB and foreign currency).¹⁴

4.3. Data Description

In this paper, we combine data from three main sources: (1) firm-level balance sheet data from the Annual Industrial Survey of China and firm bank relationship lending data CSMAR, Datastream and iFinD; (2) city-level economic data from the Statistical Year Book at either the city or the provincial level; and (3) land transaction and city-level industrial land price data manually extracted from various official websites operated by the Land Bureau of China.

14. The Bank of China also is the sole supplier of foreign currency funding in the domestic inter-bank market, allocating foreign currency funding to other domestic commercial banks in China. However, the sum of the foreign currency lending balance of all of the other next largest banks (CBC, ICBC and ABC) was only 20.7 billion USD. In 2003, their foreign currency lending balance was only about 4% of the total lending balance of the other big domestic banks.

4.3.1. *Firm level data*

Industrial firms' asset accumulation, investment, and leverage behavior during the global financing cycle are crucial ingredients of my analysis. Moreover, we wish to investigate how firms' borrowing and asset accumulation behavior varies across cities that have different levels of access to China's major domestic global bank (BOC) relative to foreign banks. Two major firm-level databases fit my goal perfectly. The first is the Annual Industrial Survey (AIS in the following paragraphs) and the second is the CSMAR's firm-bank relationship lending database for listed firms.

The AIS is a panel survey of all SOEs and privately-owned enterprises that had revenue of at least five million RMBs (about 601.48 k USD in 2003 USD/RMB) during the period 1998 to 2014. The survey includes rich information about firms' balance sheets, income statements, and cash flows as well as the ownership structure of all manufacturing firms. As of 2007, the database consists of more than 330,000 Chinese industrial firms in a wide industry category that includes more than 40 major industrial categories, 90 industrial groups, and 600 industrial classes. The total output value of firms in AIS covers about 95% of China's nation-wide industrial output value. Further, comparing the summary statistics of the total number of firms' in each city in the AIS and the city-level total number of industrial firms, the coverage on average exceeds 92%. AIS's high coverage allows us to acquire a perfect measure of the leveraging and asset accumulation as well as the foreign credit issuance of China's industrial firms at the city-level. This is because industrial firms are the main foreign credit issuers in China. We drop SOE's from our sample. This leaves me with a sample of 285,298 firms and 2,368,897 firm-year observations. We rely on the AIS to construct firm-level variables on debt issuance, capital expenditures, and TFP. To measure the leverage of firms, we utilize firms' total debt outstanding scaled by lagged total assets. To measure tangibility of firms, we use the firms' PPE (property, plants and equipment) scaled by lagged total assets. We calculate the firms' TFP for each year from 2003-2009 and aggregate it at city level to gauge the industrial sector's productivity change of in the city over time.

4.3.2. City-level Characteristics

Cities are the other key unit of experimental laboratory of our paper as the source of heterogeneity comes from the city heterogeneous presence of Bank of China. The cities in our analysis are prefecture-level cities, which is the administrative unit one level lower than provincial- or municipality- level administrative unit. There are in total 333 prefecture-level cities in China, with an average 10 in each province.¹⁵ ¹⁶ The average geographical size of a prefecture-level city is comparable to metropolitan statistical areas (MSA) in the U.S.

In this analysis, there are two key sets of variables: the city-level total lending balances of financial institutions in (1) RMB and in (2) RMB plus Foreign Currency. We obtain the city-level total RMB lending balance to the industrial sector from *China City Statistical Yearbook*, and the lending balances in both foreign and domestic currencies from the *China Statistical Yearbook for the Regional Economy*.¹⁷ ¹⁸

Aside from the main variables of concern, we employ a wide category of city-level control variables to establish the validity of our identification methodology. We focus on three main categories of city-level characteristics. First are basic macroeconomic development indicators, including GDP, GDP per capita, real GDP growth rate, unemployment rate, and endowment of land supply. Second is the city's industrial structure, among which are the total employment/output in industrial sector, service sector, real estate sector, and financial sector. Third is the city's FDI and Export exposures, among which we include the city's total Export/GDP, FDI/GDP, no. of FDI contracts, % of firms that are exporters. From the *China City Statistical Yearbook* and the provincial/city-level statistical yearbook we obtain a balanced panel of city-level characteristics for 316 prefecture-level cities. The summary

15. In our analysis, we exclude Hong Kong SAR and Macao SAR.

16. The establishment of an prefecture-level city must meet the following three criteria: first, the city must have a non-rural population size over 250,000; second, a total gross output value of over 2.5 billion RMB (US\$353 million); third, the total industrial and agricultural output value need to exceed 35% of the local GDP.

17. *China City Statistical Yearbook* is available from 1985 and *China Statistical Yearbook of Regional Economy* starts from 2000.

18. In both cases, we supplement the data with the provincial and city-level statistical yearbook for both consistency and completeness of city coverage.

statistics of the city-level variables are provided in Table 4.1.

4.3.3. *City-level Land Price and Transactions*

Land is a very special type of asset that joins domestic credit intermediation and cross-border credit intermediation. Because absence of any frictions or limitation on contracting space, land could be used by local firms as collateral to reach both domestic and foreign credit. We obtain the city level land prices and transactions from various resources.

The first piece of this data is city-level industrial and commercial land price data. The main source of this piece of data is the terminal of China Real Estate Information (operated by the National Information Center of China and the China Land Value Monitoring Report.¹⁹ ²⁰ From CREI we obtained collateralized financing by industrial firms at the prefecture city level for 301 prefecture cities. CREI also contains information on industrial and commercial land prices for 70 major cities in China. The China Land Value Monitoring Report records industrial and commercial land prices for 116 cities. Combining these two sources of data and supplementing them with city-level Statistical Yearbook data we obtain commercial and industrial land price data for 214 prefecture-level cities.

The final piece of data for this part is the city level commercial land transactions and commercial mortgage issuance information. This information is collected from the official website of China's Land Transaction website.²¹ The website publishes the *piece-by-piece* land transaction record and land mortgage record. The starting year of the piece-by-piece land transaction record is 1997, each of the 1.8 million total transaction records document the date of the transaction, the buyer and seller of the land, the location of the land, the primary purpose of the land, and the characteristics of the buyer and seller (personal or corporate). The land mortgage publication records a total of 166,756 pieces of transaction between 1999 and 2009. This part of our analysis focuses on transactions between firms and

19. <http://www.crei.cn/>

20. <http://www.landvalue.com.cn/>

21. <https://www.landchina.com/>

banks.²² Table 4.17 summarizes data for this part of analysis.

4.4. Framework of Empirical Tests

In this section, we lay out the framework for our empirical analysis, from which we draw the predictions that will be tested empirically. At the big-picture level, we are interested in the following two questions: 1) Economically, what does the replacement of foreign banks by domestic lenders in cross-border capital transmission boil down to? 2) What does this replacement mean to emerging market economies?

4.4.1. Rise of Domestic Banks in Cross-border Credit Transmission: A Completion of Contracting Space

A salient feature of emerging market economies is their relatively weak legal infrastructure and low average corporate transparency. Based on these facts, (Jiang and Xu (2019)) document that foreign banks and domestic banks have drastically different lending technologies in extending credit to borrowers from EMEs. In particular, while domestic banks often accept domestic fixed assets (primarily land and properties) as collateral for credit issuance, foreign banks rarely conduct collateralized lending against physical assets in emerging markets. This difference in the lending technologies of distinct types of lenders is shown to be related to the challenge that foreign lenders in monitoring and seizing domestic fixed assets.²³ As a result, the credit extended by foreign banks to EME borrowers is largely

22. About 80% of the transaction transpires between a local firm and a local bank.

23. The difficulties that foreign banks have in seizing the physical collateral is reflected in multiple facts. Anecdotal evidence in China's "ghost collateral" cases indicates that domestic steel firms used fraudulent collateral to cheat foreign banks that were unable to conduct frequent monitoring on collateral, and this resulted in big losses from the loan. Furthermore, it has been shown (Jiang and Xu (2019)) that within the emerging market economies, economies that have lower resolving insolvency scores (those economies where it takes longer to register property or longer to resolve insolvency) rarely see foreign bank participation in cross-border loans collateralized by domestic tangible assets. The reasoning is that the more complex and time-consuming the property registration or insolvency process it takes, the higher the cost for foreign lenders relative to domestic lenders it is to make sure the value of the tangible collateral is still guaranteed.

covenant-based and earning transparency-based.²⁴

Differences in lending technologies translate into differences in the contingency space of cross-border debt contracts when foreign credit is intermediated towards an economy. The replacement of foreign banks by EME domestic lenders in the cross-border credit transmission marks a completion of the *contracting* space that allows credit agreements to be written against domestic hard assets as collateral. In other words, when domestic banks play a major role in channeling cross-border credit, the debt capacity of borrowing firms in EMEs can be made contingent on their choice of asset structure. This option is not available to firms when only foreign banks intermediate external credit; in this case the only acceptable collateral is 1) agency guarantee notes and promissory notes of firms or the firms' parent companies with financial covenants, or 2) the assignment of future cash flows etc (Dong (2004)).²⁵

In effect, the increasing role that domestic banks from EMEs play in the transmission of cross-border credit to these economies gives greater flexibility to how the contracts for these credit agreements can be written.

4.4.2. *Mixed Blessing to the Real Economies*

Increased flexibility in the contracting of cross-border credit agreements can help the economy acquire a more efficient allocation of credit during the easing phase, but it may induce domestic industrial firms to over-reach credit by acquiring domestic hard collateral (land). This dampens asset prices and impairs domestic credit intermediation more during the tightening phase.

24. The work of Jiang and Xu (2019), who examine the same loan package granted to a same borrower, demonstrates that foreign and domestic lenders tend to sort into different tranches that are collateralized by different assets. Furthermore, each 10% increase in the presence of foreign banks in a given tranche decreases by about 23.4% the likelihood that the tranche is secured by land, properties, or real estate, yet it increases the financial covenant inclusion by 13.5%.

25. According to World Bank Doing Business Survey, physical-assets-secured debt in EME is about 75.8% of total non-financial corporate debt. In contrast, Lian and Ma (2018) find that 80% of the debt of U.S. non-financial firms are based on their cash flows, while Benmelech et al. (2019) find that the secured debt on U.S. non-financial firms' balance sheets is steadily declining and the issuance of hard asset secured debt is counter-cyclical.

During the easing phase of a global financing cycle, if an economy's cross-border credit can only be intermediated by foreign banks, with the limited contracting space they are willing to offer, only the high cash flow transparency firms will get the credit. Consequently, a wedge is likely to emerge between the marginal social value of the last dollar of foreign credit and the marginal productivity of the firm that received it. In this sense, the economy does not fully benefit from the foreign credit supply because the last unit of cross-border capital could have been allocated to the borrowers with a higher marginal product of capital. On the other hand, in an economy in which all cross-border credit flows are channeled by domestic banks, a larger set of borrowers would be eligible to compete for the foreign credit, thanks to the enlarged flexibility in the contracting space. This increased contingency in debt contracting allows firms that have a high marginal productivity of capital to compete for cheap cross-border capital. As such, the economy can reap more benefits from the booming global financial market and boost more of its real economic growth.

However, too much contracting flexibility could induce firms to stretch for debt capacity by overly piling up tangible assets such as C&L land during the easing phase.²⁶ The increased demand for industrial land as collateral drives up the economy's industrial land prices. The higher value of domestic collateral can further generate a multiplier effect, enabling firms that borrow domestic credit to also enlarge their debt capacity. This amplification effect boosts economic growth during the easing phase. But when the global financial condition suddenly reverses, firms find that high tangibility is no longer desirable because there is no need to maintain debt capacity and, thus, they attempt to dump some of the tangible assets they accumulated during the easing phase purely for debt capacity purposes. In this scenario, downward pressure will be exerted on the price of domestic collateral, which impairs firms that borrow domestic credit on the basis of the same set of domestic collateral.²⁷

26. The interplay between easing financing conditions and firms' debt capacity stretching behavior has been studied in several previous works, including Calomiris et al. (2017), Almeida and Campello (2007), etc.

27. The negative effect of collateral price drop on corporate financing capacity has been investigated by numerous works, such as Gan (2007), Chaney et al. (2012), Cvijanović (2014), etc.

4.4.3. Hypothesis for Testing

From the above discussion, which concerns the potential real impact of the rise of domestic banks in cross-border credit transmission to EMEs, some readily testable predictions can be drawn.

Consider two otherwise identical cities A and B. Suppose that during the global financing cycle the volume of foreign credit that the two cities receive is identical. In city A foreign banks channel all foreign credit, whereas in city B domestic banks are in charge of transmitting foreign credit. Based on our discussion in section 4.2, we would expect the real economic outcomes in city B to be more volatile than those in city A during the global financing cycle.

Put formally, in the following empirical analysis, we test the following hypothesis:

Hypothesis: *Conditional on the same volume of foreign credit inflow, a city with a higher fraction of foreign credit flowing into its industrial firms channeled by local domestic banks would*

- *enjoy faster real GDP growth, faster growth of employment in industrial sectors, faster industrial firm TFP growth, and faster overall domestic credit growth during the episode of 2003-2007;*
- *but it also would experience a more severe slow-down in their real GDP, industrial employment and firm TFP growth during the 2008-2009 tightening period.*

Throughout the global financing cycle we also expect that cities that have a higher share of domestic bank-channeled foreign credit will be associated with a more volatile price of domestic collateralizable assets, such as C&L land. Furthermore, firms in such areas tend to respond in their asset structure choice when they seek to issue more foreign credit during the easing phase of the financing cycle. In what follows, we empirically test the implications generated by this mechanism using a natural experiment in China during the global financing cycle of 2003-2009.

4.5. Real Impact of Domestic Bank-Channeled Foreign Credit at city level

In this section, we investigate how the structure of cross-border credit can impact real outcomes. By exploiting variations at the city level, we examine how the share of domestic bank-channeled foreign credit affects a city's real GDP growth, employment growth, and firm TFP growth during the global financing cycle. We conduct the analysis for the boom period, 2003-2007, and the downturn period, 2008-2009.

4.5.1. *Measuring Domestic Bank-Channeled Foreign Credit*

The goal of this section is to establish causal correlations between local access to domestic bank-channeled foreign credit and local real economic outcomes. We start by constructing the key variable in our analysis, which is the share of foreign credit that was channeled by domestic banks in each city during 2003-2007.

Before constructing a measure of domestic bank-channeled foreign credit, we document a series of characteristics of foreign credit borrowing by industrial firms in China. We find the following three properties of Chinese industrial firms' domestic (proxied by RMB borrowing) and foreign credit borrowing (proxied by FX borrowing):

1. Firms' domestic credit and domestic relationship lending tend to be local;
2. Firms' foreign credit **from foreign banks** tend to be given from foreign banks outside city where the firms is located;²⁸
3. Firms' foreign credit **from domestic banks** tend to be from local branches of a domestic global bank (BOC).

Utilizing lending relationship and bond issuance information for 2916 firms from CSMAR, Datastream and iFindD, we construct a panel of firm-bank paired lending (or bond issuance)

28. Here we exclude four big cities in which there is a high presence of foreign bank offices: Beijing, Shanghai, Guangzhou and Shenzhen.

with information on the firms' location, the lenders' location, and the loan's currency of denomination over time.²⁹ On average, for each firm there are 5.89 RMB-loan relationship domestic banks. Of these, 4.56 are located in the same city as the firms for which they arrange loans; for each firm in a given year, 87.2% of total RMB borrowing is acquired through banks located in the firm's home city. Finally, of the 1073 (out of 2916) companies' with USD borrowing, 622 companies borrowed from foreign banks outside their own city location; among those who borrowed USD from local banks in their own city, 80.4% of the borrowing amount came from a BOC branch in that city. An extreme case is the bond issuance behavior of some large industrial firms: Feihe Dairy is a big dairy manufacturer headquartered in Qiqiha'er, a prefecture-level city, in the province of Heilongjiang. In 2005, the company tried to issue USD debt, but because the presence of Bank of China branches in the city is low, the company ended up issuing USD bond.³⁰

Given these documented lending patterns, we utilize the de facto measure to capture the share of domestic bank-channeled foreign credit. That is, we calculate the percentage of total foreign credit flow into the city's industrial sector firms that's lent directly by domestic banks:

$$\% \text{Domestic foreign credit} = \frac{\Delta D_c^{\text{FX},03-07,\text{domestic banks}}}{\Delta D_c^{\text{FX},03-07}} \quad (4.1)$$

$$= \frac{\Delta D_c^{\text{FX},03-07,\text{domestic banks}}}{\Delta D_c^{\text{FX},03-07,\text{foreign banks}} + \Delta D_c^{\text{FX},03-07,\text{domestic banks}}} \quad (4.2)$$

where c indexes city. The numerator is the total foreign credit flow into the industrial sector that is lent out by domestic banks, while the denominator is total foreign credit flow to the local industrial sector of city c . Throughout our analysis, we proxy the foreign credit using

29. We restrict the sample to firm-bank pairs that have lending relationships that span at least 3 years.

30. Another real-world example is that of Fuyao Glass and Luoyang Glass, each of which is a major glass product producers in China. Fuyao Glass is located in Fuqing city, in the province of Fujian. In 2006, the firm tried to borrow USD debt, but because there were no BOC branches in the city at that time, the firm borrowed from Citibank Beijing and Citibank Guangzhou. In contrast, that same year, Luoyang Glass, which is located in Luoyang, a city in which BOC has a market share of over 21.1% in 2006, borrowed USD directly from BOC.

the foreign currency denominated loan and the domestic credit using the RMB denominated loan.

We construct the measure through three steps. First, we aggregate the local industrial firms' total net debt increase from 2003-2007 using the AIS firm balance sheet data. This gives us the measure of total credit flow, including that of domestic credit and foreign credit, into the local industrial sector during the 2003-2007 period.

$$\Delta D_c^{total,03-07} = \underbrace{\sum_i \text{Total debt}_{2007}^{i,c} - \sum_i \text{Total debt}_{2003}^{i,c}}_{\Delta D_c^{FX,03-07} + \Delta D_c^{RMB,03-07}}$$

where i indexes firm i in the industrial sector and c indexes the city. The above expression measures total credit flow into the industrial sector of city c , including both foreign currency denominated and RMB denominated credit.

In the second step, we utilize the data from the city level statistical yearbooks, which gives us the total RMB lending balances to the city's industrial sector of the local banks. We subtract from $\Delta D_c^{total,03-07}$ to get the total foreign credit flow to the industrial sector in city c — i.e., the denominator in 4.1. To be more precise, we construct

$$\widetilde{\Delta D_c^{FX,03-07}} = \Delta D_c^{total,03-07} - \left[\sum_b (\text{RMB loan balance}_{2007}^{b,c}) - \sum_b (\text{RMB loan balance}_{2003}^{b,c}) \right] \quad (4.3)$$

where b indexes banks and c indexes the city. In other words, we subtract the total incremental of a firm's debt balance by the incremental of the local banks' RMB lending balance. Noting the empirical pattern wherein the RMB borrowing of firms tend to be from local banks while foreign currency borrowing tends to be from banks located outside of the firm's city, we estimate the firms' total foreign credit issued during the 03-07.

In the third step, while still utilizing the data from city level statistical yearbook, we extract the total foreign currency loan balance increase of local domestic banks through

2003-2007. In other words, we carry out the following approximation:

$$\Delta D_c^{\text{FX},03-07,\widetilde{\text{domestic banks}}} = \sum_b (\text{FX loan balance}_{2007}^{b,c}) - \sum_b (\text{FX loan balance}_{2003}^{b,c})$$

Combining the above three steps, our measurement for domestic bank-channeled foreign credit in city c is:

$$\% \text{Domestic channeled foreign credit} = \frac{\Delta D_c^{\text{FX},03-07,\widetilde{\text{domestic banks}}}}{\Delta D_c^{\text{FX},03-07}}$$

Summarizing the constructions just described, to construct measures for the total foreign credit that is channeled by local domestic banks at the city level, we combine AIS firms' balance sheet data and local domestic banks' annual year-end lending balance data from city-level statistical yearbook. The construction is based on the fact that the domestic credit of Chinese industrial firms tends to come from local domestic banks, while foreign currency credit tends to come either from a foreign bank outside of the city or a local domestic global bank.

4.5.2. *Baseline Correlations*

Having constructed the measure for our key economic variable, We start the analysis with the following set of baseline regression equations that correlate the percentage of domestic global bank-channeled foreign credit with city-level real economic outcome variables.

$$\begin{aligned} \Delta(Y_{03-07})_c &= \alpha + \beta^{\text{easing}}(\% \text{Domestic share of foreign credit}_{03-07}) + \gamma \mathbf{X}_c + \epsilon_c \\ \Delta(Y_{08-09})_c &= \alpha + \beta^{\text{downturn}}(\% \text{Domestic share of foreign credit}_{03-07}) + \gamma \mathbf{X}_c + \epsilon_c \end{aligned} \quad (4.4)$$

where c indexes a prefecture-level city. Y , the main outcome variable, includes real GDP, the total number of employees in the industrial sector, and the average TFP growth rate of local industrial firms. $\Delta(Y)_c$ is constructed to reflect the average growth rate of the outcome

variable between 2003-2007. We calculate the ΔGDP as $\text{Ln}(\text{GDP}_{04-07}) - \text{Ln}(\text{GDP}_{00-03})$, we construct ΔEmp as $\text{Ln}(\text{Emp}_{04-07}) - \text{Ln}(\text{Emp}_{00-03})$ and we construct ΔTFP growth as $\text{TFP growth}_{04-07} - \text{TFP growth}_{00-03}$. GDP is the real GDP, and GDP_{04-07} is the average GDP of a city between 04-07. Emp is the total number of employees in the industrial sector of the city, and Emp_{04-07} is the average industrial sector employees in the city from 04 to 07. TFP growth is the city-level average of all industrial firms' TFP growth in a given year, while $\text{TFP growth}_{04-07}$ is the average city-wide industrial TFP growth from 2004-2007. \mathbf{X} is a vector of city-level control variables that include the total foreign credit to the city scaled by the city's total credit, the agricultural labor share, the industrial sector labor share, the financial sector labor share, the real estate sector labor share, the average labor wage, unemployment rate, total fixed asset investment scaled by GDP, total population, total land resource, and total foreign-owned firms' value-added scaled by total value-added by all firms.

