Journal of Monetary Economics 94 (2018) 27–40

Contents lists available at ScienceDirect

Journal of Monetary Economics

journal homepage: www.elsevier.com/locate/jmoneco

Credit expansion and credit misallocation☆

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A R T I C L E   I N F O

Article history:
Received 28 April 2014
Revised 25 September 2017
Accepted 27 September 2017
Available online 29 September 2017

JEL classification:
G01
G21
G33
E58

Keywords:
Corporate liquidity
Collateral values
Asset specificity
Speculation
Financial intermediaries

A B S T R A C T

We develop a general equilibrium model to analyze the interaction between two sectors with differing degree of financial friction in the context of liquidity injections (credit expansion). We show that excessive liquidity injection can overheat the sector with lower friction, crowding liquidity out of the sector with higher friction. The crowding-out manifests in a self-reinforcing spiral because of feedback between liquidity inflows, asset prices, and collateral values. The paper highlights the effect of financial frictions on the allocation and distribution of liquidity in an economy, demonstrating misallocation of liquidity (credit) under excessive liquidity injection.

1. Introduction

Misallocation of credit (or capital) can be a critical reason for underperformance of the aggregate economy (Hsieh and Klenow, 2009; Restuccia and Rogerson, 2008). Importantly, misallocation of credit is often particularly severe following large-scale capital inflows or credit expansion for an economy. For example, the financial integration in the EU since the late 1990s led to massive foreign credit pouring into the EU's peripheral countries. The capital inflow, however, resulted in relatively unproductive firms in the nontradables sector expanding at the expense of more productive tradables firms (see Reis, 2013). In the same spirit, in response to the 2007–2009 global financial crisis, the Chinese government implemented some aggressive credit expansion policies in an attempt to save the real economy from recession. The result, however, was a surge in real estate prices while small and medium-sized businesses in the real economy had an even harder time obtaining corporate liquidity. Notably, the mortgage-asset bubble that crowded out commercial loans and triggered the 2007–2009

☆ We are grateful to the editor, Ricardo Reis, and three referees for their detailed comments and suggestions. We thank David Cook, Liang Dai, Sudipto Dasgupta, Giovanni Dell'Ariccia, Itay Goldstein, Xiuping Hua, Shiyang Huang, Mark Loewenstein, Yang Lu, Abhiroop Mukherjee, Hernan Ortiz-Molina, Raghuram Rajan, Daniel Sanches, Hyun Song Shin, Zhongzhi Song, Jeremy Stein, Ercos Valdivieso, Larry Wall, Tianxi Wang, Yong Wang, Jenny Xu, and seminar participants at the FIRS conference, WFA meetings, EFA meetings, CICF conference, Bank of Canada conference on "Collateral, Liquidity, and Central Bank Operations", the Macro-Finance Workshop at SJTU, Federal Reserve Bank of Atlanta conference on "The Impact of Extraordinary Monetary Policy on the Financial Sector" and their 2017 Annual Financial Markets Conference, Chicago Booth, HKU, and HKUST for helpful comments and discussion.

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https://doi.org/10.1016/j.jmoneco.2017.09.012
0304-3932/

crisis in the U.S. was also rooted in an environment of massive liquidity injections (see the evidence in Chakraborty et al., 2013).[1]

We present a new channel for misallocation across sectors, arising from the interaction of capital inflows with differing degree of credit friction across sectors. In the model, financial intermediaries (“banks”) lend to entrepreneurs, but due to the financial contracting friction can only lend to them up to the value of their collateral. Hence, lending is limited. The value of the collateral, given by the asset re-sale value in the secondary market, is in turn endogenously determined by the economic activity, which depends on the amount that is lent to entrepreneurs and invested by them. When the government conducts credit expansion by injecting liquid funds into the banking system, this stimulus can ignite a self-reinforcing cycle: the liquidity injection increases lending, which increases investment, which increases collateral prices, which then enables more lending and investment, and so on. In other words, there is a feedback loop between bank lending, secondary-market asset prices, and collateral values.

We then introduce into the economy two sectors, Sectors 1 and 2, with differing degree of financial friction in secondary-market trading. Specifically, the two sectors differ in asset specificity (Williamson, 1985), which determines margin financing (i.e., asset leverage) in the secondary market. Lower asset specificity enables higher asset leverage. Hence, the difference in financial friction, which originates in asset specificity, results in heterogeneity in secondary-market trading activities across sectors. This heterogeneity causes collateral prices to respond asymmetrically to liquidity injections across the two sectors. The price in the sector with lower asset specificity (Sector 2 in our model) responds more strongly to liquidity injections than that in the sector with higher asset specificity (i.e., Sector 1).