The coefficients of interest are β^{easing} and β^{downturn} , which capture the effect of having a higher percentage of domestic banks that channel foreign credit towards the local industrial firms, holding other variables fixed. Importantly, to maximize the explanation power of the coefficient, we must control for the level of foreign credit to the city (as a share of total credit to local firms). Otherwise the observed strong correlation between domestic banks-channeled foreign credit share and the real local economic outcome variables could simply be driven by the effect of the differential volume of foreign credit to different cities.

Table 4.4 and Table 4.5 show the results of the baseline regression. In Table 4.4, we find that holding the volume of foreign credit, a 10% increase in the share of domestic bank-channeled foreign credit is associated with 2.6% faster real GDP growth at the city level, a 5.57% higher industrial sector employment growth rate, and a 2.08% increase in the TFP growth rate of local firms. On the other hand, Table 4.5 indicates that when global financing suddenly tightened in 2008-2009 (and holding the level of total foreign credit flow), a 10% higher share of domestic bank-channeled foreign credit during the easing phase of global financing cycle was associated with a 2.20% reduction in real GDP growth during the downturn, a 1.12% decrease in industrial sector employment growth, and a 2.47% decrease

in TFP growth.

These results show that, on the one hand, having a higher share of foreign credit channeled by domestic banks can boost the local real economy growth more during the easing phase of global financial cycle; but on the other hand, it can also result in more severe real sluggishness when the foreign credit suddenly leaves exogenously. Overall, our results suggest that when everything else remains the same, cities that have a higher share of foreign credit channeled by domestic banks experience more volatile real economic outcomes during the global financing cycle.

4.5.3. *Identification Challenges*

Although telling, the analysis just described focuses on the documentation of novel correlations. Identifying the causal effect of having a high share domestic bank-channeled foreign credit on local real economic outcomes is challenging for two reasons.

First, the de facto measures of the share of foreign credit received by local industrial firms from domestic banks are equilibrium outcome variables, and these would be determined jointly by credit demand factors and credit supply factors. In this situation, equation 4.4 will not satisfy $E[\%Domestic\ foreign\ credit_{2003-2007\epsilon_c}] = 0$ because there might be unobserved local factors that are driving up the channeling of foreign credit by domestic banks. This would result in an upward bias of the coefficient of estimation and, more importantly, the estimation would become meaningless. This is so because the ultimate driving force of the observed volatility in real outcome would reside on the demand side and could not be attributed to the role that domestic banks play in transmitting foreign credit during the global financial cycle.

The second challenge is a reverse causality issue. Consider, for example, the boom phase of the financing cycle. Suppose in a city there are many firms that have a high growth potential. In this situation, local domestic banks might find that to meet the demand for credit they need to reach out to the international financing market. In this case, the high share in foreign credit channeled by domestic banks for this city is actually the outcome of

the high growth potential of firms in the city. In other words, it would be logically incorrect to attribute the high real growth rate in this city during the boom period to a relatively high share of domestic bank-channeled foreign credit.

In the remainder of this section, we conduct an IV analysis to construct the exogenous component in city-wise variation for identification.

4.5.4. *Instrumental Variable Analysis*

The ideal experiment would be as follows. Consider otherwise identical cities A and B . During the easing years of the global financial cycle 2003-2007, industrial firms in both cities received \$100 USD foreign credit. But for some completely exogenous reasons, for city A \$80 of the \$100 USD was lent by local domestic banks; while for city B only \$20 was lent by local domestic global banks and the other \$80 was lent by foreign banks. In this setting, differences in real outcomes in the two cities are likely to be driven by the distinctive character of the foreign credit flow to each city.

That said, to obtain the composition differences in the percentage of cross-border credit flows that domestic banks channel into the region, we need exogenous variation in some factors across cities that will precipitate the equilibrium differences seen in the compositional difference. In the case of China, what allows us to conduct this exercise is the fact that a single specialized bank—the Bank of China (BOC)—supplies foreign currency lending and provides access to the global funding market for non-financial firms in China.

The existence of a single dominant domestic global bank provides a perfect source of withincountry regional heterogeneity in the access of domestic industrial firms to foreign credit during the 2003-2009 global financial cycle. Figure ?? displays the distribution of Bank of China branches across China's 316 cities. The figure shows the number of Bank of China branches per 10 local commercial bank branches in 2002. The cities marked in red are located in areas that have the densest distributions of Bank of China branches, with an average of more than 2 BOC branches in 10 local commercial banks. Although the eastern and coastal regions of China are traditionally regarded as especially developed and open,

many cities in the inland regions also have an intensive Bank of China branch distribution. In every province that contains on average 13-16 prefecture cities, there are red-, orange-, and blue-shaded cities, indicating rich within-province heterogeneity. Similarly, in Figure ??, we display Bank of China's market share in local commercial banks' lending market across the 316 prefecture-level cities in China in 2002. The rich heterogeneity is also apparent in and consistent with the distribution of BOC branching intensity.

(I) Construction of Instrumental Variables

To approximate this ideal setting and overcome the challenges mentioned above, we employ an instrumental variable and utilize the stickiness in the branch network structure of the dominant domestic global bank, the Bank of China. The network structure of the Bank of China across cities fits our purposes well for two reasons. First, as described section 2.2, of the four largest banks in China, the Bank of China plays the most substantial role in the foreign currency credit market. That being said, firms located in cities where the Bank of China has a relatively high market share can access to domestic bank channeled foreign credit more easily, if lending is local. Second, the branching structure of the Bank of China across cities, as measured by the Bank of China's market share among all commercial banks in each city, was formed over the long run in the past and has been sticky over years.³¹ Therefore, when the 2003-2009 global financing cycle arrived, Bank of China's local branching concentration and local market share were likely to be orthogonal with both the external financial cycle and local demand-side factors that could interact with the global financial cycle.

Combined together, the variation Bank of China's local market share across cities can provide us with a source of exogenous variation in the city-level foreign credit structure that we need for identification purpose. Therefore, by instrumenting the de facto share of domestic bank-channeled foreign credit **flow** with the pre-cycle share of the total lending **stock** balance of the Bank of China among all commercial banks in the city, we are

31. China's banking market was concentrated and was not deregulated until after the 2009 crisis. Before deregulation, domestic commercial banks could open only a limited number of branches in each city (Gao et al. (2017)).

able to extract the component of the domestic channeled foreign credit that is exogenously determined. In particular, we construct two instrumental variables using the Bank of China's total loan balance market share in city c during the year 2000-2002 $Z_c = Ave. \sum_{t=2000}^{2002} (\frac{Bank\ of\ China\ loan\ balance_{c,t}}{Total\ loan\ balance\ financial\ institution_{c,t}})$, and BOC's branching intensity in different cities before the financial cycle in 2002:

$$(IV-1) Z_c^1 = Ave. \sum_{t=2000}^{2002} \left(\frac{BOC\ loan\ balance_{c,t}}{Total\ loan\ balance\ financial\ institution_{c,t}} \right)$$

$$(IV-2) Z_c^2 = \left(\frac{\#of\ BOC\ branches_{c,2002}}{Total\ \# \ of\ bank\ branches_{c,2002}} \right)$$

(II) Validity of Instrument

Our reduced form estimation will causally identify the effect that having more domestic bank-channeled foreign credit has on local real economic outcomes if the geographical concentration of domestic global banks across cities is not sorted on the basis of local characteristic variables that affect the economic variables of the global financial cycle. One example of the problematic sorting would be that the Bank of China is particularly concentrated in cities that host higher-than-average numbers of exporting firms or FDI projects. Where this is the case, the easing phase of the global financial cycle will lead to a higher demand because of local exporting firm demand and local FDI demand. These special demand-side factors drive up the relative percentage of domestic bank-channeled foreign credit during the easing phase, and these variables will also drive up other local real economic outcome variables, such as real GDP and employment. The regression results thus cannot be interpreted as the causing effect of having a higher domestic bank-channeled foreign credit on local real outcomes.

We establish the exogeneity of the Bank of China's city-specific distribution measure by both the intensity of its branch offices and the loan market share in the city to a rich set of pre-cycle city-level observable characteristic variables. First, we consider the city-level employment distribution across major economic sectors. City-level observable characteristics

in this category includes local employment in industrial sectors, real estate sectors, service sectors and financial sector. The second category of local characteristic variables consist of a set of variables that measure a city's basic economic development speed. We include in this category local real GDP growth rate, GDP per capita growth rate, transportation capacity growth rate, city-level construction land areas, and arable land areas. The third category of local variables to be tested consists of measures of city-level FDI and export exposure. We include local FDI/GDP, local export income/GDP, % of local industrial firms that are exporters % of local industrial firms that have foreign ownership, and the output value/GDP of local joint-venture firms. Specifically, I test the following correlation

$$Ave.X_{c,1999-2002} = \alpha + \beta BOC_{c,2002} + \epsilon_c$$

The left-hand-side variable is the average city-level characteristic variable during the 1999-2002 period, while the right-hand-side variable measures BOC presence in the city; it is either the number of BOC branches per 10 local commercial bank branches in 2002 or the BOC's year-end loan balance in the city in 2002.

The results of the test are reported in Table 4.31 and Table 4.32. In Panel A of Table 4.31 and Table 4.32, we find that the presence of the Bank of China is slightly positively correlated with local GDP per capita. In all baseline specifications, we include the local GDP per capital as a baseline control variable. Other than this variable, the BOC's local branching intensity is not correlated with other indicators that measure pre-cycle local economic potential and resource endowment. In Panel (B), we report the correlation between measures of BOC presence and local labor force structure by sector. We find no statistical significance between measures of local BOC presence and the percentage of local employees who work in the industrial sector, which is the main focus of this paper.

We also find no significant correlation between local BOC presence and local employment in the real estate sector. The weak correlation between the local BOC presence and the sectoral distribution of labor employment helps us enhance the strength of IV in the respect

that the local presence of BOC is unlikely to be correlated to the geographic distribution of specific sectors. Thus any potential reasons that global financial cycle might favor growth of specific sectors is not likely to be correlated with the relative supply of domestic channeled foreign credit by the BOC in the local area.

Finally, in Panel (C), we establish a correlation between local FDI exposure and local BOC presence. In Panel (C) of Table 4.32, we find a slight positive correlation between the local BOC presence (measured by loan balance market share) and the output/ GDP of local foreign-owned firms. To address this concern, we include this variable in all of our baseline controls.

(III) Baseline Results of IV Regressions

In our IV analysis, we estimate the following two-stage regression model:

First stage:

$$\Delta\% \text{Domestic share of foreign credit}_{c,03-07} = \alpha + \beta Z_c + \theta \mathbf{X} + \epsilon_c$$

Second stage:

(4.5)

$$\Delta(Y_{03-07})_c = \alpha + \beta^{\text{easing}}(\widehat{\% \text{Domestic share of foreign credit}}_{03-07}) + \gamma \mathbf{X}_c + \epsilon_c$$

$$\Delta(Y_{08-09})_c = \alpha + \beta^{\text{downturn}}(\widehat{\% \text{Domestic share of foreign credit}}_{03-07}) + \gamma \mathbf{X}_c + \epsilon_c$$

Table 4.6 shows the results of first-stage regressions using the pre-cycle BOC market share and pre-cycle BOC branching intensity as the instrumental variable. A 10% increase in the pre-cycle BOC lending balance market share is associated with a 22.7% increase in the domestic channeled foreign credit during the easing phase of the cycle. A 10% increase in the number of branches in the city's BOC branch network is associated with a 6.31% higher domestic channeled foreign credit during the easing phase of the financial cycle.

Tables 4.7 and 4.8 show the results of the 2SLS regression of equations 4.5. Columns (1), (3) and (5) of Tables 4.7 and 4.8 provide the regression results of local real GDP growth with respect to the domestic channeled foreign credit using the pre-cycle BOC market share as the instrumental variable (IV-1). Columns (2), (4) and (6) show the results when BOC pre-cycle

branching intensity is used as the instrumental variable (IV-2). Comparing the results with the cross-sectional regression results, we find that the 2SLS results hold robustly. A 10% higher domestic-channeled foreign credit leads to a real GDP growth that is 1.93% faster, a 4.08% higher industrial sector employment growth, and a 1.58% faster local TFP growth during the booming phase of the global financial cycle. But in accordance with our cross-sectional analysis, we find that a 10% higher domestic-channeled foreign credit leads to a 1.99% decrease in the local real GDP growth rate, a 2.01% slowdown in local employment growth in the local industrial sector, and a 1.78% slowdown in local TFP growth when global financial conditions tightened.

4.5.5. Allocation of Credit

In this subsection, we further investigate the real impact of having a higher share of domestic bank-channeled foreign credit in a city during the easing phase of the global financing cycle. In previous sections, we showed that cities that have a higher share of domestic bank-channeled foreign credit experience faster real output growth, faster employment growth, and higher TFP growth. Consider two cities that have comparable levels of foreign credit but a differential proportion of the foreign credit channeled by local domestic banks. If they display differences in real outcomes, it must be that in the two cities the same amounts of foreign credit are allocated differently. To create the mapping between the lender difference and the real outcome difference, the following must hold. First, more credit must have been allocated to firms that are more able to reach credit that is collateralized by hard assets, if they are located in cities that enjoy easier access to domestic banks that channel foreign credit. Second, these firms should experience a higher growth potential in terms of their production expansion and productivity; thus, they are able to create more employment and TFP growth at the city level. To test these two conjectures, we use disaggregated firm-level data across cities and examine two categories of firms: those that had already been operating; and those that were new entrants.

(I) Credit Allocated to Incumbent Firms

We start with our analysis of credit allocation among the incumbent firms. The regression specification is written as follows:

$$\Delta D_{i,j,c} = \alpha + \gamma_j + \beta_0 \text{DCFC}_c + \beta_1 \text{DCFC}_c \times 1[\text{Char}] + \theta X_{i,c} + \epsilon_{i,j,c} \quad (4.6)$$

where i indexes firm i , j indexes industry j , and c indexes city. $\Delta D_{i,j,c}$ is defined as $\text{Ave.} \frac{\text{Current Liabilities}}{\text{Total Assets}}_{04-07} - \text{Ave.} \frac{\text{Current Liabilities}}{\text{Total Assets}}_{00-03}$, which is the *within-firm* incremental in leverage ratio post the financial cycle compared to its pre-cycle level. DCFC_c stands for city c 's domestic bank-channeled foreign credit for the 2003-2007 time period, which is defined above. $1[\text{Char}]$ is an indicator variable that specifies the features of the firm. It could be $1[\text{High-tangibility}]$, $1[\text{Young firm}]$, $1[\text{High pre-ROA}]$.³²

Table 4.12 shows the regression results of the above specification. For all of the three dimensions of firm characteristics, we conduct both OLS regression and IV regression using the two instrumental variables constructed in section 4.5.4. We find that a 10% increase in the city-level domestic bank-channeled foreign credit is associated with an average 3.6% increase in credit (compared with other firms) allocated to firms in high-tangibility industries; an average 1.45% increase in credit allocated to firms that are less than 7 years old; and an average 1.06% more credit allocated to firms with high pre-cycle ROA.

In Figure 4.10, we demonstrate the dynamics of the credit growth of forms organized by firm characteristics and their pre-cycle exposure to BOC in the city. To display the comparison more clearly, we run the regression while separating firms according to whether their pre-cycle local BOC market share is above or below median, and we run the regression for young/old firms and high-ROA/Low ROA firms separately. The regression equation is specified as

32. "High-tangibility" is defined as firms that have average PPE/Assets of above 0.45 during 2000-2003 (or above the 75th percentile). "High pre-ROA" is defined as those firms that had an average annual ROA above 0.07 during 2000-2003 (or above the 75th percentile). A "young firm" is defined as those that in 2003 were less than 7 years old (the median of overall firm age distribution is 7).

follows:

$$D_{i,j,c,t} = \alpha_i + \gamma_{j,t} + \sum_{\substack{q \in [2000-2007] \\ q \neq 2003}} \beta_q 1[t = q] + \theta X_{i,c,t} + \epsilon_{i,j,c,t} \quad (4.7)$$

The coefficient estimates and 95th confidence intervals are plotted in Figure 4.10. Consistent with the static cross-sectional regression conducted above, the year-to-year credit growth of firms does not seem to be different across young/old groups or high-ROA/low-ROA groups before the initiation of the global financial cycle. This is true for both high-BOC exposure and low-BOC exposure cities. However, following the initiation of the global financial cycle, young and high ROA firms located in cities that have strong BOC exposure started to display high credit growth on their balance sheet a higher credit growth than that experienced by older or less profitable, and the dispersion is statistically significant. When the tightening phase of the cycle was reached, however, the pattern was reversed: young and profitable firms in cities that had higher pre-cycle BOC exposure experienced a more drastic slowdown in their debt capacity.

(II) Credit Allocated to Newly Entered Firms

We now turn our analysis to new firms. To start, we run the city-level regression paralleling equation 4.5. The left-hand-side variable is the total number of newly entrant firms during 2003-2007, and on the right-hand side, the main regressor is the fraction of total foreign credit channeled by domestic banks. The control variables are those defined in regression equation 4.5:

$$\Delta \text{New firms} = \alpha + \beta \text{Domestic channeled foreign credit} + \gamma \mathbf{X}_c + \epsilon_c$$

Table 4.13 shows the result of this specification. Column (1) shows the OLS regression results and column (2) and (3) the results of 2SLS regressions using IV-1 and IV-2, as defined above. A 10% higher domestic bank-channeled foreign credit during the boom period is associated with a 4.04% increase in the total number of new firms that are entering the local industrial

sector.

Why have more new firms in cities that have easier access to domestic global banks entered the industrial sector while fewer new firms have entered in cities that have parallel levels of total foreign credit but a poorer domestic global bank presence? Remember that a crucial difference between domestic banks (BOC) and foreign banks is that the former can complete the contracting space by writing debt contracts that are based on the tangible assets of local firms. By investigating the new entrant firms' tangibility property, we can verify and strengthen our conjecture. Table ?? and Figure 4.11 visualize this part of the analysis.

In Table ??, we show the summary statistics of new entrant firm tangibility and compare it to that of pre-existing firms in the economy. We define tangibility as the total book value of PPE scaled by total assets. Consistent with our conjecture, new entrant firms are more tangible than incumbent firms on average: the median tangibility of existing firms is 0.309, while the mean tangibility of new entrant is 0.343. Furthermore, the median tangibility of new entrant firms in cities that have a high pre-cycle BOC market share (above the 75th percentile, or 33.2%) is 0.393.

In Figure 4.11, we compare the tangibility distribution of new entrant firms and incumbent firms in the economy overall and in cities with High and Low pre-cycle BOC market share. In the left panel of Figure 4.11, we compare the tangibility of new entrant firms located in cities that have a high pre-cycle BOC market share and the overall tangibility of pre-existing firms. The five bins are sorted on the basis of the corresponding industries' average tangibility during 1998-2003. The height of the bars represents the percentage of incumbent firms/new entrant firms that come from industries with representative tangibility within the range marked below the bar. It is apparent that the industrial tangibility of new entrant firms is significantly more distributed to the right than that of the incumbent firms. The right panel compares the new firms' tangibility distribution in high BOC-exposure cities and low BOC-exposure cities. The comparison remains sharp.

In Table 4.15, we conduct a regression analysis that parallels columns (3)-(6) of Table 5,

which analyzes the credit growth of young firms in cities. The young firm here is an extreme case; these are new firms that entered between 2003 and 2007. The results are qualitatively and quantitatively similar to those presented in columns (3)-(6) of Table 4.6, new entrant firms located in cities that have a 10% higher share of domestic bank-channeled foreign credit see an average 2.68% increase in borrowing during the easing phase.

(III) From Credit Allocation to Real TFP Changes

In parts (I) and (II) of this section, we established the overall effects (direct and indirect) on firm credit allocation of having a higher share of domestic bank-channeled foreign credit: (1) young firms from high-tangibility sectors that have a high pre-cycle ROA tend to be able to expand their debt capacity substantially if they are located in cities that provide greater domestic-channeled foreign credit; (2) new firms from high-tangibility sectors tend to be more able to enter the industry, while new firms located in cities that have high domestic-channeled foreign credit tend to have higher overall credit growth.

How does this map onto the differential cross-city differences in TFP growth that we demonstrated in Section 4.5? Figure 4.12 shows the overall aggregate TFP growth of firms and firms located in cities that have different pre-cycle BOC market shares. Consistent with the 2SLS regression analysis, firms in cities that have a high pre-cycle BOC market share did bring more volatility to the city's TFP during the cycle.

In Figure 4.13 and Figure 4.14, we demonstrate that the enlarged debt capacity of young and high-ROA firms from relatively tangible sectors drove up the TFP growth more in cities that had a higher share of domestic bank-channeled foreign credit. In Panel (a) of 4.13, we show that across all tangibility bins, young firms had a significantly (about 1.5%) higher TFP growth than old firms. In Panel (b), we show that because of their enlarged debt capacity, young firms located in cities that had a high domestic-channeled foreign credit saw significantly higher TFP growth than older local firms. Similar patterns hold for firms that had high pre-ROA.

In summary, our finding shows that during the study period, a high domestic banks presence led to higher domestic-channeled foreign credit, which translated into a higher debt

capacity in new, young, and high ROA firms in tangible sectors. This was so because these firms generally had higher TFP growth, and their enlarged debt capacity contributed to higher city-level TFP growth during the easing phase.

4.6. Domestic Credit Intermediation during the Global Financing Cycle

In section 4.5, we demonstrate that given the same level of foreign credit exposure, cities in which a higher share of foreign credit was being channeled by domestic banks had more volatile real outcomes during the 2003-2009 global financing cycle. In particular, we find that these cities enjoyed a higher growth rate in local GDP, employment, and firm TFP during the boom period, but they experienced a more severe slowdown in these real economic outcomes when the hot money suddenly left. A question immediately comes to mind: When the same amount of foreign credit comes and leaves two cities, why is one city affected a lot while the other is considerably less affected?

In this section, we investigate the mechanism that underlies the linkages between more volatile real economic outcomes and higher shares of domestic bank-channeled foreign credit.

4.6.1. Lending relationship of domestic banks without global funding access

More volatile real economic outcomes are usually associated with more volatile credit issuance. Given that the comparison described above experiences the same level of exposure to foreign credit, one natural conjecture would be that volatility in domestic credit issuance drives the excessively volatile real outcomes.

It is not difficult to imagine that in all cities, the foreign currency borrowing of industrial firms will co-move closely with the dynamics of the global financial cycle. This is almost by definition how the supply of foreign currency credit is determined by the global financial market. However, it would be more surprising if the domestic currency borrowing also expands and shrinks sharply over the global financial cycle. After all, the funding cost in

the domestic financial market should not be directly affected by changes in international financing market conditions.

In this section, we show that behind the excessive volatility in real economic outcomes is a more affected domestic credit intermediation. In particular, we focus our attention on local firms' lending relationship associated with domestic banks that have no access to the global financing market. In principle these domestic local banks should be immunized to fluctuations in the global financing market because their stable funding source is the domestic financing market.

More precisely, we find that the credit issuance amount of firms that continually borrow from their domestic banks tended to increase during the 2003-2007 global financial cycle and decrease during the 2008-2009 downturn years. Moreover, the sudden expansion and shrinkage of loan amounts is more likely to happen in firms that borrow on the basis of their plant, land and property holdings and in firms located in cities that have highly volatile commercial and industrial land prices. Also, the borrowing capacity of firms that display sudden expansions and contractions in their borrowing constraints tend to be those that are from high-tangibility industrial sectors.

4.6.2. Empirical results

In this part, we display the empirical evidence that supports the argument outlined above.

(I) Empirical Specification

To construct the sample for our analysis, we use a panel of firm-bank pair dataset compiled from CSMAR and Datastream, and using a identification technique similar to the one used by (Khwaja and Mian (2008b)), we study how loan amounts change within firm-bank pairs during the global financial cycle. We also examine how it interacts with whether the firm is located in a city that went through high land price changes during the financing cycle and whether the firm is from a high-tangibility sector. The summary statistics of the sample used in this section's empirical analysis are shown in Table 4.16. Our sample covers a total

of 3287 firms in 60 major Chinese cities, most of which are listed firms. The average number of relationship banks of firms is 5.89, while the average number of relationship years is 4.6. The sample covers all firms' borrowing from their relationship banks during the 1999-2013 time period. We write down the following baseline specification to study how the firms' borrowing amount changes as the global financial cycle condition changes.

$$\begin{aligned}
 Ln(1+Amount)_{f,b,t} &= \alpha_f + \mu_b + \beta_1 1[\text{Easing/Tightening}]_t \\
 &+ \beta_2 1[\text{Easing/Tightening}]_t \times 1[\text{Land}]_{f,b,t} \\
 &+ \beta_3 1[\text{Easing/Tightening}]_t \times 1[\text{Land}]_{f,b,t} \times 1[\text{High C-P}]_f + \gamma x + \epsilon_{f,b,t}
 \end{aligned} \tag{4.8}$$

where f indexes firm, b indexes bank and t indexes year. The left-hand side is the loan amount from bank b to firm f in year t . $1[\text{Easing}]_t$ is a dummy variable that switches to 1 if the year range is 2004-2007 and $1[\text{Tightening}]_t$ is a dummy variable that switches to 1 if the year range is 2008-2009. $1[\text{Land}]_{f,b,t}$ is an indicator variable that takes the value of 1 if firm f 's borrowing from bank b is based on land, properties and real estate asset as collateral. $1[\text{High C-P}]_f$ is an indicator variable that takes the value of 1 if firm f is located in a city that has high commercial land price volatility during the global financial cycle. ³³

(II) Baseline results

Table 4.18 and Table 4.19 display the results of the above baseline specifications in the easing phase and tightening phase, respectively. Firm level fixed effects and bank level fixed effects are included to control for time-invariant factors that might be correlated with the dynamics of the credit amount on both the firms' and the bank's side. The industry-year fixed effect is included to capture time-varying industry-wide factors that might be systemically correlated with the cycle and, thus, systemically affect the loan issuance volume of firms in certain industries. Also, the firm-bank pair fixed effect is included so that we can remove variations driven by pair level invariant factors.

33. A city is defined as one with high commercial land price volatility if $\frac{\text{Commercial land price}_{08-09} - \text{Commercial land price}_{07}}{\text{Commercial land price}_{07}}$ is larger than or equal to 15.39%, which is the 75-th percentile of price jump among all the 214 cities.

In column (1) of Table 4.18 we show the correlation between the indicator of easing phase of the global financial cycle and the average borrowing amount of firms without interaction terms. On average, during the easing phase, firms' borrowing amount increase by 18.5% from a given relationship domestic bank, despite the fact that these domestic banks do not have access to the booming global financing market. Similarly, shows that during the tightening phase in 2008-2009 of the global financing cycle, the amount that firms borrowed from their domestic relationship lenders in the local area shrank on average by 37.1%. These facts suggest that the lending relationship of domestic local banks, which are not directly affected by global financial conditions, also responded significantly to fluctuations in the global financing market.

(III) Which Types of Lending Relationships are More Affected?

In column (2) of Table 4.18, we include the interaction of easing-phase dummy variable and the dummy variable indicating whether the loan is secured by the firm's land-related assets. We find that after including the interaction between these two indicator variables, the interaction term absorbed more than half (a magnitude of 0.111) of the significant coefficient on the easing phase indicator itself. This indicates that the increase in the average borrowing amount during the easing phase was driven by firms that borrowed by pledging their land-related fixed assets. Quantitatively, firms that did not borrow on the basis of their fixed assets received on average only about a 5.21% increase in their loan amount, while firms that borrowed using their fixed assets received an additional 11.1% increase in their total loan amount during the same easing phase

(IV) Cross-city Analysis: C&I Land Price and Relationship Lending

In column (3), we add interaction terms between dummy variables that indicate whether the firm is located in a city that has a high commercial land price volatility during the global financial cycle and a dummy variable that indicates the easing phase. As in the pattern in column (2), we find that the added interaction term absorbs most of the quantity on the single easing phase dummy in column (1), indicating that the observed increase in the

borrowing amount during the easing phase is driven mainly by firms located in cities whose whose commercial & industrial land prices rise quickly during the financial cycle. Finally in column (4), we add triple interaction term to the easing phase dummy, the fixed-assets collateral dummy, and the high C& I land volatility city dummy. We find that the coefficient of the easing phase dummy goes to the triple interaction term. This indicates that, during the easing phase of the global financial cycle, *domestic* credit capacity gets stretched out the most by firms pledging their land and property type assets as collateral, and they are able to do so because they are located in cities where the commercial land prices are more pro-cyclical.

Paralleling the analysis with borrowing amount dynamics during the easing phase of the global financial cycle, we perform the same analysis for the tightening phase (2008-2009). The results are reported in Table 4.19. Symmetric with the results presented in Table 4.18, the amount that firms borrow on average from the same relationship bank during the 2008-2009 tightening phase shrinks by 37.1%, but most of the average treatment effect of the tightening phase on the debt capacity shrinkage is driven by firms that pledge their land-related fixed assets and that sit in cities that experience a deeper decline in local C&I property prices during the tightening phase. Quantitatively, the shrinkage of the credit capacity of those firms that pledge fixed assets and that are situated in a high C&I land price volatility city is nearly 4 times that of firms located elsewhere.

(V) Subsample Analysis: Revolving Credit Lending Relationships

In the above analysis, we utilize all firm-bank pair lending relationships to investigate (1) how the equilibrium loan amount within pairs changes during the easing and tightening periods of global financial cycles and (2) how the equilibrium loan amount changes with the collateral and collateral price volatility of the city in which the firm is located. The observed loan amount could be driven by both the credit demand side and the credit supply side, but it would not be sharp enough to allow us claim that the observed volatility in the loan amount is driven by the supply side rather than by some unobserved fundamental on the credit demand side. For example, during the tightening period, the observed stronger contraction

in the amount borrowed by firms that pledged their office buildings could be simply because the firm simply found it has no promising investment project to finance, thus the firm decides to borrow less. The observed contraction in the loan amount of these firms could not be attributed to impaired domestic credit intermediation driven by a deterioration of local asset price conditions. The reverse causality arises when less firms want to pledge their land thus we see lower land prices in that city.

To tighten our interpretation, we shrink our sample to firm-bank pairs of revolving credit line issuance during the global financial cycle. The loan amount reported in these types of lending refers to the upper bound of the line of credit rather than to the actual usage amount of credit by the firm. Focusing on the revolving credit sub-sample enables us to tease out unobservable demand side factors that are not a banks' credit supply to the firm. The results of the revolving-credit line sub-sample are reported in Table 4.20 and Table 4.21. All the results are qualitatively and quantitatively similar to the results obtained in the full sample analysis.

We next take one more step to determine which types of firms are most likely to stretch their debt capacity by pledging their land-related fixed assets during the easing phase. Table 4.22 and Table 4.23 report the results for this part of the analysis. Consistent with the findings in the previous tables, during the easing phase, the average borrowing amount tends to be 13.4% higher than during other period, after interacting with indicator variable whether the firm comes from high-tangibility industry, the magnitude of the coefficient on $1[\text{Easing}]$ was largely absorbed, indicating that the observed increase in average borrowing capacity was largely driven by firms from high-tangibility industries. In column (4), the triple interaction among $1[\text{Easing}]$ and $1[\text{High-tangibility}]$, and $1[\text{High commercial land price volatility city}]$ absorbed all the magnitude $1[\text{Easing}]$ on average. This indicates that the borrowing capacity of high-tangibility firms located in high-commercial price volatility cities were the main drivers of the observed increase in average borrowing capacity: while the borrowing capacity of firms increased on average by 2.3%, firms from the high-tangibility sector, which is located in cities that went through high commercial land price, see a 13.2% increase in borrowing

capacity within their relationship lender. Similarly, during the tightening phase, as shown in Table 4.22, while the borrowing capacity of firms shrank on average by 12.1%, firms from the high-tangibility sector located in cities that went through a deeper decline in local land prices saw an additional 36.9% reduction in borrowing capacity.

4.7. Firm behavior during the Global Financial Cycle

In the previous two sections, we show that cities with high domestic global bank (BOC) exposure will see a higher share of foreign credit channeled by local domestic global banks during the easing phase of the global financing cycle. Accompanying the more active role played by domestic global banks in the cross-border credit transmission, these cities experience a higher degree of volatility in real economic outcomes. We find that as a main driving force of the excess volatility in real outcomes, the intermediation of domestic credit is also affected during the global financing cycle, especially in areas that feature more volatile C&L land prices.

In this section, we address the following questions: 1) Why are C&I land prices in certain areas more volatile than in others? 2) Through what channel can the price of C&I land affect the intermediation of domestic credit when foreign credit leaves? 3) What role does domestic bank-channeled foreign credit play in this process?

4.7.1. *What Firms can do about their Debt Capacity?*

Our answers to the questions posed above hinge crucially on firm behavior during the global financing cycle. Consider an emerging market economy with no domestic global banks that can access the global funding market. For firms in this economy, the only possible source of foreign credit is borrowing directly from foreign banks. But as documented in (Jiang and Xu (2019)), foreign banks are generally unable to lend against fixed assets as collateral to extend credit to borrowers from emerging markets. Instead, in lending to these borrowers, foreign banks rely heavily on the inclusion of covenants that guarantee the transparency of

borrowers' cash flow. In this situation, during the easing phase of global financing cycle, although firms in this EME hope to enlarge their debt capacity in order to support more foreign credit issuance, playing with their asset tangibility is not a solution.

Let us now consider a scenario in which all foreign credit received by an emerging market is channeled by its domestic banks. Unlike foreign banks, which monitor closely and frequently, domestic banks in EMEs are more able to write debt contracts on tangible assets as collateral to extend cross-border capital. That said, the debt capacity of a firm could be made contingent on the firm's tangible asset holding if the firm is borrowing from a domestic bank. When domestic banks actively engage in the transmission of foreign credit to local industrial firms, one dimension of contracting contingency gets completed: cross-border credit agreements can now be written on domestic tangible assets as collateral. This newly emerged contracting contingency allows and incentivizes firms to actively increase their tangible asset holdings, allowing firms to enlarge their debt capacity and reap the benefit of cheap foreign credit during the easing phase of the global financial cycle.

The flexibility offered by this additional contracting contingency in cross-border capital transmission can be beneficial in that it allows the foreign credit to be more efficiently allocated to firms that need it most. Borrowers with a high marginal product of capital can now pledge their tangible input assets as collateral in order to support the amount of credit they want to borrow. As a by-product of such debt capacity stretching behavior by firms seeking to borrow foreign credit, C&I land prices increase during the easing phase, allowing firms that borrow against these assets to receive more domestic credit. But once the global financial condition reverses, high debt capacity no longer needs be maintained on the firms' side. Instead, firms want to get rid some of the tangible assets that they accumulated to increase their debt capacity. This exerts a downward pressure on local collateral prices, which then spreads out to negatively impact domestic credit intermediation because domestic credit and foreign credit are contingent on the common collateral base in the local economy

Mapping this reasoning onto this paper's empirical setting, one can easily imagine that in cities where the foreign credit supply of domestic banks is more elastic, firms would be more

likely to engage in such debt-capacity reaching behavior. Firms' debt-capacity reaching behavior will lift up local domestic collateral prices, amplifying the foreign-credit-induced credit boom into the domestic credit market, thereby boosting real output, employment, and TFP growth. But when this amplification becomes large enough, the coming global financial cycle reversal will more negatively impact the local domestic collateral price, resulting in a more severe real outcome slow-down. This mechanism perfectly explains the cross-sectional general equilibrium findings noted in Section 4.5, and it is in line with the previous literature about financial liberalization and macroeconomic volatility in the non-tradable sector asset prices (Tornell and Westermann (2002)).

4.7.2. Changes in Firm Tangibility over Global Financing Cycle

In this section, we use firm and city-level dataset from China to empirically investigate changes in firms' asset structure during the global financing cycle. Specifically, the goal of this section is to characterize how firms will react differently in terms of their tangible asset accumulation when their city has a differential availability of domestic global banks that channel foreign credit. We also determine which types of firms engage in such asset structure distorting behavior during the global financing cycle.

(I) Differences in Firm Behavior across Regions

Consistent with the set-up in Section 4.5, we exploit the exogenous heterogeneity in the different shares of foreign credit that are channeled by domestic banks at the city level, and we examine whether firms located in different cities display different asset accumulation and debt issuance patterns. To measure a firm's leveraging behavior we examine its year-to-year change in short-term debt scaled by lagged total assets. We also measure the asset accumulation behavior of firms using the year-to-year change in fixed assets. Consistent with the measurement construction presented in Section 4.5, we we measure firms' exposure to domestic bank-channeled foreign credit during the global financial cycle through the share of foreign currency credit that is lent by domestic banks in the city where the firm is located.

The following equation specifies the regression for this part of analysis.

$$\Delta y_{i,c,2003-2007} = \alpha + \beta(\% \text{Domestic share of foreign credit}_{c,2003-2007}) + \gamma \mathbf{X} + \epsilon_{i,c} \quad (4.9)$$

where $\Delta y_{i,c,2003-2007}$ is the outcome variable, it is either $\frac{\text{Total Debt}_{2007}}{\text{Assets}_{2006}} - \frac{\text{Total Debt}_{2004}}{\text{Assets}_{2003}}$ or $\Delta \text{Tangibility}$ is $\frac{\text{PPE}_{2007}}{\text{Assets}_{2006}} - \frac{\text{PPE}_{2004}}{\text{Assets}_{2003}}$ or $\frac{\text{Total fixed investment between 2004-2007}}{\text{Assets}_{2003}}$. i indexes firm, c indexes city, \mathbf{X} is a vector of firm controls and city controls that takes out other firm and city level unobservables that may interfere with the effect of the domestic bank-channeled foreign credit. Table 4.24 shows the regression results in the specification above.

The estimation of interest is the coefficient of the interaction term between the easing-phase dummy and the city's domestic global bank exposure. Column (1) shows the regression without control variables and interaction terms. It shows that during the easing phase of global financial cycle, firms on average are 1.64% faster in their year-to-year short-term debt issuance. In column (2), we add the interaction term between the firm i 's exposure to domestic bank-channeled foreign credit and the easing-phase dummy, and we find that the magnitude of the coefficient of the interaction term absorbs the coefficient of the easing-phase dummy. This means that the observed average treatment effect of the global financial cycle on the within-firm short-term debt growth is mostly driven by firms located in cities that have high domestic global bank exposure. 10% of the domestic bank-channeled foreign credit share in the city is correlated on average with a 12.4% higher annual short-term debt growth at the firm level.

Similarly, in column (3) and (4), we find that although all firms on average increase their tangibility by 2.1% during the easing phase of the global financial cycle, a 10% higher domestic bank-channeled foreign credit in the local city is associated with a 13.7% higher tangibility growth on the local firms' balance sheet. In other words, firms located in areas where a larger fraction of foreign credit is transmitted by domestic banks generally increase more of their asset tangibility during the easing phase of the global financing cycle.

(II) Firm Behavior and Firm Types

Through the following cross sectional regression, we next investigate what types of firms are more likely to stretch for high debt capacity by distorting their asset structure during the easing phase of the global financial cycle:

$$\begin{aligned}
 Ave.\Delta y_{i,c,2003-2007} = & \alpha + \beta_1(\%Domestic\ share\ of\ foreign\ credit_{2003-2007}) \\
 & + \beta_2(\%Domestic\ share\ of\ foreign\ credit_{2003-2007}) \times 1[High\ tangibility] + \gamma X + \epsilon_{i,c}
 \end{aligned}
 \tag{4.10}$$

The unit of observation in this regression is firm i in city c . The left-hand side variable $Ave.\Delta y_{i,c,2003-2007}$ is either the firm i 's average short-term liability growth or tangibility growth during the the easing phase in city c . On the right-hand side, we interact the share of domestic bank-channeled foreign credit with the indicator variable that takes value 1 if the firm is from a high-tangibility industry sub-category or if the firms' pre-cycle accounting transparency is low. The results of the specification are reported in Table 4.25. Paralleling the pattern of results in Table 4.24, and controlling for the level of foreign credit that flows into a city, firms that have a higher tangible asset structure and that are less transparent tend to have a faster short-term debt capacity growth if the higher percentage of the city's foreign credit is channeled by domestic banks rather than foreign banks.

4.7.3. *C&I Land Price over Global Financing Cycle*

Having examined the behavior at the firm end , we now study how the behavior of these firms affects local collateral prices during the global financial cycle , especially during its tightening phase (2008-2009).

We explore how the cross-sectional differences in city-level commercial and industrial land prices change across cities and how these changes are related to different levels in the share of domestic bank-channeled foreign credit. We investigate how different cities' collateral prices change during both the easing and tightening phases of the global financial cycle. We write

down the following cross-sectional regression specification:

$$\begin{aligned}\Delta(P_{2003-2007}^{\text{land}})_c &= \alpha + \beta_1(\% \text{Domestic share of foreign credit}_{2003-2007}) + \gamma X + \epsilon_c \\ \Delta(P_{2008-2009}^{\text{land}})_c &= \alpha + \beta_1(\% \text{Domestic share of foreign credit}_{2003-2007}) + \gamma X + \epsilon_c\end{aligned}\quad (4.11)$$

The unit of observation is the city. The left-hand side variables are defined as $\frac{P_{2007}^{\text{land}} - P_{2003}^{\text{land}}}{P_{2003}^{\text{land}}}$ and $\frac{\text{Ave. } P_{2008-2009}^{\text{land}} - P_{2007}^{\text{land}}}{P_{2007}^{\text{land}}}$ respectively, which measures degree of the commercial and industrial land price decline between the tightening phase and the easing phase.

In columns (1) and (3), we run the OLS specification that relates the share of domestic bank-channeled foreign credit during 2003-2007 with to the degree of the land price drop in the city. And in columns (2) and (4), we run the same set of regressions using the 2SLS approach described in Section 4.5. We find that a 10% increase in the share of domestic bank -channeled foreign credit will lead to a 30% heavier decrease in the land price during the tightening period.