This asymmetry across sectors creates a ‘crowding-out’ effect. If too much liquidity is injected into the economy, the asset price and thus the collateral value in Sector 2 can increase so fast that it leads to a rise in the real interest rate in the economy. This occurs because when the collateral value increases, more entrepreneurs qualify for borrowing and thus more of them compete for loans, driving up the interest rate. With the collateral value in Sector 1 not responding much, the higher interest rate in the economy drives down the “discounted” value of the collateral in that sector, crowding out liquidity of Sector 1. The crowding-out manifests in a self-reinforcing spiral as more liquidity entering Sector 2 drives up the interest rate, which leads to additional liquidity leaving Sector 1 (for Sector 2), driving up the interest rate further, and so on. In short, injecting too much liquidity into the economy actually reduces the amount of liquidity entering Sector 1. If, on the other hand, too little liquidity is injected, Sector 1 of course cannot obtain much liquidity. As a result, we show that there exists an optimal level of liquidity injection for the government.

Our paper highlights the effect of financial frictions on the allocation and distribution of liquidity in the economy. In the two-sector economy setting, we show not only that liquidity tends to move to the sector with lower friction (i.e., the allocation effect) but also that the sector with lower friction can suck liquidity out of the other sector (i.e., the crowding-out effect).[2]

There is a large literature on financial frictions, and our paper follows the seminal work of Kiyotaki and Moore (1997).[3] The innovation is that we consider multiple sectors with varying degrees of asset specificity. In this literature, Benmelech and Bergman (2012) build a novel framework for studying the interplay between financing frictions, liquidity, and collateral values. The authors show that the credit easing policy sometimes does not work because additional liquidity injections may not raise firm asset collateral values and thus credit traps can form. Additional liquidity injections in their model are ineffective but harmless to the economy. Our paper adds to this literature in two ways. First, we study the distribution of liquidity in a two-sector economy, and demonstrate the danger of excessive liquidity injections (beyond inflation): excessive liquidity actually hurts the aggregate economy because it causes misallocation of liquidity across sectors. Second, we provide a new micro-foundation for the effect of liquidity injections on asset prices.

Our paper is related to the growing literature on unconventional credit policies.[4] As Gertler and Kiyotaki (2010) write, “Since these policies are relatively new, much of the existing literature is silent about them.” In the comments on Reis’ (2009) paper,[5] Besley (2009) notes that “it is possible for central banks to distort the allocation of credit, causing excess credit creation in some areas. Thus, it is important to consider the sectoral credit impact as well as the aggregate effects.” Our research addresses this gap by studying a credit policy model with two sectors and showing cross-sectoral distortions under excess credit creation.

The paper is organized as follows. Section 2 lays out the model setup. Section 3 presents the one-sector economy equilibrium. Section 4 studies the two-sector economy. Section 5 examines the robustness of the model. Section 6 discusses related empirical evidence. Section 7 concludes.

[1] In fact, in response to the bursting of the Internet bubble in early 2000, the Federal Reserve Bank had adopted a policy of unprecedented credit easing for a prolonged period between 2001 and 2005.

[2] Tirole (1985) and Farhi and Tirole (2012) show that bubbles in unproductive assets can crowd out investments in unrelated real assets. In contrast, in our paper, overheating occurs in the productive investment of a less frictioned sector, crowding out investment in a sector with higher friction. See also Miao and Wang (2014, 2015).

[3] Brunnermeier (2013) provide an excellent recent survey. Another related literature links corporate finance and macroeconomics (e.g., Acharya and Naqvi, 2012; Acharya and Viswanathan, 2011; Allen and Gale, 2000; Chen and Song, 2013; Diamond and Rajan, 2006; Shleifer and Vishny, 2010a; 2010b).

[4] See, e.g., Gertler and Karadi (2011); Gertler and Kiyotaki (2010); Reis (2009); Stein (2012).

[5] Reis (2009) presents a credit policy model suggesting that providing credit to traders in securities markets can be an effective way of intervention.

2. Model setup

Consider an economy with two sectors, Sector 1 and Sector 2. The two sectors differ in asset specificity, which we will elaborate on. Each sector consists of a continuum of self-employed entrepreneur-households of measure one (as in Mendoza, 2010). For ease of exposition, we do not distinguish between the two sectors until Section 4. In the economy, there is also a set of competitive financial intermediaries ("banks") that supply capital to entrepreneurs, and a government (or policymaker). The model has three dates: T_0, T_1 and T_2. There is no time discount between dates.