4.7.4. *A Dynamic Diff-in-Diff Analysis*

To further nail down the mechanism, we examine how the time-varying dynamics of city level industrial land transactions by firms and industrial land prices differ when the industrial firms in the cities are differently exposed to Bank of China at the beginning of the global financial cycle. We write down the following regression specifications:

$$y_{c,t} = \alpha_c + \mu_s + \sum_{t=1999, s \neq 2003}^{2009} \beta_s \text{BOC}^{\text{pre}} \mathbf{1}[s = t] + \theta \left(\frac{\text{Total FX credit}}{\text{GDP}} \right)_{c,t} + \gamma \mathbf{X}_{c,t} + \epsilon_{c,t} \quad (4.12)$$

where c indexes city, t indexes year, and BOC^{pre} is the measure of the city's exposure to the Bank of China. The specification is measured either in the market share of BOC in the city's lending market in 2002 or as the total number of BOC branches per 10 local commercial bank branches. We estimate the above specification for 214 cities.

We utilize four key variables related to local firm industrial land transactions. The first

is the total value of financing collateralized by land in the city; the second is the industrial land price; the third is the total number of sums of industrial land transactions; and the fourth is the total number of pieces of industrial land that have been traded on the land market. Graphical illustrations of the results on β_s as well as the 95% confidence intervals are shown in Figure 4.17 and Figure 4.18. In Figure 4.17, the measure used to determine city-level exposure to domestic global banks before the initiation of global financial cycle is the city level BOC's market share in the local loan market in year 2002. In Figure 4.18, the city level BOC's branch network is measured by the number of BOC branches per 10 commercial bank branches.

In the years leading up to the initiation of the global financial cycle in 2003, there was no difference in local industrial land transactions in cities that had high relative to low domestic global bank presence. The insignificance of the estimation results during the pre-2003 period indicates that the observed ex-post effect that domestic global bank exposure had on the industrial land transaction behavior of industrial firms was probably not driven by local demand cycles, local firms' expectations switches, or corporate investment expansion that had started long before the global financial cycle. The local land transaction dynamism by local industrial firms started to become active in 2004. Cities that prior to 2003 had experienced a higher exposure to domestic global banks witnessed a faster turnover in land transactions, measured both by the number of transactions and the amount of land traded. Importantly, the city-level total value of loans secured by industrial land and the local industrial land prices climbed the most in cities that had experienced a high pre-cycle exposure to domestic global banks.

This upward tilting trend in cities that had experienced a high exposure to domestic global banks continued until 2007. In 2008, when the global financial cycle started to enter the tightening period, industrial land transactions and industrial land prices started to fall sharply in cities that had experienced high domestic global bank exposure during the pre-cycle period. The sharp expansion and contraction in these cities that occurred at the beginning of the cycle is consistent with the amplifier effect of high domestic bank-channeled

foreign credit on the collateralizable asset accumulation behavior of firms.

In Figure 4.16, we provide a sharper comparison of local industrial land prices and commercial mortgage issuance behavior by local firms between cities that had experienced either a high or low exposure to BOC. We normalize the industrial land price and commercial mortgage volume of the subsequent years by the industrial land price in 2003 and the number of total commercial mortgage issuance by local firms in 2003 respectively. In both panel (a) and panel (b), the darker gray dotted line plots the corresponding variable for cities within the top 25th percentile of pre-cycle BOC exposure, while the lighter gray dotted line plots the corresponding variables for cities within the lower 25-th percentile of pre-cycle BOC exposure.³⁴ For both variables, we find that in the years leading up to the start of the global financial cycle (in 2003), there was no significant difference in the trends of industrial land prices and commercial mortgage issuance by cities. Starting in 2003, cities that had experienced a high pre-cycle exposure to the BOC started to experience faster growth in industrial land prices and higher growth in the annual commercial mortgage issuance. Moreover, when the cycle suddenly reversed in 2008-2009, cities that had experienced a high pre-cycle exposure to BOC underwent a more severe decline in industrial land prices and commercial mortgage issuance dynamism.

4.8. Conclusion

The growing degree of the inter-connectedness between emerging market economies and the global financial market has caught the attention of policy makers around the world. A major transformation in this process is the increasingly important role played by domestic banks in the transmission of cross-border capital to EMEs. For these economies, having a larger share of foreign credit transmitted by domestic banks in EMEs can be a mixed blessing.

34. Each dot in the figure corresponds to the weighted average of the indexed industrial land price and commercial mortgage issuance (indexed using 2003 as base year) of cities, weighted by the city's real GDP in 2003.

This paper proposes and empirically identifies a novel channel through which the replacement of foreign banks by domestic banks in the transmission of cross-border capital to EMEs impacts these economies. The replacement of foreign banks by domestic lenders from EMEs in the cross-border credit transmission marks a completion of the contracting space because it allows credit agreements to be written against domestic hard assets as collateral. Increased flexibility in the contracting of the cross-border credit agreement can help the economy acquire a more efficient allocation of credit during the easing phase, but it can induce domestic industrial firms to overreach on credit by acquiring domestic collateral, which dampens asset prices and impairs domestic credit intermediation, particularly during the tightening phase.

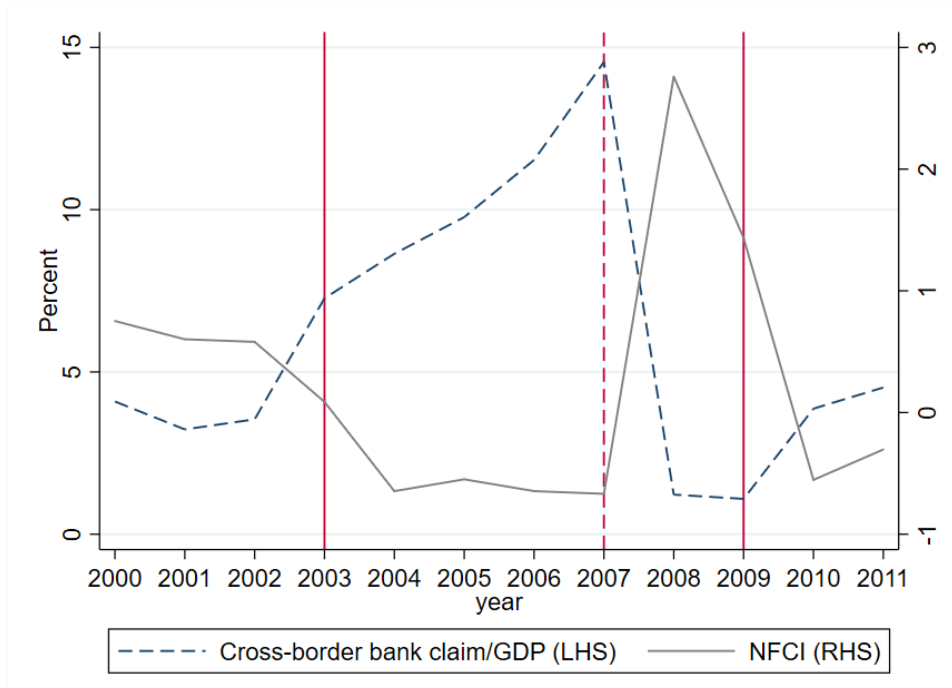
We leverage a unique within-country cross-city heterogeneity of domestic global bank distribution in China and disaggregate data at different scopes to identify this channel over a single global financing cycle (2003-2009). Our cross-city analysis reveals that cities that obtain a higher de facto percentage of foreign credit channeled by domestic banks demonstrated during the 2003-2009 global financial cycle a higher real economic volatility. These cities experienced a faster real GDP growth, a faster growth of employment in industrial sectors, a faster industrial firm TFP growth, and a faster overall domestic credit growth during the 2003-2007 episode. Yet these cities also experienced a more severe slowdown in their real GDP, industrial employment, and firm TFP growth during the 2008-2009 tightening period.

We find that beneath the excess volatility in the local real economy is a more affected domestic credit intermediation. In particular, we examine the lending relationships of banks that lack access to the international financing market. We find that lending relationships in cities that went through a higher industrial land price volatility also displayed drastic expansion and shrinkage in the total amount of credit issuance during the global financial cycle. Moreover, this expansion and shrinkage in the borrowing amount was especially severe for firms that used land and properties for commercial and industrial usage to obtain financing.

Finally, we turn to behavior on the firm end. In particular, we investigate changes in firms' tangible asset holdings during the easing phase of the credit cycle. My key finding

suggests that holding the total volume of foreign credit to a city controlled, firms located in cities that received higher domestic bank-channeled foreign credit significantly increased their asset tangibility (measured by PPE/Total assets), made higher cumulative fixed assets investments, and became more highly leveraged, as indicated by their total debt. Such asset structure distorting behavior during the easy phase of the global financing cycle had an impact on the local real economy during the tightening periods. This occurred because the behavior exerted an extra downward pressure on the price of domestic tangible assets.

Fig. 4.2. Global Financing Cycle 2003-2009



Notes: The above figure shows the global financial cycle of 2003-2009. The grey line shows the Financial Condition Index constructed by IMF, and the right-hand side shows the evolution of weighted average of cross-border claims/GDP from BIS.

Table 4.1. Summary Statistics of City-level characteristics

	Mean	Sd.	25-th	50-th	75-th
Population	1091.87	6616.13	239.32	369.57	592.05
Unemployment rate	0.07	0.04	0.05	0.06	0.08
Agriculture labor share	0.05	0.07	0.01	0.03	0.06
Industrial labor share	0.25	0.12	0.17	0.24	0.32
Construction labor share	0.07	0.04	0.04	0.06	0.08
Real estate labor share	0.01	0.01	0.00	0.01	0.01
Financial labor share	0.03	0.01	0.03	0.03	0.04
Commercial labor share	0.06	0.02	0.05	0.06	0.07
Land resource	36736.48	214471.03	6581.57	10610.96	18095.79
Arable land p/c	1.35	1.22	0.67	0.97	1.47
Transport capacity	18881.60	117017.78	2879.28	4898.52	9671.65
GDP	1079.15	5972.06	195.89	315.85	702.53
GDP p/c	15716.24	56549.32	6543.59	9849.91	14819.72
GDP growth	0.13	0.49	0.08	0.14	0.18
Ave. wage	12775.00	3936.50	10254.40	11921.82	13994.47
Agriculture value to GDP	18.59	9.58	10.63	17.76	26.23
Industrial value to GDP	45.22	10.15	37.84	45.86	51.93
Service value to GDP	36.18	6.52	32.79	35.83	39.52
no. Industrial firms	1711.85	10771.25	177.48	362.10	747.06
Value added domestic firm	0.57	0.28	0.35	0.53	0.72
Value added foreign firm	0.07	0.12	0.01	0.03	0.06
Fixed investment/GDP	0.32	0.11	0.24	0.30	0.36
FDI/GDP	0.03	0.03	0.00	0.01	0.03
no. FDI contracts	349.51	2283.84	12.21	30.86	115.43
No. of cities	316				

The above table shows the summary statistics of city-level characteristic variables during 2003-2007. The data are collected from City Statistical Yearbook of China from 2003-2007, CEIC and city-level statistical yearbook. Population is reported in 10,000 people, unemployment rate is calculated as the total number of people reported as unemployed scaled by total number of people in labor force. Agricultural, manufacturing, construction, real Estate and construction and commercial labor share are the total number of workers working in these sectors divided by total labor force. Land resource is the total area of land in square meters. Arable Land per capita is reported in acre/person. Transport capacity is the total number of passengers reported in 10,000 persons. GDP is the real GDP reported in 10,000 RMB, GDP per capita is reported in RMB per person and Real GDP growth is the average annual growth rate between 2003-2007, reported in percentage. Agriculture, industrial and service value to GDP are the sectors output value added scaled by GDP. no. industrial firms is the total number of industrial firms, value added domestic firms is the total of domestic non-state-owned firms' total value added scaled by total industrial sector value added, value added foreign firms is the share of total industrial sector value added made by foreign owned firms. Fixed investment/GDP is the total value of fixed investment scaled by GDP. FDI/GDP is the total value of actual FDI scaled by GDP. no. FDI contracts is the total number of FDI signed during the year.

Table 4.2. Summary Statistics of Firm-level characteristics

	N	Mean	Sd.	p(25)	p(50)	p(75)
Total assets	2406888	9.58	1.38	8.65	9.44	10.38
Age	2406888	8.06	8.69	3	6	10
Employees	2406888	204.26	712.84	50	95	188
Current debt outstanding	2406888	0.71	0.29	0.05	0.53	0.75
Long-term debt outstanding	2406888	0.11	0.87	0.02	0.08	0.14
Tangibility	2406888	0.53	0.67	0.16	0.31	0.52
Value-added	2406888	8.61	1.39	7.71	8.49	9.42
Cash flow	2126382	7.10	2.02	5.79	7.10	8.48
ROA	2406888	0.11	2.47	0.01	0.04	0.14
R&D expenses	998338	0.002	0.086	0	0.025	0.032
Investment rate	2406888	0.07	0.18	0	0.011	0.051
Labor productivity	2406888	3.95	1.14	4.21	3.89	4.65
Wage bill	2406888	7.08	1.22	7.08	7.22	7.83
TFP	2406888	0.01	0.25	0.002	0.008	0.09
TFP Growth	2406888	0.01	0.36	0.001	0.004	0.057

This table summarizes the main firm-level variables utilized in the empirical analysis. The data comes from NBS Annual Industrial Survey (AIS). Total assets is the log of total assets, and the variable total assets is reported in 1000 RMB. Age is the firm age, which is calculated as the current year minus the year when the firm registered. Employees is the total number of employees working in the firm. Current debt and Long-term debt are total current debt outstanding and total long-term debt outstanding scaled by lagged total assets. Tangibility is defined as total fixed assets (property, plants and equipment) scaled by total assets. ROA is defined as operating profit scaled by total assets, value added and cash flow are the log of industrial value added and cash flow of the firm respectively. Wage bill is the log of total payroll payable. Labor productivity is defined as the log of value added per worker.

Table 4.3. Summary Statistics of City-Lending

	Mean	Sd.	25-th	Median	75-th
Panel A: City-level summary					
Deposits	872.59	1384.63	206.40	425.90	725.30
Loans (RMB+Foreign currency)	597.58	823.27	129.00	267.50	503.00
Loans (RMB)	573.95	1024.90	118.00	223.50	461.00
C& I loan balance (RMB)	135.50	294.12	24.71	58.12	144.43
C& I loan share	0.27	0.42	0.16	0.24	0.32
Agricultural loan balance (RMB)	41.89	48.79	12.41	30.52	49.08
Agricultural loan share	0.14	0.09	0.07	0.13	0.19
Panel B: Firm-level aggregation					
C& I borrowing (RMB+Foreign currency)	177.27	348.49	27.27	70.19	89.57
Δ C& I borrowing (RMB+Foreign currency)	88.37	92.37	32.32	79.23	101.58
Panel C: Domestic channeled foreign credit					
Domestic channeled foreign credit (%)	0.52	0.38	0.12	0.39	0.58
Observations	316				

This table summarizes the ingredients utilized in the construction of the measure of domestic banks channeled foreign credit as a share of total foreign credit. Panel A provides the city-level summary statistics extracted from *China Statistical Yearbook for Regional Economy* and *China City Statistical Yearbook*. The table summarizes the 316 cities' average balances of deposits or loans during the 2003-2007 episode. Deposits are the total year-end deposits at the local banks, Loans (RMB+Foreign currency) are the total RMB-denominated and foreign currency-denominated loan balances outstanding at the local banks in the city. Loans (RMB) are the total RMB-denominated loan balances. C&I loan balance (RMB) is the total commercial and industrial loan balances on local banks' balance sheets that are denominated in RMB. Agricultural loan balance is the total RMB-denominated agricultural loan balance at the end of the year. Panel (B) provides the summary statistics the aggregated borrowing from the firms' side. C& I borrowing (RMB+Foreign currency) is the book value of total debt outstanding aggregating all firms in the city at the end of 2007. And Δ C& I borrowing (RMB+ Foreign currency) is the net increase in total book value of debt from 2003-2007, aggregating all firms' balance sheet in a city. Panel (C) presents the summary statistics of the share of domestic bank-channeled foreign credit at city level according to the calculation based on 4.5.1.

Table 4.4. Real impact of domestic bank channeled foreign credit

	Δ GDP			Δ Emp		Δ TFP	
	(1)	(2)	(3)	(4)	(5)	(6)	
Domestic channeled foreign credit	0.287** (0.0953)	0.260** (0.0872)	0.576*** (0.639)	0.557*** (0.627)	0.246** (0.0831)	0.208** (0.0695)	
Foreign credit/Total credit	0.573** (0.0189)	0.569* (0.0253)	0.365* (0.143)	0.173* (0.0703)	0.480** (0.154)	0.461* (0.198)	
Observations	306	306	306	306	306	306	
R ²	0.458	0.439	0.378	0.434	0.410	0.411	
Province FE	✓	✓	✓	✓	✓	✓	
City-level Controls	-	✓	-	✓	-	✓	

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: the table presents the results of regression in equation 4.4 for the easing period between 2003 and 2007. ΔGDP is $Ln(GDP_{04-07}) - Ln(GDP_{00-03})$, which is the differences between average real GDP post the cycle during the easing phase of the cycle and the pre-cycle average GDP. ΔEmp is $Ln(Emp_{04-07}) - Ln(Emp_{00-03})$, where "emp" is the total number of employees in working industrial sector firms. ΔTFP growth is defined as $TFP_{growth_{04-07}} - TFP_{growth_{00-03}}$. TFP growth is the average TFP growth of firms in a given city during the specified episode. City-level control variables include the total foreign credit to the city scaled by the city's total credit, agricultural labor share, industrial sector labor share, financial sector labor share, real estate sector labor wage, unemployment rate, total fixed asset investment scaled by GDP, total population, total land resource and total foreign-owned firms' value-added scaled by total value-added by all firms.

Table 4.5. Real impact of domestic bank channeled foreign credit: Tightening period

	Δ GDP			Δ Emp		Δ TFP	
	(1)	(2)	(3)	(4)	(5)	(6)	
Domestic channeled foreign credit	-0.255*** (0.0679)	-0.220** (0.0718)	-0.147** (0.0486)	-0.112** (0.0356)	-0.278** (0.0933)	-0.247** (0.0827)	
Foreign credit/Total credit	-0.456* (0.221)	-0.536* (0.223)	-0.174* (0.0857)	0.196* (0.0918)	-0.253* (0.104)	-0.264* (0.0.108)	
Observations	306	306	306	306	306	306	
R ²	0.416	0.433	0.369	0.419	0.395	0.417	
Province FE	✓	✓	✓	✓	✓	✓	
City-level Controls	-	✓	-	✓	-	✓	

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: the table presents the results of regression in equation 4.4 for the tightening period between 2008 and 2009. ΔGDP is $Ln(GDP_{08-09}) - Ln(GDP_{04-07})$, which is the differences between average real GDP post the cycle during the easing phase of the cycle and the pre-cycle average GDP. ΔEmp is $Ln(Emp_{08-09}) - Ln(Emp_{04-07})$, where "emp" is the total number of employees in working industrial sector firms. ΔTFP growth is defined as $TFP_{growth_{08-09}} - TFP_{growth_{04-07}}$. City-level control variables include the total foreign credit to the city scaled by the city's total credit, agricultural labor share, industrial sector labor share, financial sector labor share, real estate sector labor share, average labor wage, unemployment rate, total fixed asset investment scaled by GDP, total population, total land resource and total foreign-owned firms' value-added scaled by total value-added by all firms.

Table 4.6. First Stage

Dependent Variable: Domestic channeled foreign credit		
	(1)	(2)
BOC-market share (IV-1)	2.274*** (0.641)	
BOC-branching (IV-2)		0.631*** (0.182)
Foreign credit/Total credit	2.823 (3.686)	0.723 (0.670)
Agriculture labor share	0.00659 (0.535)	-0.000557 (0.0973)
Manufacturing labor share	0.223 (0.293)	0.0349 (0.0533)
Financial labor share	4.724 (3.251)	1.391* (0.591)
Real estate labor share	-3.992 (4.634)	-0.450 (0.842)
GDP/pc	0.00390 (0.00791)	0.000657 (0.00144)
Unemployment rate	-0.332 (0.718)	-0.0522 (0.130)
FDI/GDP	0.352 (0.413)	0.0689 (0.0492)
$\frac{\text{Foreign-owned value added}}{\text{Total value-added}}$	-136.6* (60.93)	-26.49* (11.08)
Transportation capacity	-0.0555 (0.0563)	-0.0126 (0.0102)
Population	0.0400 (0.0713)	0.0169 (0.0130)
Land	-0.0772 (0.0440)	-0.0106 (0.00800)
Observations	306	306
R^2	0.108	0.134

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table presents the first-stage regressions.

Table 4.7. Real impact of domestic bank channeled foreign credit: 2SLS

	Δ GDP		Δ Emp		Δ TFP	
	IV-1	IV-2	IV-1	IV-2	IV-1	IV-2
Domestic Channeled Foreign credit	0.179** (0.0598)	0.193*** (0.0566)	0.113** (0.0444)	0.108** (0.0524)	0.189*** (0.0547)	0.158** (0.0516)
Foreign credit/Total credit	0.197** (0.0659)	0.155* (0.0665)	0.127* (0.0545)	0.133** (0.0532)	0.175** (0.0589)	0.161* (0.0605)
Observations	306	306	306	306	306	306
R^2	0.571	0.584	0.403	0.401	0.452	0.489
Province FE	✓	✓	✓	✓	✓	✓
City-level Controls	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: the table presents the results of 2SLS regression specified in equation 4.5 for the easing period between 2003 and 2007. Δ GDP is $Ln(GDP_{04-07}) - Ln(GDP_{00-03})$, which is the differences between average real GDP post the cycle during the easing phase of the cycle and the pre-cycle average GDP. Δ Emp is $Ln(Emp_{04-07}) - Ln(Emp_{00-03})$, where "emp" is the total number of employees in working industrial sector firms. Δ TFP growth is defined as TFP growth₀₄₋₀₇ - TFP growth₀₀₋₀₃. TFP growth is the average TFP growth of firms in a given city during the specified episode. City-level control variables include the total foreign credit to the city scaled by the city's total credit, agricultural labor share, industrial sector labor share, financial sector labor share, real estate sector labor share, average labor wage, unemployment rate, total fixed asset investment scaled by GDP, total population, total land resource and total foreign-owned firms' value-added scaled by total value-added by all firms.

Table 4.8. Real impact of domestic bank channeled foreign credit: Tightening period 2SLS

	Δ GDP		Δ Emp		Δ TFP	
	IV-1	IV-2	IV-1	IV-2	IV-1	IV-2
Domestic Channeled Foreign credit	-0.0928** (0.0378)	-0.0993** (0.0389)	-0.0872*** (0.0293)	-0.0766*** (0.0269)	-0.189** (0.0634)	-0.178** (0.0585)
Foreign credit/Total credit	-0.189** (0.0703)	-0.158** (0.0591)	-0.105* (0.0522)	-0.124* (0.0533)	-0.185** (0.0606)	-0.146* (0.0712)
Observations	306	306	306	306	306	306
R ²	0.455	0.434	0.312	0.299	0.426	0.463
Province FE	✓	✓	✓	✓	✓	✓
City-level Controls	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: the table presents the results of 2SLS-regression in equation 4.5 for the tightening period between 2008 and 2009. ΔGDP is $Ln(GDP_{08-09}) - Ln(GDP_{04-07})$, which is the differences between average real GDP post the cycle during the easing phase of the cycle and the pre-cycle average GDP. ΔEmp is $Ln(Emp_{08-09}) - Ln(Emp_{04-07})$, where "emp" is the total number of employees in working industrial sector firms. ΔTFP growth is defined as $TFP_{growth_{08-09}} - TFP_{growth_{04-07}}$. City-level control variables include the total foreign credit to the city scaled by the city's total credit, agricultural labor share, industrial sector labor share, financial sector labor share, real estate sector labor share, average labor wage, unemployment rate, total fixed asset investment scaled by GDP, total population, total land resource and total foreign-owned firms' value-added scaled by total value-added by all firms.

Table 4.9. Firms' TFP Growth and Domestic Channeled Foreign Credit

	Dependent Variable: ΔTFP					
	Easing phase			Tightening phase		
	OLS	IV-1	IV-2	OLS	IV-1	IV-2
Domestic channeled foreign credit	0.0361** (0.0121)	0.0210*** (0.00594)	0.0365** (0.0121)	-0.0171** (0.00576)	-0.0132** (0.00443)	-0.0188*** (0.0505)
Foreign credit/Total credit	0.0588*** (0.0115)	0.0704** (0.0235)	0.0754** (0.0242)	-0.0354* (0.0144)	-0.0382** (0.0129)	-0.0403** (0.0134)
Observations	168633	158714	168494	158714	158714	158714
R^2	0.114	0.115	0.125	0.103	0.112	0.117
Province FE	✓	✓	✓	✓	✓	✓
Baseline Controls	✓	✓	✓	✓	✓	✓
Industry FE	✓	✓	✓	✓	✓	✓
Region FE	✓	✓	✓	✓	✓	✓
City controls	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table presents regression analysis of firm asset tangibility adjustment behavior shown in equation 4.9. The left-hand side variable is the change in asset tangibility between 2004 and 2007 at firm level, and is calculated as $\frac{PPE_{2007}}{Assets_{2007}} - \frac{PPE_{2004}}{Assets_{2004}}$. The main explanatory variable on the right-hand side is the fraction of total foreign-currency denominated loans to local firms made by local domestic banks at the city level. Provincial fixed effects is controlled in column (1), column (2) add baseline controls which include GDP per capita, foreign-owned industrial firms output/GDP, industrial sector labor share, financial sector labor share and total construction land areas. Industry fixed effects are added in column (3), and region fixed effects are added in column (4). Finally, in the column (5), we explicitly control further for the city's export exposure by including the local industrial firms' total export value/GDP and fraction of industrial firms that are exporters. Standard errors are clustered at the city level.

Table 4.10. Firms' Employment Growth and Domestic Channeled Foreign Credit

	Dependent Variable: ΔEmp					
	Easing phase			Tightening phase		
	OLS	IV-1	IV-2	OLS	IV-1	IV-2
Domestic channeled foreign credit	0.174** (0.0584)	0.112** (0.0371)	0.125*** (0.0353)	-0.103** (0.0343)	-0.122** (0.0392)	-0.142** (0.0454)
Foreign credit/Total credit	0.0132** (0.00441)	0.0194* (0.00822)	0.0121*** (0.00323)	-0.0143* (0.00653)	-0.0238* (0.0155)	-0.0252* (0.0103)
Observations	169247	159249	169103	159249	159249	159249
R^2	0.142	0.159	0.162	0.099	0.133	0.146
Province FE	✓	✓	✓	✓	✓	✓
Baseline Controls	✓	✓	✓	✓	✓	✓
Industry FE	✓	✓	✓	✓	✓	✓
Region FE	✓	✓	✓	✓	✓	✓
City controls	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table presents regression analysis of firm asset tangibility adjustment behavior shown in equation 4.9. The left-hand side variable is the change in asset tangibility between 2004 and 2007 at firm level, and is calculated as $\frac{\text{PPE}_{2007}}{\text{Assets}_{2007}} - \frac{\text{PPE}_{2004}}{\text{Assets}_{2004}}$. The main explanatory variable on the right-hand side is the fraction of total foreign-currency denominated loans to local firms made by local domestic banks at the city level. Provincial fixed effects is controlled in column (1), column (2) add baseline controls which include GDP per capita, foreign-owned industrial firms output/GDP, industrial sector labor share, financial sector labor share and total construction land areas. Industry fixed effects are added in column (3), and region fixed effects are added in column (4). Finally, in the column (5), we explicitly control further for the city's export exposure by including the local industrial firms' total export value/GDP and fraction of industrial firms that are exporters. Standard errors are clustered at the city level.

Table 4.11. Firms' Output Growth and Domestic Channeled Foreign Credit

	Dependent Variable: Δ Output value-added					
	Easing phase			Tightening phase		
	OLS	IV-1	IV-2	OLS	IV-1	IV-2
Domestic channeled foreign credit	0.161** (0.0526)	0.145** (0.0458)	0.157** (0.0544)	-0.128* (0.0605)	-0.144** (0.0452)	-0.159** (0.0607)
Foreign credit/Total credit	0.222*** (0.0278)	0.191*** (0.0439)	0.133*** (0.0304)	-0.146** (0.0448)	-0.173*** (0.0442)	-0.135** (0.0413)
Observations	169307	159324	169164	159324	159466	159053
R^2	0.629	0.633	0.628	0.635	0.634	0.634
Province FE	✓	✓	✓	✓	✓	✓
Baseline Controls	✓	✓	✓	✓	✓	✓
Industry FE	✓	✓	✓	✓	✓	✓
Region FE	✓	✓	✓	✓	✓	✓
City controls	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table presents regression analysis of firm asset tangibility adjustment behavior shown in equation 4.9. The left-hand side variable is the change in asset tangibility between 2004 and 2007 at firm level, and is calculated as $\frac{PPE_{2007}}{Assets_{2007}} - \frac{PPE_{2004}}{Assets_{2004}}$. The main explanatory variable on the right-hand side is the fraction of total foreign-currency denominated loans to local firms made by local domestic banks at the city level. Provincial fixed effects is controlled in column (1), column (2) add baseline controls which include GDP per capita, foreign-owned industrial firms output/GDP, industrial sector labor share, financial sector labor share and total construction land areas. Industry fixed effects are added in column (3), and region fixed effects are added in column (4). Finally, in the column (5), we explicitly control further for the city's export exposure by including the local industrial firms' total export value/GDP and fraction of industrial firms that are exporters. Standard errors are clustered at the city level.

Table 4.12. Allocation of Credit: Incumbent Firms

	Debt growth ₀₄₋₀₇								
	OLS	IV-1	IV-2	OLS	IV-1	IV-2	OLS	IV-1	IV-2
DCFC	0.0108 (0.0272)	0.0117 (0.0233)	0.0114 (0.0277)	0.0329 (0.0215)	0.0323 (0.0215)	0.0362 (0.0223)	0.0286* (0.0111)	0.0237* (0.0109)	0.0252* (0.0105)
DCFC×1[High-tangibility]	0.361*** (0.121)	0.364** (0.119)	0.366*** (0.103)						
1[High Tangibility]	-0.0145* (0.00782)	-0.0236* (0.0103)	-0.0210* (0.00789)						
DCFC×1[Young firm]				0.145*** (0.0294)	0.141*** (0.0325)	0.155*** (0.0314)			
1[Young firm]				-0.0992 (0.0144)	-0.0951 (0.0144)	-0.0790 (0.0144)			
DCFC×1[High ROA]							0.106*** (0.0358)	0.108*** (0.0332)	0.0956** (0.0321)
1[High ROA]							-0.0300*** (0.00878)	-0.0303*** (0.00878)	-0.0282*** (0.00878)
Foreign credit/Total credit	0.0714 (0.0517)	0.0767 (0.0572)	0.115* (0.0532)	0.121* (0.0517)	0.122* (0.0572)	0.111* (0.0532)	0.109* (0.0517)	0.0958 (0.0622)	0.114* (0.0513)
Observations	169596	169596	169596	169596	169596	169596	169596	169596	169596
R ²	0.010	0.010	0.011	0.011	0.011	0.012	0.011	0.011	0.011
Province FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Baseline Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Industry FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Region FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
City controls	✓	✓	✓	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table shows feature of the Firm-level debt growth and how it correlates with city-level domestic bank channeled foreign credit:

$$\Delta D_{i,j,c} = \alpha + \gamma_j + \beta_0 \text{DCFC}_c + \beta_1 \text{DCFC}_c \times 1[\text{Char}] + \theta X_{i,c} + \epsilon_{i,j,c} \quad (4.13)$$

$\Delta D_{i,j,c}$ is the *within-firm* incremental in leverage ratio post the financial cycle compared with its pre-cycle level. DCFC_c is abbreviated for domestic channeled foreign credit of city c during 2003-2007. $1[\text{Char}]$ is an indicator variable specifying the features of the firm, it could be $1[\text{High-tangibility}]$, $1[\text{Young firm}]$, $1[\text{High pre-ROA}]$. IV-1 is the instrumental variable using BOC's pre-cycle loan market share in the city; and IV-2 is the instrumental using the BOC's pre-cycle branching intensity in the city.

Table 4.13. Domestic channeled foreign credit and new firm

	Δ New firms		
	OLS	IV-1	IV-2
Domestic channeled foreign credit	0.404* (0.151)	0.712** (0.228)	0.549** (0.181)
Foreign credit/Total credit	2.746* (1.149)	2.108* (0.852)	2.544* (1.006)
Observations	306	306	306
R^2	0.759	0.794	0.800
Province FE	✓	✓	✓
City-level Controls	✓	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table shows the average within-firm debt growth for firms that were newly established across different cities. Δ New firms is the difference in the natural log of total number of firms in the city in 2007 and 2003. Column (1) is the OLS regression results and Column (2) and (3) are 2SLS regression results. IV-1 is the instrumental variable using BOC's pre-cycle loan market share in the city; and IV-2 is the instrumental using the BOC's pre-cycle branching intensity in the city. City -level control variables include the total foreign credit to the city scaled by the city's total credit, agricultural labor share, industrial sector labor share, financial sector labor share, real estate sector labor share, average labor wage, unemployment rate, total fixed asset investment scaled by GDP, total population, total land resource and total foreign-owned firms' value-added scaled by total value-added by all firms.

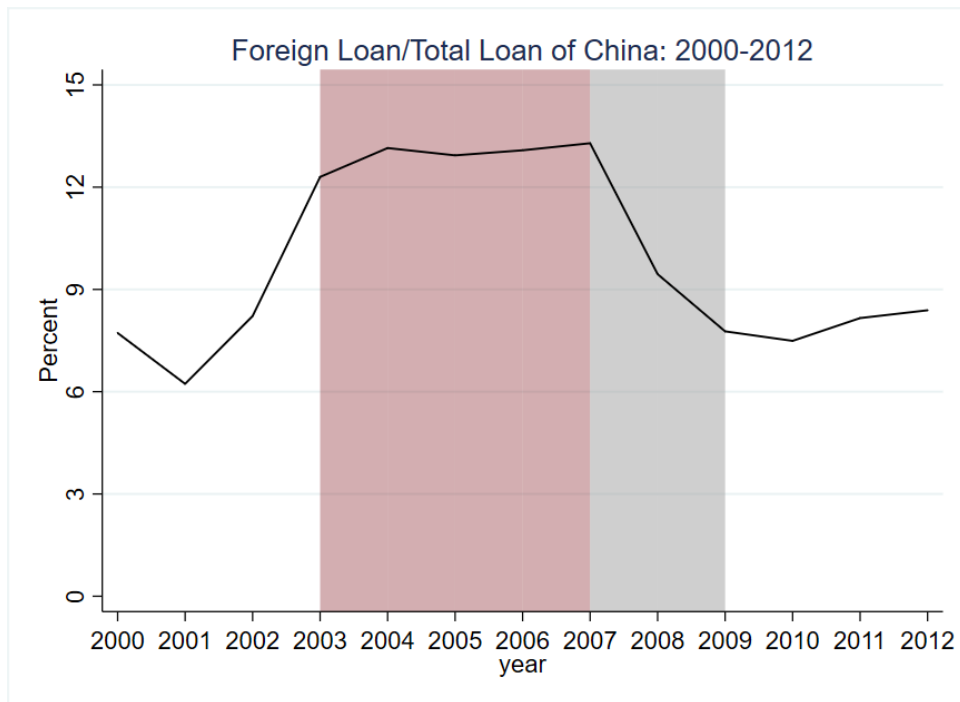


Fig. 4.3. Share of Foreign Credit in Total Credit in China: 2000-2012

Notes: The above figure shows the evolution of foreign-currency lending balance as a share of total lending of China's financial institutions from 2000 to 2012. The figure is compiled by data from Almanac of China's Banking and Finance.

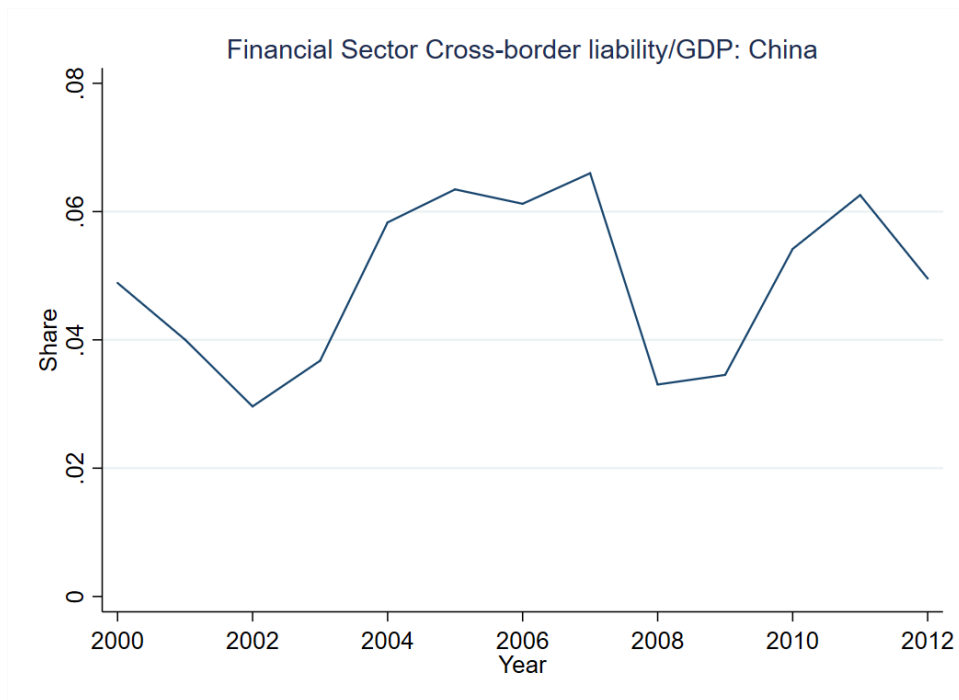


Fig. 4.4. Share of cross-border liability of financial sector: China 2000-2012
 Notes: The above figure shows the evolution of total cross-border liabilities of China's financial sector as a share of GDP. The cross-border liabilities of financial sector is from the Locational Banking Statistics, which report the claims of China's banking sector held by all BIS reporting foreign banks.

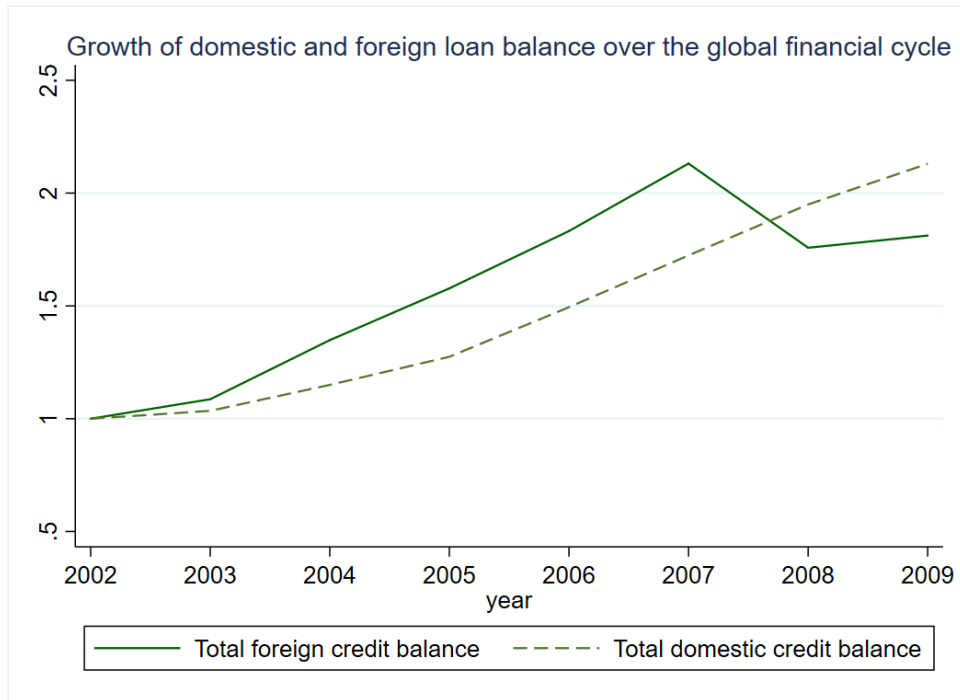


Fig. 4.5. Growth of domestic credit balance and foreign credit balance

Notes: The above figure shows the growth of Bank of China's total foreign-currency lending balance and total RMB balance lending evolution from 2002-2009. The base year is 2002. The figure is compiled from data offered in Almanac of China's Banking and Finance.

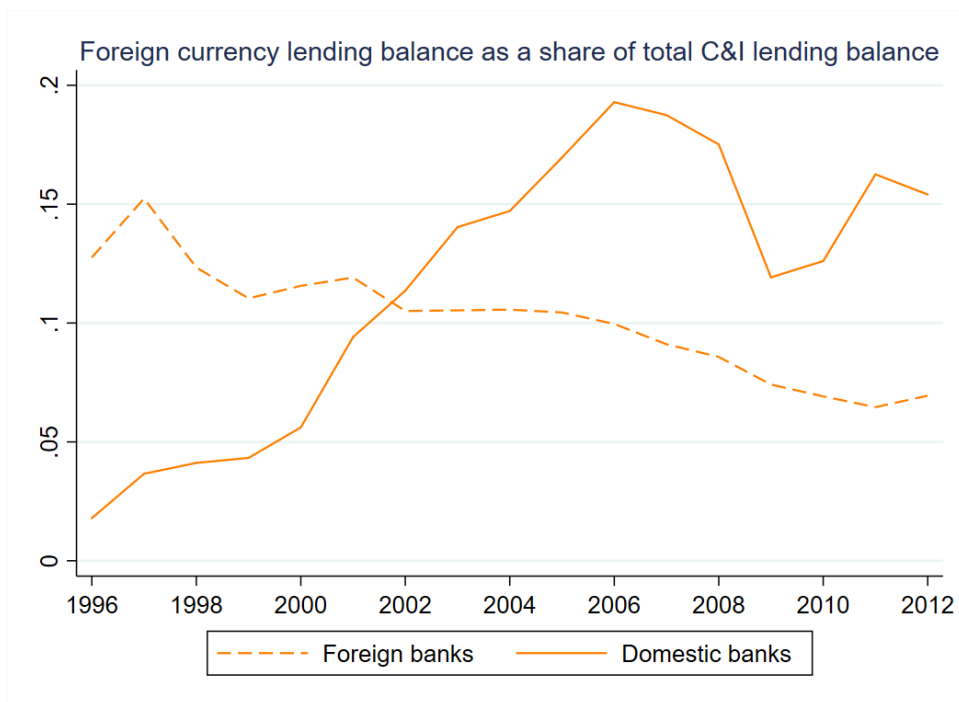
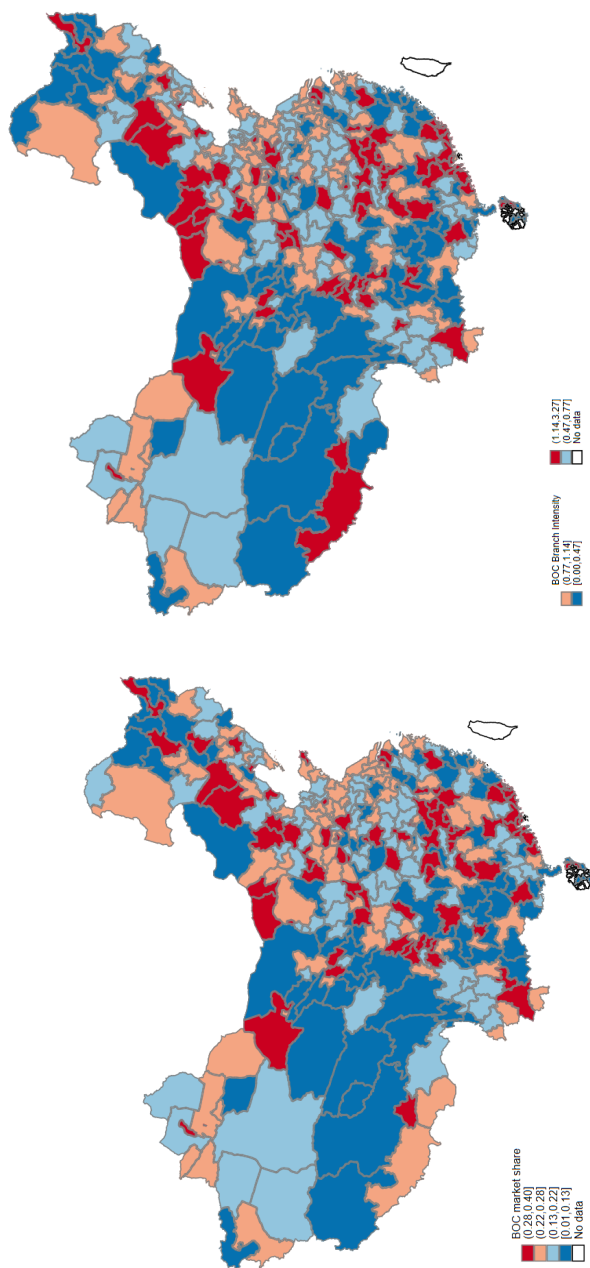


Fig. 4.6. Share of Domestic banks' foreign currency lending in China

Notes: The above figure shows evolution of foreign banks' total lending balance and domestic banks' foreign-currency lending balance as a share of total C& I lending balance in China. The nominator is the total lending balance of foreign banks and the total foreign-currency lending balance of domestic banks. The denominator is the total C& I lending balance of financial institutions in China.

Fig. 4.7. BOC Distribution in China

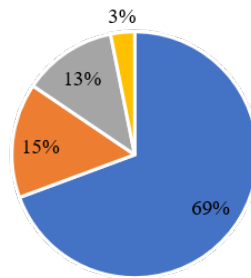


Notes: The above figure shows the industry decomposition of foreign banks' lending balance to Chinese borrowers. Panel (a) shows Bank of China's lending balance market share at prefecture-level cities in 2002. The areas are shaded total BOC lending balance as a share of local bank lending balances. And panel (b) shows Bank of China's branching distribution at prefecture-level cities in 2002. The areas are shaded by the total number of BOC branches per 10 local commercial bank branches.

Fig. 4.8. Foreign banks' lending by industry in China

Foreign funded banks' lending decomposition

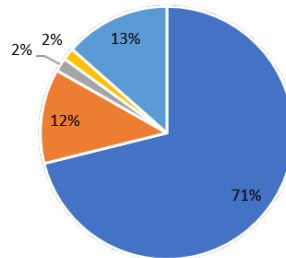
- Industrial and commercial sector
- Real Estate
- Wholesale and utilities
- Personal consumption and services



(a)

Foreign funded banks' lending decomposition

- Industrial and commercial sector
- Real Estate
- Wholesale and utilities
- Personal consumption and services
- Transportation



(b)

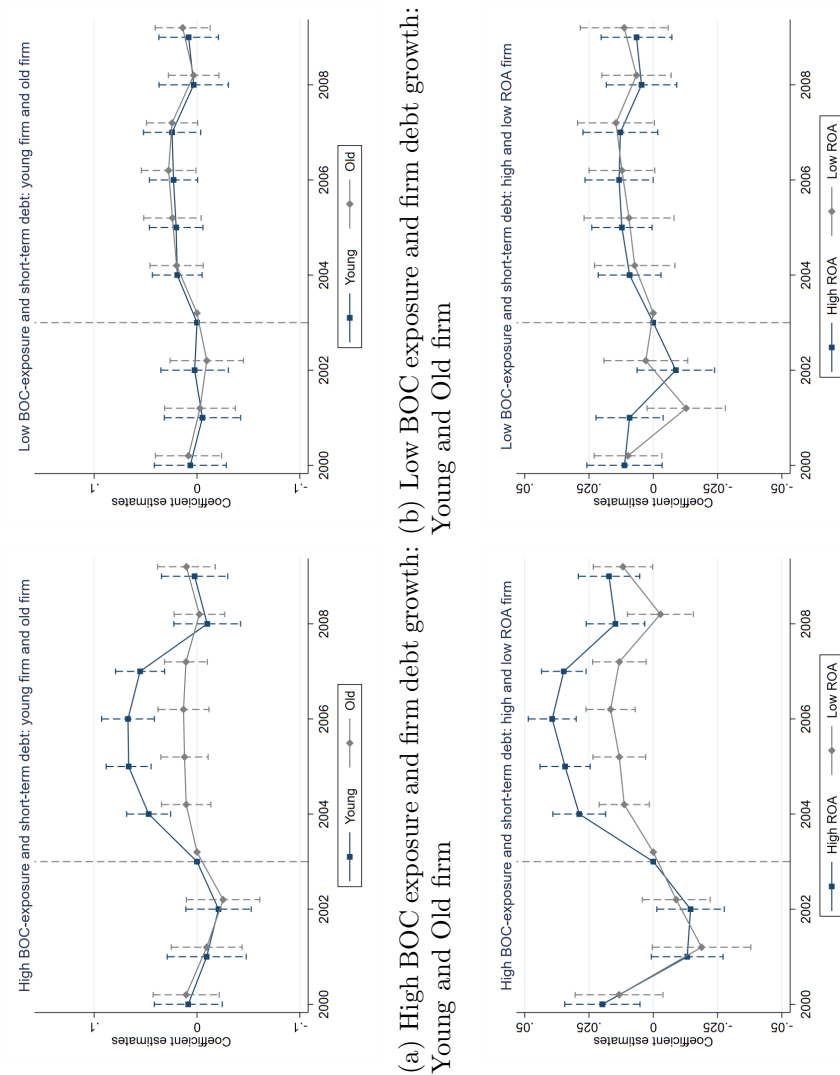
Notes: The above figure shows the industry decomposition of foreign banks' lending balance to Chinese borrowers. Panel (a) is extracted from PBOC's annual news report, and panel (b) is compiled using cross-border syndicated lending from 2000-2009 using data from Dealscan. In both figures, the darkest blue shaded area represents the share of foreign bank lending to industrial and commercial sectors.



Fig. 4.9. Bank of China's Dominance in FX Lending Market

Notes: The above figure shows evolution of foreign banks' total lending balance and domestic banks' foreign-currency lending balance as a share of total C&I lending balance in China. The nominator is the total lending balance of foreign banks and the total foreign-currency lending balance of domestic banks. The denominator is the total C&I lending balance of financial institutions in China.

Fig. 4.10. BOC exposure and Firm Credit Growth



(a) High BOC exposure and firm debt growth: Young and Old firm

(b) Low BOC exposure and firm debt growth: Young and Old firm

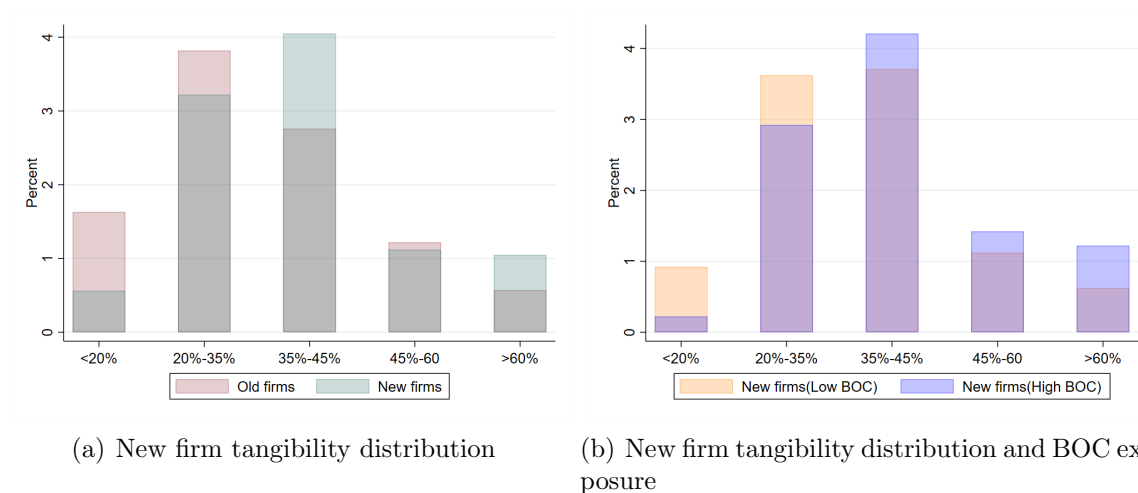
(c) High BOC exposure and firm debt growth: High ROA and Low ROA firms

(d) High BOC exposure and firm debt growth: High ROA and Low ROA firms

$$D_{i,j,c,t} = \alpha_i + \gamma_{j,t} + \sum_{q \neq 2003}^{q \in [2000-2007]} \beta_q 1[t = q] + \theta X_{i,c,t} + \epsilon_{i,j,c,t}$$

Notes: The above four figures shows the coefficient of estimates of equation 4.7. High BOC cities are defined as cities with above-median local BOC market share pre-cycle. Young firms are defined as firms under the age of 7. High ROA firms are defined as firms with above-median pre-cycle ROA in the city that they are located.

Fig. 4.11. Firm industry distribution and BOC exposure



Notes: The above figure shows the distribution of new entrant firms in terms of their tangibility. The five categories (from left to right) of industry are characterized by the industry's pre-cycle (1998-2002) average tangibility (PPE/Assets). For example, category 1 "<20%" means industries with pre-cycle average tangibility being less than 20%. The height of the bar represents the percentage of new entrant firms from 2003-2007 that fall into a given category of industry group. Panel (a) compares the distribution of pre-cycle old firms' tangibility distributions and all the new entrant firms tangibility distributions. Panel (b) compares the tangibility distribution of new entrant firms that are located in high BOC exposure cities and those in low BOC exposure cities.

Table 4.15. Domestic channeled foreign credit and new firm debt growth across cities

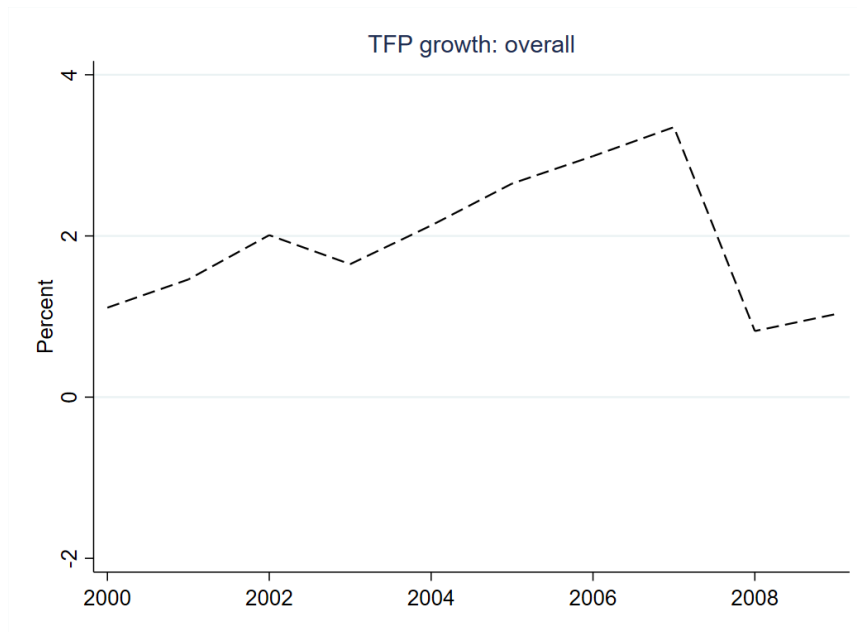
	Debt growth		
	OLS	IV-1	IV-2
Domestic channeled foreign credit	0.268** (0.0896)	0.365*** (0.0878)	0.339** (0.0927)
Foreign credit/Total credit	0.217** (0.0709)	0.143* (0.0588)	0.146* (0.0618)
Observations	37418	37418	37418
R^2	0.094	0.123	0.122
Province FE	✓	✓	✓
City-level Controls	✓	✓	✓

Standard errors in parentheses

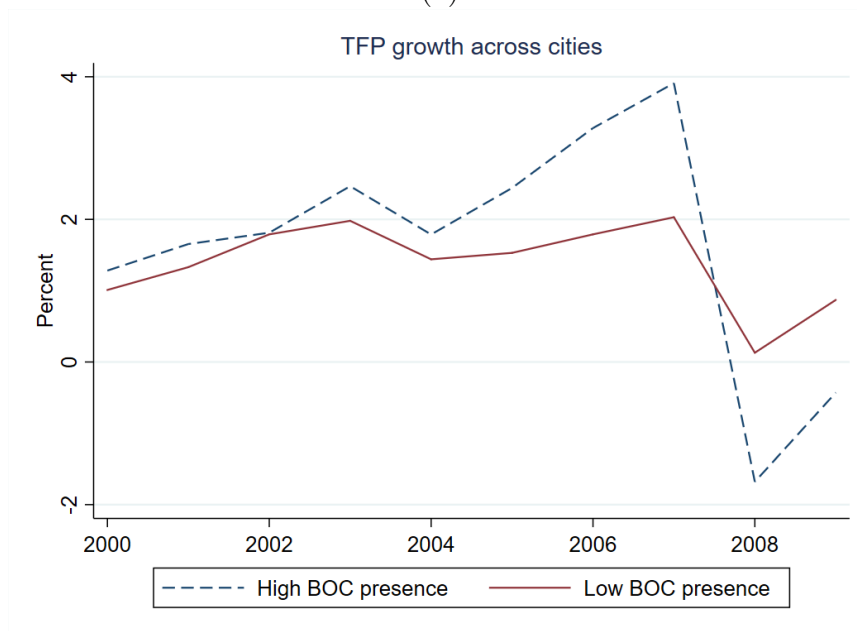
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table shows the average within-firm debt growth for firms that were newly established across different cities. IV-1 is the instrumental variable using BOC's pre-cycle loan market share in the city; and IV-2 is the instrumental using the BOC's pre-cycle branching intensity in the city. City -level control variables include the total foreign credit to the city scaled by the city's total credit, agricultural labor share, industrial sector labor share, financial sector labor share, real estate sector labor share, average labor wage, unemployment rate, total fixed asset investment scaled by GDP, total population, total land resource and total foreign-owned firms' value-added scaled by total value-added by all firms.

Fig. 4.12. Distribution of Bank of China Lending Balance Market Share



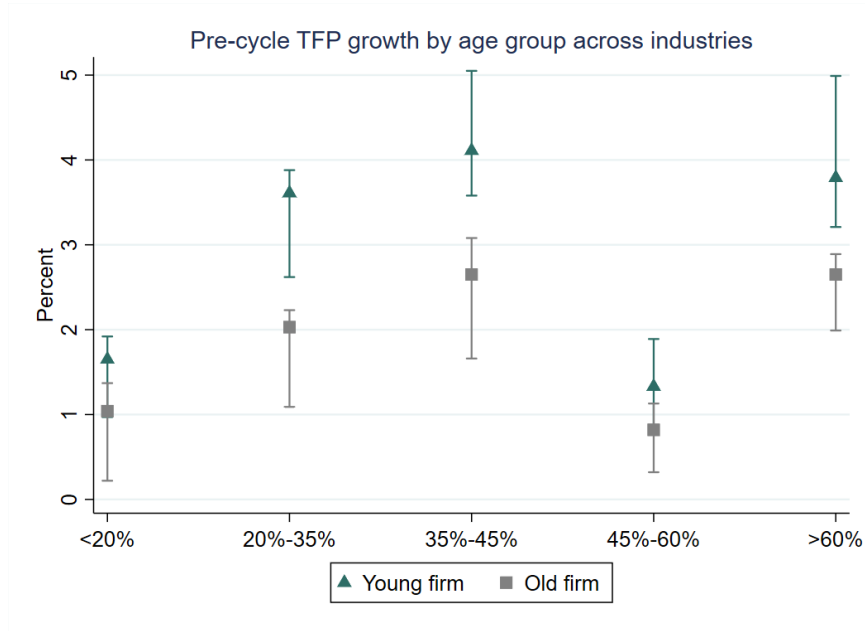
(a)



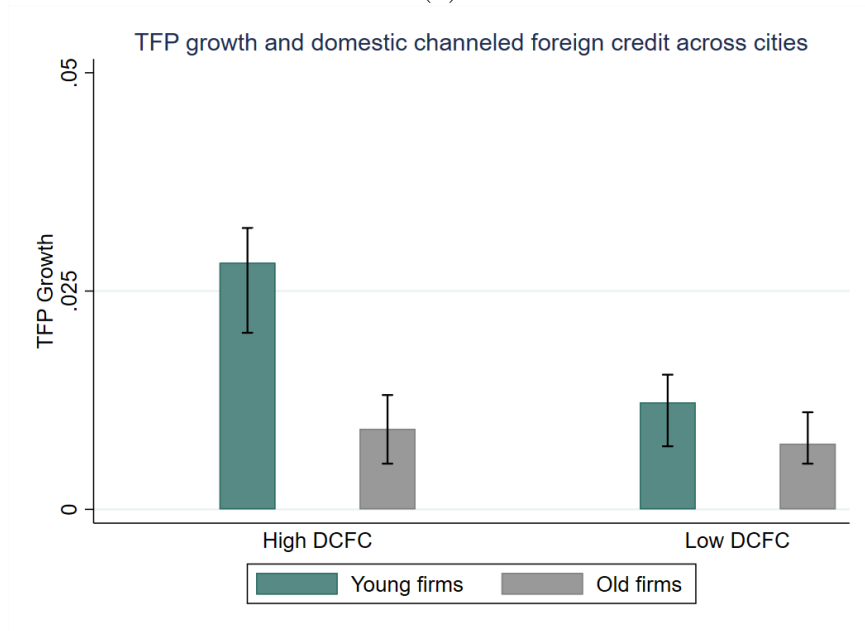
(b)

Notes: The figure compares firm-level TFP growth during 2003-2007 in cities with high and low domestic channeled foreign credit during the 2003-2007 period.

Fig. 4.13. Distribution of Bank of China Lending Balance Market Share



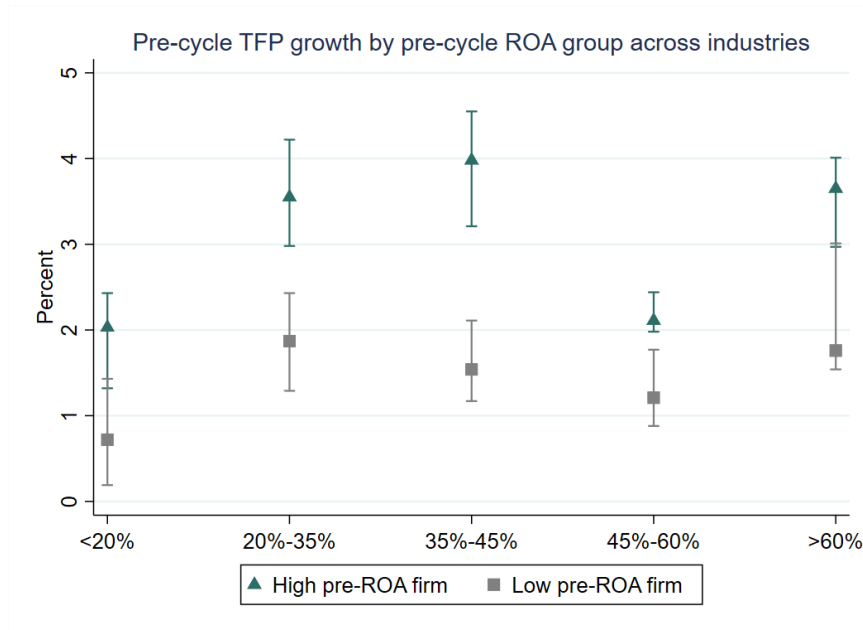
(a)



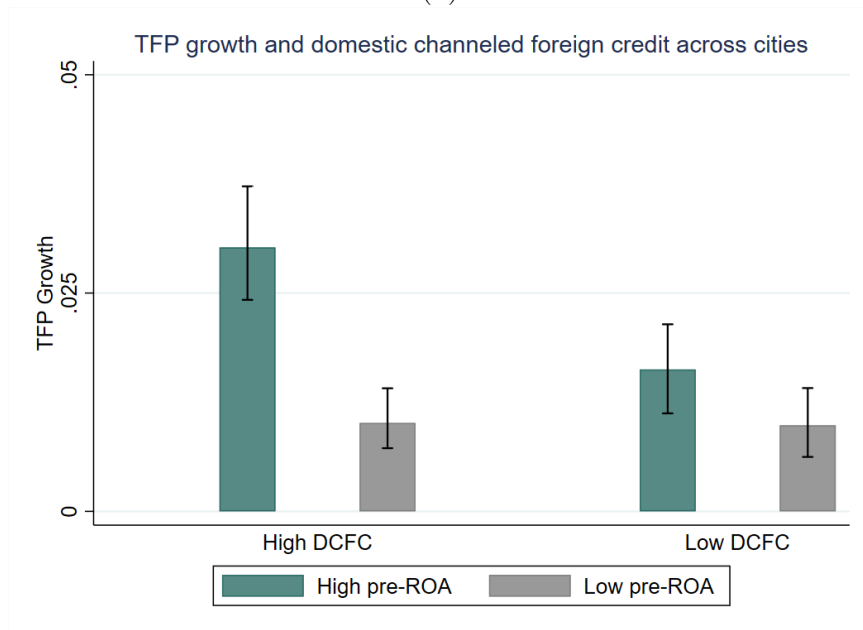
(b)

Notes: The figure compares firm-level TFP growth during 2003-2007 in cities with high and low domestic channeled foreign credit during the 2003-2007 period. Panel (a) demonstrates the young and old firms' pre-cycle TFP growth across industry groups sorted by the industries' pre-cycle tangibility. Panel (b) compares the young and old firms' TFP growth during the cycle for those located in high DCFC cities and those in low DCFC cities.

Fig. 4.14. Distribution of Bank of China Lending Balance Market Share



(a)



(b)

Notes: The figure compares firm-level TFP growth during 2003-2007 in cities with high and low domestic channeled foreign credit during the 2003-2007 period. Panel (a) demonstrates the high-ROA and low-ROA firms' pre-cycle TFP growth across industry groups sorted by the industries' pre-cycle tangibility. Panel (b) compares the high-ROA and low-ROA firms' TFP growth during the cycle for those located in high DCFC cities and those in low DCFC cities.

Table 4.16. Summary Statistics of domestic relationship lending and collateral

Panel A: Firm-bank pair			
	Mean	Sd.	Median
Total #. of firms	3287		
Total #. of banks	672		
Ave. # of firms/year (2003-2012)	1617		
% of firms located in high CL price volatility cities	31.9%		
% of lending (/year) secured by fixed assets	72.8%		
	Mean	Sd.	Median
#. of years relationship within each bank-firm pair	4.58	2.83	4
#. of banks within each firm-year	5.27	4.23	6
#. of banks each firm has relationship	5.89	6.13	4
Ln(Total borrowing amount)(CNY)	15.89	2.37	17.42
Panel B: Collateral Type			
	Mean	Sd.	Median
Property, Land, Plant and Factory	0.82	0.48	1.00
Security holdings	0.06	0.24	0.00
Account receivables, Earning and Cash flow	0.10	0.30	0.00
Machine and Equipment	0.08	0.27	0.00
More than two of the above categories	0.22	0.42	0.00

Table 4.17. Summary City Level Land Prices and Transactions

	# of cities	Mean	Std. Dev	25th	Median	75th
Industrial land price	214	548.52	189.34	252.34	454.23	798.28
Commercial land price	214	655.13	156.29	335.28	389.38	933.26
Financing volume collateralized by land	301	186531.12	389151.22	82634.77	288232.27	492342.76
# of industrial land transactions	289	113.54	89.23	22.15	42.45	89.32
# of pieces of industrial land purchases	289	84.78	79.27	9.28	31.49	56.78
Commercial mortgage issuance	251	34.39	45.33	3.39	14.52	59.89

Notes: The above table presents the summary statistics of city-level industrial land prices and transaction dynamics from 2002-2009. Financing volume collateralized by land is the total amount (in 10000 RMB) of loans that's collateralized by land in a city in a given year. # of industrial land transactions is the total number of sums of land transactions and # of pieces of land purchases are the total number of industrial land transacted during a year. Commercial mortgage issuance is the total number of sums of commercial mortgage transactions issued by local industrial firms.

Table 4.18. Real impact of domestic bank channeled foreign credit: easing period

	(1)	(2)	(3)	(4)
	Ln[1+amount]			
1[Easing]	0.185*** (0.0129)	0.0521*** (0.0104)	0.0631*** (0.00923)	0.0212*** (0.0134)
1[Easing]×1[Land]		0.111*** (0.0230)		0.0747*** (0.0219)
1[Easing]×1[Land]× 1[High commercial land price volatility city]				0.167*** (0.034)
1[Land]		0.0979** (0.0341)		0.0984** (0.0341)
1[Easing]×1[High commercial land price volatility city]			0.113*** (0.0240)	
1[High commercial land price volatility city]			0.340 (0.0480)	
Observations	23233	23233	23233	23233
Adjusted R^2	0.796	0.801	0.798	0.803
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
Firm-Bank FE	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The above table presents the regression results in equation 4.8. The dependent variable is the natural log of total loan amount of loans lent by a domestic local bank to its local relationship lender. 1[Easing] is an indicator variable that equals to 1 for years 2003-2007, 1[Land] is an indicator variable that equals to 1 if the loan is secured by land, properties and buildings. 1[High commercial land price volatility city] is an indicator variable that equals to 1 if the city's industrial land price decreased by more than 20% during the 2008-2009 compared with 2007.

Table 4.19. Real impact of domestic bank channeled foreign credit: easing period

	(1)	(2)	(3)	(4)
			Ln[1+amount]	
1[Tightening]	-0.371*** (0.0308)	-0.499*** (0.0321)	-0.155*** (0.0219)	-0.0923*** (0.0182)
1[Tightening]×1[Land]		-0.108*** (0.0368)		-0.103** (0.0382)
1[Tightening]×1[Land]× 1[High commercial land price volatility city]				-0.364*** (0.0317)
1[Land]		0.0590** (0.0224)		0.0589* (0.0322)
1[Tightening]×1[High commercial land price volatility city]			-0.237*** (0.0332)	
1[High commercial land price volatility city]			-0.105 (0.164)	
Observations	23233	23233	23233	23233
Adjusted R^2	0.797	0.802	0.798	0.811
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
Firm-Bank FE	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The above table presents the regression results in equation 4.8. The dependent variable is the natural log of total loan amount of loans lent by a domestic local bank to its local relationship lender. 1[Tightening] is an indicator variable that equals to 1 for years 2008-2009, 1[Land] is an indicator variable that equals to 1 if the loan is secured by land, properties and buildings. 1[High commercial land price volatility city] is an indicator variable that equals to 1 if the city's industrial land price decreased by more than 20% during the 2008-2009 compared with 2007.

Table 4.20. Real impact of domestic bank channeled foreign credit

	Ln[1+amount]			
	(1)	(2)	(3)	(4)
1[Easing]	0.134*** (0.0189)	0.0235*** (0.00501)	0.0442*** (0.00826)	0.0109*** (0.00202)
1[Easing]×1[Land]		0.128*** (0.0208)		0.0323*** (0.00421)
1[Easing]×1[Land]× 1[High commercial land price volatility city]				0.114*** (0.0222)
1[Land]		0.145 (0.0933)		0.138 (0.143)
1[Easing]×1[High commercial land price volatility city]			0.0928*** (0.0172)	
1[High commercial land price volatility city]			0.109 (0.126)	
Observations	9946	9946	9946	9946
Adjusted R^2	0.818	0.821	0.826	0.833
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
Firm-Bank FE	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The above table presents the regression results in equation 4.8. The dependent variable is the natural log of total loan amount of loans lent by a domestic local bank to its local relationship lender. 1[Easing] is an indicator variable that equals to 1 for years 2003-2007, 1[Land] is an indicator variable that equals to 1 if the loan is secured by land, properties and buildings. 1[High commercial land price volatility city] is an indicator variable that equals to 1 if the city's industrial land price decreased by more than 20% during the 2008-2009 compared with 2007.

Table 4.21. Real impact of domestic bank channeled foreign credit

	Ln[1+amount]			
	(1)	(2)	(3)	(4)
1[Tightening]	-0.405*** (0.0823)	-0.377*** (0.0802)	-0.163*** (0.0823)	-0.0982*** (0.0226)
1[Tightening] × 1[Land]		-0.0202 (0.0323)		-0.105*** (0.0235)
1[Tightening] × 1[Land] × 1[High commercial land price volatility city]				-0.353*** (0.0552)
1[Land]		0.186 (0.469)		0.169 (0.568)
1[Tightening] × 1[High commercial land price volatility city]			-0.413*** (0.0416)	
1[High commercial land price volatility city]			-0.203 (0.272)	
Observations	9946	9946	9946	9946
Adjusted R^2	0.809	0.811	0.818	0.822
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
Firm-Bank FE	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The above table presents the regression results in equation 4.8. The dependent variable is the natural log of total loan amount of loans lent by a domestic local bank to its local relationship lender. 1[Tightening] is an indicator variable that equals to 1 for years 2008-2009, 1[Land] is an indicator variable that equals to 1 if the loan is secured by land, properties and buildings. 1[High commercial land price volatility city] is an indicator variable that equals to 1 if the city's industrial land price decreased by more than 20% during the 2008-2009 compared with 2007.

Table 4.22. Real impact of domestic bank channeled foreign credit

	Ln[1+amount]			
	(1)	(2)	(3)	(4)
1[Easing]	0.149*** (0.0283)	0.0298*** (0.00612)	0.0388*** (0.00752)	0.0229*** (0.00308)
1[Easing]×1[High-tangibility]		0.143*** (0.0198)		0.0212*** (0.00403)
1[Easing]×1[High-tangibility]× 1[High commercial land price volatility city]				0.132*** (0.0234)
1[High-tangibility]		0.122 (0.106)		0.144 (0.152)
1[Easing]×1[High commercial land price volatility city]			0.0733*** (0.0135)	
1[High commercial land price volatility city]			0.118 (0.137)	
Observations	9946	9946	9946	9946
Adjusted R^2	0.722	0.725	0.794	0.799
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
Firm-Bank FE	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The above table presents the regression results in equation 4.8. The dependent variable is the natural log of total loan amount of loans lent by a domestic local bank to its local relationship lender. 1[Easing] is an indicator variable that equals to 1 for years 2003-2007, 1[Land] is an indicator variable that equals to 1 if the loan is secured by land, properties and buildings. 1[High commercial land price volatility city] is an indicator variable that equals to 1 if the city's industrial land price decreased by more than 20% during the 2008-2009 compared with 2007.

Table 4.23. Real impact of domestic bank channeled foreign credit

	(1)	(2)	(3)	(4)
	Ln[1+amount]			
1[Tightening]	-0.412*** (0.0593)	-0.381*** (0.0588)	-0.201*** (0.0502)	-0.121*** (0.0211)
1[Tightening]×1[High-tangibility]		-0.0332 (0.0405)		-0.129*** (0.0321)
1[Tightening]×1[High-tangibility]× 1[High commercial land price volatility city]				-0.369*** (0.0576)
1[High-tangibility]		0.202 (0.433)		0.177 (0.332)
1[Tightening]×1[High commercial land price volatility city]			-0.422*** (0.0602)	
1[High commercial land price volatility city]			-0.344 (0.498)	
Observations	9946	9946	9946	9946
Adjusted R^2	0.689	0.692	0.732	0.745
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
Firm-Bank FE	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The above table presents the regression results in equation 4.8. The dependent variable is the natural log of total loan amount of loans lent by a domestic local bank to its local relationship lender. 1[Tightening] is an indicator variable that equals to 1 for years 2008-2009, 1[Land] is an indicator variable that equals to 1 if the loan is secured by land, properties and buildings. 1[High commercial land price volatility city] is an indicator variable that equals to 1 if the city's industrial land price decreased by more than 20% during the 2008-2009 compared with 2007.

Table 4.24. Firms' Response I

	(1)	(2)	(3)	(4)	(5)
$\Delta \text{Tangibility}_{04-07}$					
% Domestic channeled foreign credit	0.0233*** (0.00617)	0.0229*** (0.00632)	0.0187*** (0.00522)	0.0192*** (0.00531)	0.0203*** (0.00503)
% Foreign credit/GDP	0.252*** (0.0502)	0.214*** (0.0423)	0.211*** (0.0402)	0.199*** (0.0398)	0.192*** (0.0359)
Observations	173118	173118	173118	173118	173118
R^2	0.0182	0.122	0.159	0.233	0.256
Province FE	✓	✓	✓	✓	✓
Baseline Controls		✓	✓	✓	✓
Industry FE			✓	✓	✓
Region FE				✓	✓
Export exposure				✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table presents regression analysis of firm asset tangibility adjustment behavior shown in equation 4.9. The left-hand side variable is the change in asset tangibility between 2004 and 2007 at firm level, and is calculated as $\frac{PPE_{2007}}{\text{Assets}_{2006}} - \frac{PPE_{2004}}{\text{Assets}_{2003}}$. The main explanatory variable on the right-hand side is the fraction of total foreign-currency denominated loans to local firms made by local domestic banks at the city level. Provincial fixed effects is controlled in column (1), column (2) add baseline controls which include GDP per capita, foreign-owned industrial firms output/GDP, industrial sector labor share, financial sector labor share and total construction land areas. Industry fixed effects are added in column (3), and region fixed effects are added in column (4). Finally, in the column (5), we explicitly control further for firms' and cities' export exposure by including the local industrial firms' total exporting goods value/total goods value and fraction of industrial firms that are exporters in the city. Standard errors are clustered at the city level.

Table 4.25. Firms' Response II

	(1)	(2)	(3)	(4)	(5)
	Δ Total Debt ₀₄₋₀₇				
% Domestic channeled foreign credit	0.0288* (0.00962)	0.0288*** (0.00822)	0.0402*** (0.0876)	0.0353** (0.0855)	0.0376*** (0.0823)
% Foreign credit/GDP	0.129** (0.0469)	0.133** (0.0483)	0.132** (0.0455)	0.163*** (0.0421)	0.154*** (0.0478)
Observations	173118	173118	173118	173118	173118
R^2	0.0499	0.103	0.154	0.188	0.233
Province FE	✓	✓	✓	✓	✓
Baseline Controls		✓	✓	✓	✓
Industry FE			✓	✓	✓
Region FE				✓	✓
Export exposure				✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table presents regression analysis of firm asset tangibility adjustment behavior shown in equation 4.9. The left-hand side variable is the change in total current debt between 2004 and 2007 at firm level, and is calculated as $\frac{\text{Total Current Debt}_{2007} - \text{Total Current Debt}_{2004}}{\text{Assets}_{2006}}$. The main explanatory variable on the right-hand side is the fraction of total foreign-currency denominated loans to local firms made by local domestic banks at the city level. Provincial fixed effects is controlled in column (1), column (2) add baseline controls which include GDP per capita, foreign-owned industrial firms output/GDP, industrial sector labor share, financial sector labor share and total construction land areas. Industry fixed effects are added in column (3), and region fixed effects are added in column (4). Finally, in the column (5), we explicitly control further for firms' and cities' export exposure by including the local industrial firms' total exporting goods value/total goods value and fraction of industrial firms that are exporters in the city. Standard errors are clustered at the city level.

Table 4.26. Firms' Response III

	(1)	(2)	(3)	(4)	(5)
Δ Fixed Asset Investment ₀₄₋₀₇					
% Domestic channeled foreign credit	0.0275*** (0.00622)	0.0289*** (0.00643)	0.0332*** (0.00651)	0.0343*** (0.00633)	0.0298*** (0.00653)
% Foreign credit/GDP	0.0508*** (0.0123)	0.0455*** (0.0114)	0.0429*** (0.0112)	0.0403*** (0.0102)	0.0412*** (0.0114)
Observations	173118	173118	173118	173118	173118
R^2	0.0823	0.113	0.175	0.211	0.232
Province FE	✓	✓	✓	✓	✓
Baseline Controls		✓	✓	✓	✓
Industry FE			✓	✓	✓
Region FE				✓	✓
Export exposure				✓	✓

Standard errors in parentheses

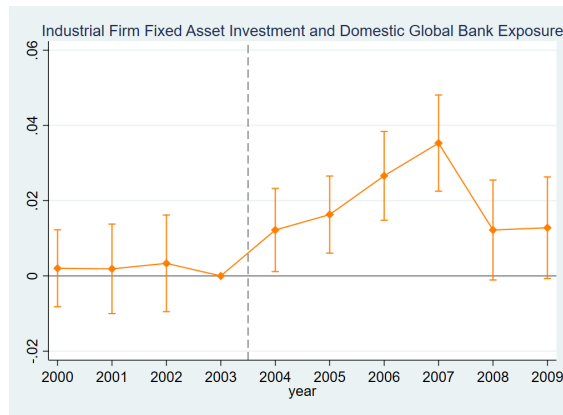
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table presents regression analysis of firm asset tangibility adjustment behavior shown in equation 4.9. The left-hand side variable is the increase in total fixed-asset investment between 2004 and 2007 at firm level, and is calculated as $\frac{\text{Total fixed investment between 2004-2007}}{\text{Assets}_{2003}}$. The main explanatory variable on the right-hand side is the fraction of total foreign-currency denominated loans to local firms made by local domestic banks at the city level. Provincial fixed effects is controlled in column (1), column (2) add baseline controls which include GDP per capita, foreign-owned industrial firms output/GDP, industrial sector labor share, financial sector labor share and total construction land areas. Industry fixed effects are added in column (3), and region fixed effects are added in column (4). Finally, in the column (5), we explicitly control further for firms' and cities' export exposure by including the local industrial firms' total exporting goods value/total goods value and fraction of industrial firms that are exporters in the city. Standard errors are clustered at the city level.

Fig. 4.15. Firm Behavior and Pre-Cycle Exposure to BOC



(a) Local firm Tangibility and BOC exposure (b) Firm Total Debt Growth and BOC Exposure



(c) Firm Fixed Assets Investment and BOC Exposure

The figures above show the coefficient estimates of the following regression equation at the firm level with different corresponding left-hand side variables:

$$y_{i,c,t} = \alpha_c + \mu_s + \sum_{t=1999, s \neq 2003}^{2009} \beta_s \text{BOC}^{pre} \mathbf{1}[s = t] + \theta \left(\frac{\text{Total FX credit}}{\text{GDP}} \right)_{c,t} + \gamma \mathbf{X}_{c,t} + \epsilon_{c,t}$$

In Panel (a), the left-hand side variable is the firm-level PPE/Assets(t-1); in panel (b), the left-hand side variable is firm-level Total current debt/Assets(t-1); in panel (c), the left-hand side variable is firm-level total fixed-asset investment/Assets(t-1). baseline controls which include GDP per capita, foreign-owned industrial firms output/GDP, industrial sector labor share, financial sector labor share and total construction land areas. Standard errors are clustered at the city level.

Table 4.27. Local Commercial and Industrial Land Prices:tightening phase

	ΔLocal Commercial property price		ΔLocal Industrial land price	
	OLS	IV	OLS	IV
(Domestic share of local foreign credit)	-0.0303** (0.00802)	-0.0503*** (0.00877)	-0.0233** (0.00642)	-0.0362** (0.0125)
Foreign credit/ Total credit	-0.00923* (0.00442)	-0.00762 (0.00653)	-0.0132 (0.0175)	-0.0105 (0.0154)
Observations	214	214	214	214
Adjusted R^2	0.115	0.113	0.0923	0.106
Province FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
City controls	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The above table presents the regression results of equation 4.11 in the tightening episode 2008-2009. The left-hand side variables are the changes in local commercial and industrial land prices during the tightening period and are defined as $\Delta(P_{2008-2009}^{\text{land}})_c$ are defined as $\frac{\text{Ave. } P_{2008-2009}^{\text{land}} - P_{2007}^{\text{land}}}{P_{2007}^{\text{land}}}$. The main explanatory variable is the share of foreign-currency denominated loans lent by local domestic banks during the 2003-2007 period. Column (1) and (3) are baseline regressions including province and city fixed effects and baseline controls including DP per capita, foreign-owned industrial firms output/GDP, industrial sector labor share, financial sector labor share and total construction land areas. Column (2) and (4) are 2SLS regressions using the city's pre-cycle BOC lending market share as instrumental variable.

Table 4.28. Local Commercial and Industrial Land Prices Easing phase

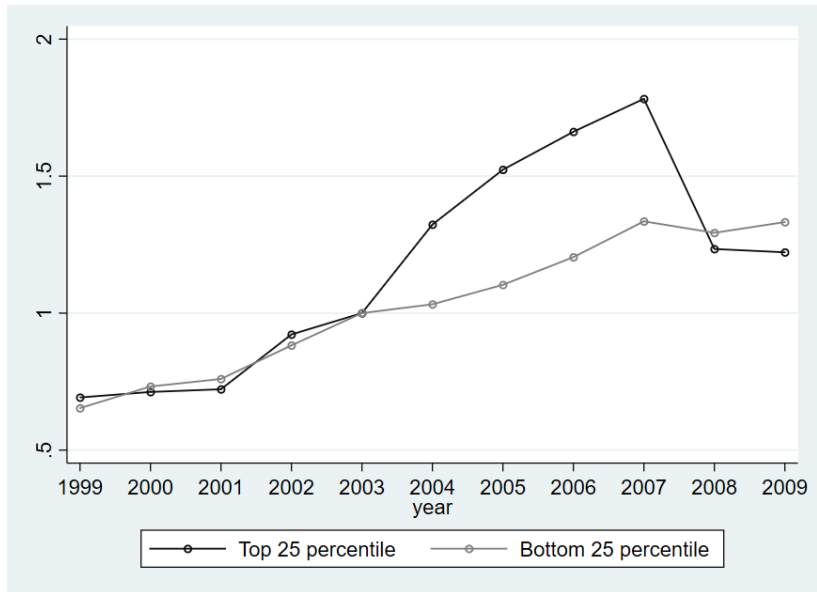
	ΔLocal Commercial land price		ΔLocal Industrial land price	
	OLS	IV	OLS	IV
(Domestic share of local foreign credit)	0.0676** (0.0288)	0.0529** (0.0166)	0.0458** (0.0166)	0.0449** (0.0161)
Foreign credit/Total credit	0.00729* (0.00323)	0.00664** (0.00262)	0.0221** (0.00742)	0.0187** (0.00659)
Observations	214	214	214	214
Adjusted R^2	0.0832	0.0917	0.0744	0.826
Province FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Baseline controls	Yes	Yes	Yes	Yes

Standard errors in parentheses

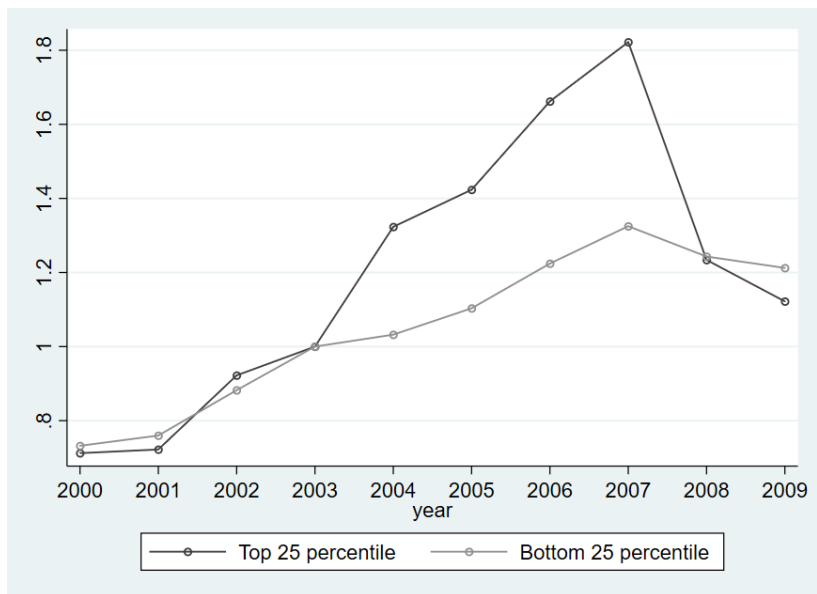
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The above table presents the regression results of equation 4.11 in the easing episode 2003-2007. The left-hand side variables are the changes in local commercial and industrial land prices during the tightening period and are defined as $\Delta(P_{2003-2007}^{\text{land}})$, c are defined as $\frac{P_{2007}^{\text{land}} - P_{2003}^{\text{land}}}{P_{2003}^{\text{land}}}$. The main explanatory variable is the share of foreign-currency denominated loans lent by local domestic banks during the 2003-2007 period. Column (1) and (3) are baseline regressions including province and city fixed effects and baseline controls including DP per capita, foreign-owned industrial firms output/GDP, industrial sector labor share, financial sector labor share and total construction land areas. Column (2) and (4) are 2SLS regressions using the city's pre-cycle BOC lending market share as instrumental variable.

Fig. 4.16. City-level Industrial Land Transaction Dynamics and Exposure to Domestic Global Bank

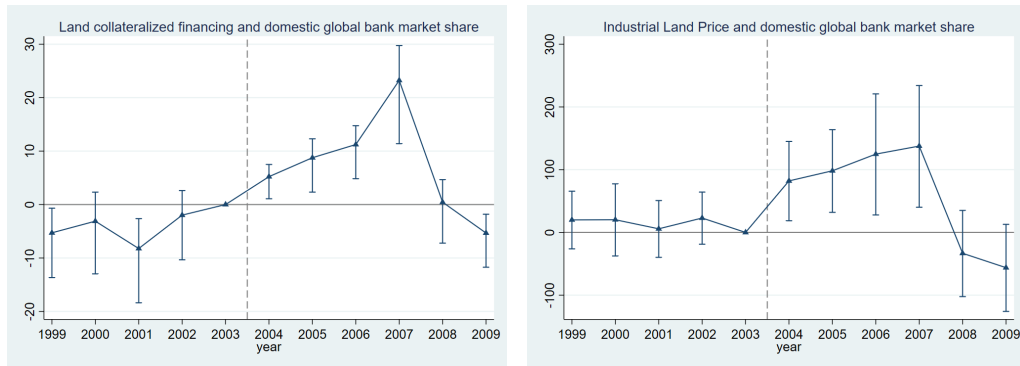


(a) Financing Collateralized by Land and Domestic Global Bank Exposure

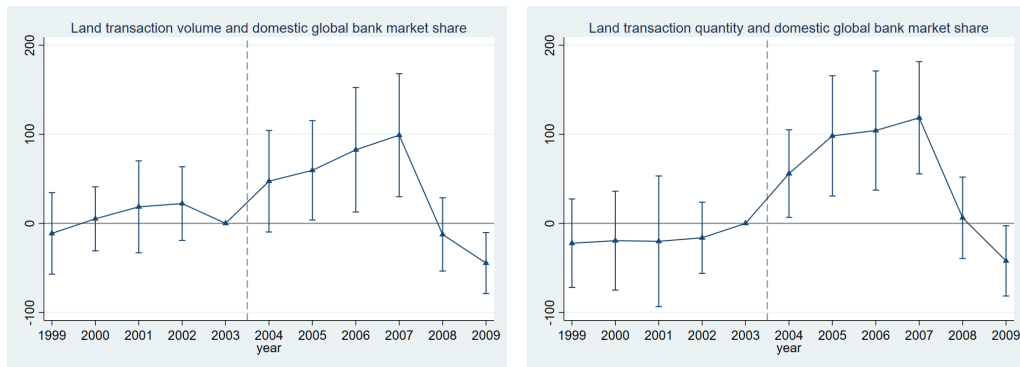


(b) Industrial Land Price and Domestic Global Bank Exposure

Fig. 4.17. City-level Industrial Land Transaction Dynamics and Exposure to Domestic Global Bank: Loan Market Share

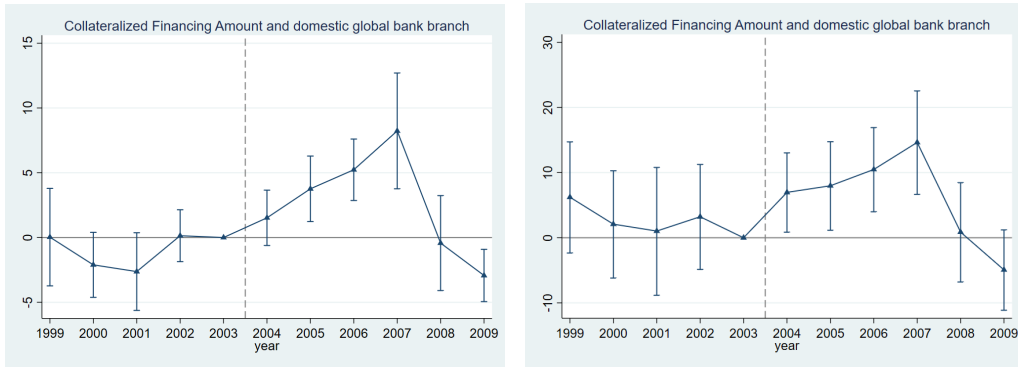


(a) Financing Collateralized by Land and Domestic Global Bank Exposure (b) Industrial Land Price and Domestic Global Bank Exposure

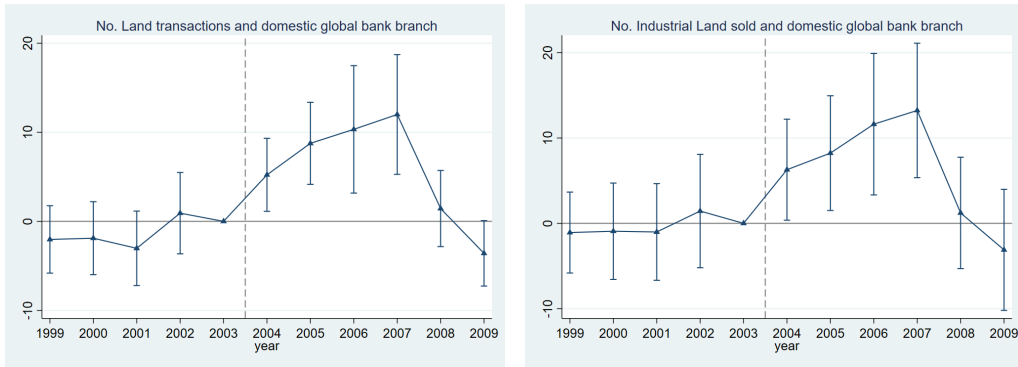


(c) NO. Sums of Industrial Land Transaction and Domestic Global Bank Exposure (d) NO. Pieces of Industrial Land Purchases and Domestic Global Bank Exposure

Fig. 4.18. City-level Industrial Land Transaction Dynamics and Exposure to Domestic Global Bank: BOC branching intensity



(a) Financing Collateralized by Land and Domestic Global Bank Exposure (b) Industrial Land Price and Domestic Global Bank Exposure



(c) NO. Sums of Industrial Land Transaction and Domestic Global Bank Exposure (d) NO. Pieces of Industrial Land Purchases and Domestic Global Bank Exposure

Table 4.29. Comparing pre-cycle city-level characteristics

	Mean(High)	Mean(Low)	Diff.	Std. Error	Obs.
Population	419.33	409.33	-10.00	36.41	316
Unemployment rate	0.06	0.06	0.00	0.01	316
Agriculture labor share	0.04	0.06	0.02	0.01	316
Manufacturing labor share	0.28	0.24	-0.03	0.02	316
Construction labor share	0.07	0.06	-0.01*	0.01	316
Real estate labor share	0.01	0.01	0.00	0.00	316
Financial labor share	0.03	0.03	-0.00	0.00	316
Commercial labor share	0.08	0.08	0.00	0.00	316
Land resource	13257.41	14951.04	1693.63	1574.28	316
Arable land p/c	1.14	1.28	0.14	0.13	316
Agriculture value to GDP	17.92	22.07	4.15*	2.04	316
Industrial value to GDP	44.96	42.25	-0.70	1.38	316
Service value to GDP	37.12	35.68	-1.45	0.93	316
no. Industrial firms	632.44	670.57	38.13	47.93	316
Value added domestic firm	0.64	0.56	-0.07*	0.04	316
Value added foreign firm	0.08	0.04	-0.04	0.03	316
Fixed investment/GDP	0.27	0.26	-0.01	0.03	316
FDI/GDP	0.02	0.02	-0.01	0.01	316
no. FDI contracts	137.43	56.26	-81.17***	31.25	316
Transport capacity	5965.99	5160.05	-805.93	801.24	316

The above table shows the summary statistics at of city-level characteristic variables during 2003-2007. The data are collected from City Statistical Yearbook of China from 2003-2007, CEIC and city-level statistical yearbook. Real GDP is reported in 10,000 RMB, Arable Land per capita is reported in acre/person, city land area is reported in km^2 , construction sector labor force, financial sector labor force, industrial sector labor force and unemployed are reported in 10,000 persons; industrial output, industrial output (foreign-funded) and fixed asset investment are reported in 10,000 RMB. FDI contract value and actual FDI are reported in 10,000 USD. GDP per capita is reported in RMB per person and Real GDP growth is the average annual growth rate between 2003-2007, reported in percentage. Passenger transportation capacity is reported in 10,000 persons.

Table 4.30. Comparing pre-cycle firm characteristics

	Mean(High)	Mean(Low)	Diff.	Std. Error	Obs.
Total assets	9.7257	9.5822	-0.1435	0.9753	166270
Age	10.9163	11.2753	0.3590	0.4621	167279
Employees	309.7672	292.1175	-17.6498*	8.7385	167279
Current debt	0.5246	0.4998	-0.0248	0.0318	166270
Long-term debt	0.0669	0.0925	0.0256	0.0319	166270
ROA	0.0612	0.0666	0.0053	0.0060	166270
Value-added	8.6086	8.4585	-0.1502	0.2102	163134
Tangibility	0.3397	0.3679	0.0282	0.0214	166270
Cash flow	9.0176	8.8041	-0.2135*	0.1178	166030
Labor productivity	-2.7713	-2.6937	0.0777	0.0532	162917
Investment rate	0.0120	0.0131	0.0011	0.0008	166270
Wage bill	7.0547	6.8445	-0.2102**	0.0671	165987

The above table shows the summary statistics at of city-level characteristic variables during 2003-2007. The data are collected from City Statistical Yearbook of China from 2003-2007, CEIC and city-level statistical yearbook. Real GDP is reported in 10,000 RMB, Arable Land per capita is reported in acre/person, city land area is reported in km^2 , construction sector labor force, financial sector labor force, industrial sector labor force and unemployed are reported in 10,000 persons; industrial output, industrial output (foreign-funded) and fixed asset investment are reported in 10,000 RMB. FDI contract value and actual FDI are reported in 10,000 USD. GDP per capita is reported in RMB per person and Real GDP growth is the average annual growth rate between 2003-2007, reported in percentage. Passenger transportation capacity is reported in 10,000 persons.

Table 4.31. BOC Branch Intensity and Local characteristics

Panel A: Local Basic Economic Conditions				
	GDP growth	GDP/pc	Transportation capacity	Arable land
	(1)	(2)	(3)	(5)
Branching	-0.392 (0.664)	3.979* (1.929)	-0.00635 (0.101)	11.643 (14.802)
Observations	306	306	306	306
Province FE	✓	✓	✓	✓
Panel B: Local Labor Conditions				
	Industrial	Financial	Real estate	Service
	(1)	(2)	(3)	(4)
Branching	0.0421 (0.0226)	0.00112 (0.00231)	0.00434 (0.00127)	0.00161 (0.00157)
Observations	306	306	306	306
Province FE	✓	✓	✓	✓
Panel C: FDI and Export Exposure				
	FDI/GDP	% of exporter	%Foreign owned	Foreign-owned output/GDP
	(1)	(2)	(3)	(4)
Branching	0.00239 (0.00131)	0.123 (0.0725)	0.0233 (0.0183)	0.00160* (0.000709)
Observations	306	306	306	306
Province FE	✓	✓	✓	✓
	Export/GDP			
	(5)			
Branching	0.00439 (0.00345)			
Observations	306			
Province FE	✓			

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table presents the regression results of equation 4.5, where the right-hand side variable is BOC's branch intensity and the left-hand side variables are divided into three categories. In Panel (A), GDP growth is the real GDP growth rate, GDP/pc is the GDP per capita, Transportation capacity is the total volume of passengers the city's transportation system carried over a year, the unit of observation is 0.1 million; Construction land is the total area (in square of kilometers) of construction stock in the city; the total arable land is the total area (in acres) of arable land in the outskirts of the city. Panel (B) shows the correlation between local labor market condition and pre-cycle BOC branching intensity. "Industrial", "Financial", "Real Estate" and "Service" refer to the share of labor force employed in the four sectors respectively, and unemployment is the unemployment rate. Panel (C) shows the correlation between the city's export and FDI exposure with the pre-cycle BOC exposure. FDI/GDP is the total dollar amount of FDI scaled by local GDP, % of exporter is the share of local industrial firms that are exporters; % foreign owned is the share of local industrial firms that have foreign ownership; Foreign-owned output/GDP and Export/GDP are the total value of output produced by foreign-owned industrial firms and exporting industrial firms scaled by GDP. All regressions are included with province-level fixed effects.

Table 4.32. BOC Market share and Local characteristics

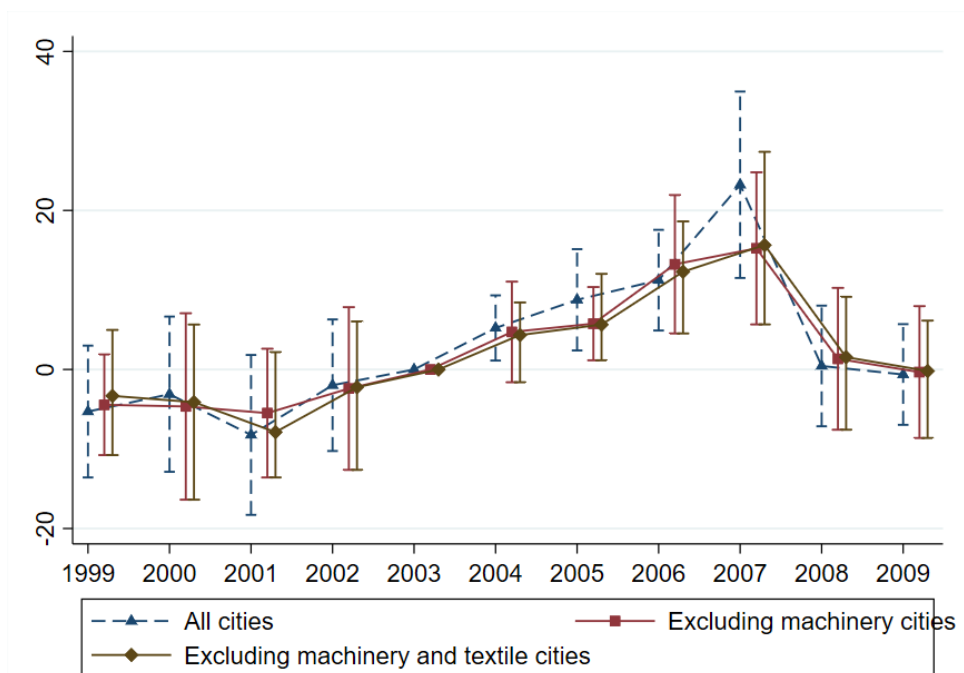
Panel A: Local Basic Economic Conditions				
	GDP growth	GDP/pc	transportation_capacity	Arable land
	(1)	(2)	(3)	(4)
Market share	0.817 (3.382)	30.28* (15.709)	0.592 (0.511)	12.672 (7.495)
Observations	306	306	306	306
Province FE	✓	✓	✓	✓
Panel B: Local Labor Conditions				
	Industrial	Financial	Real estate	Service
	(1)	(2)	(3)	(4)
Market share	0.0259 (0.175)	0.0100 (0.0117)	0.00233 (0.00649)	0.00287 (0.00365)
Observations	306	306	306	306
Province FE	✓	✓	✓	✓
Panel C: Local FDI and Export Exposure				
	FDI/GDP	% of exporter	%Foreign owned	Foreign-owned output/GDP
	(1)	(2)	(3)	(4)
Market share	0.00527 (0.00670)	0.0785 (0.0397)	0.0145 (0.0144)	0.00585 (0.00363)
Observations	306	306	306	306
Province FE	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table presents the regression results of equation 4-5, where the right-hand side variable is BOC's lending market share at the city level and the left-hand side variables are divided into three categories. In Panel (A), GDP growth is the real GDP growth rate, GDP/pc is the GDP per capita, Transportation capacity is the total volume of passengers the city's transportation system carried over a year, the unit of observation is 0.1 million; Construction land is the total area (in square of kilometers) of construction stock in the city; the total arable land is the total area (in acres) of arable land in the outskirts of the city. Panel (B) shows the correlation between local labor market condition and pre-cycle BOC lending market share. "Industrial", "Financial", "Real Estate" and "Service" refer to the share of labor force employed in the four sectors respectively, and unemployment is the unemployment rate. Panel (C) shows the correlation between the city's export and FDI exposure with the pre-cycle BOC exposure. FDI/GDP is the total dollar amount of FDI scaled by local GDP, % of exporter is the share of local industrial firms that are exporters; % foreign owned is the share of local industrial firms that have foreign ownership; Foreign-owned output/GDP and Export/GDP are the total value of output produced by foreign-owned industrial firms and exporting industrial firms scaled by GDP. All regressions are included with province-level fixed effects.

Fig. 4.19. Land Collateralized Credit and BOC exposure: Robustness



Notes: The above figure shows demonstrate the correlation between a city’s pre-cycle exposure to BOC and the city’s land-collateralized credit expansion over the financial cycle. The figure aims to provide robustness checks of whether land-collateralized credit expansion was driven by the city’s exporting firms. According to Berger and Martin (2011), China’s export during the 2000s was concentrated primarily at two categories of industries, one is machinery (HS categories 84 and 85), and the other is textile/apparel (HS categories 42, 51, 52, 58, 60, 61, 62, 63, 64). The dashed blue line is the same line as in the panel (a) of Figure 4.17. The red line plots the same coefficient estimates for cities with machinery output value-added being more than 12.2% of total industrial output value added (top 15-th percentile of cities with the highest machinery output value-added, a total of 36 cities). The olive solid line shows the coefficient estimates of cities excluding the machinery export intensive cities and the textile export intensive cities (top 15-th percentile of cities with the highest textile and apparel output value-added, a total of 18 more cities).

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