2.1. Entrepreneurs

Each entrepreneur has an asset in place at T_0 — an identical investment project across all entrepreneurs. Entrepreneurs undertook their project before T_0, which is expected to generate a constant cash flow C at T_1 and a stochastic cash flow $\widetilde{x}$ at T_2, where $\widetilde{x}$ has one of two realizations, $\widetilde{x} \in \{u, d\}$, and $u > d > 0$.

Only a part of the project's cash flow is pledgeable. More specifically, the cash flow C is non-pledgeable while a part of the cash flow $\widetilde{x}$ is pledgeable. The pledgeable part of $\widetilde{x}$ is a constant amount X, where $0 \leq X \leq d$; the remaining part $\widetilde{x} - X$ is non-pledgeable. As is standard in the financial contracting literature (e.g., Hart and Moore, 1998; Tirole, 2010), the interpretation is the following.

The project's cash flow is unverifiable and hence uncontractible. In the event that the owner of a project defaults at T_2, outside investors (i.e., debt-holders) obtain and exercise the control right over the asset; outside investors can only recover a cash flow X when they seize and operate the asset at T_2 due to asset specificity. That is, the term X measures asset specificity. The term X equivalently measures firm asset pledgeablity or collateralizability at T_2 (Williamson, 1988).

2.2. Liquidity shock

The economy (entrepreneurs) suffers an unexpected aggregate liquidity shock at T_0 (as in the business cycle literature, e.g., Kiyotaki and Moore, 1997). That is, an entrepreneur has to invest an additional amount I at T_0 to enable his project to deliver the cash flow C, where $I < C$; otherwise his project will not deliver a cash flow at T_1. Delivery of cash flow $\widetilde{x}$, however, will not be affected by the shock.

Entrepreneurs differ in their internal capital at T_0. Suppose that the amount of internal capital that an entrepreneur has at T_0 is A, which means that the entrepreneur needs an amount of external capital, $B \equiv I - A$, to be able to make his liquidity investment. We assume that B has a probability distribution (pdf), $f(B)$, across entrepreneurs, within support [0, I]. Let $F(\cdot)$ denote the cumulative distribution function (cdf) of $f(\cdot)$. Clearly, giving the distribution of B is equivalent to giving the distribution of A.

Faced with limited internal capital, entrepreneurs seek to raise external capital by borrowing from banks. The borrowing (debt) is short-term, that is, an entrepreneur needs to repay his debt at T_1. We will show that long-term debt with maturity T_2 is not optimal or feasible. Entrepreneurs who do not make the liquidity investment can deposit their spare internal capital in banks at T_0.

It is common knowledge that entrepreneurs will have diverging (heterogeneous) beliefs at T_1. For simplicity, we assume that there are two types of beliefs at T_1: high beliefs and low beliefs. High beliefs correspond to $\Pr[\widetilde{x} = u] = \theta_H$ and low beliefs to $\Pr[\widetilde{x} = u] = \theta_L$, where $\theta_H > \theta_L$. Ex ante, before T_1, the probability of developing high beliefs for an entrepreneur is π. We also denote the true probability of realizing u of $\widetilde{x}$ by θ.

There is a secondary asset market at T_1, where entrepreneurs with heterogeneous beliefs trade their assets.[6] As in Geanakoplos (2010), short-selling is not allowed in the secondary market. In reality, short-selling is either impossible or with constraints.

2.3. Banks

There is a large number of competitive financial intermediaries, simply called "banks", that make loans to entrepreneurs. Denote the net interest rate of bank loans by r. As the cash flow C of an entrepreneur's project is not contractible, the only means to force an entrepreneur to repay is to contract the entrepreneur's asset (project) as collateral. If the entrepreneur does not repay, the bank can threaten to liquidate the entrepreneur's project to sell in the secondary market at T_1. We denote by P the market price of the asset (project) in the secondary market. If an entrepreneur has the full bargaining power in renegotiating with his bank, then an entrepreneur will never be able to credibly commit to repaying more than P at T_1 (see Hart and Moore, 1994). Therefore, the collateral value of an entrepreneur's asset at T_1 is P.[7] Both P and r will be endogenized.

[6] We assume that projects are not "mature" enough at T_0 and thus entrepreneurs' assets cannot be traded at T_0 due to the inalienability of human capital (Hart and Moore, 1994).

[7] We will show that $P > X$, so the long-term debt with maturity at T_2 is not optimal or feasible for some entrepreneurs since they can raise less external financing by using long-term debt than by using short-term debt. If the support of B is assumed to be [X, I], long-term debt becomes infeasible for all entrepreneurs.

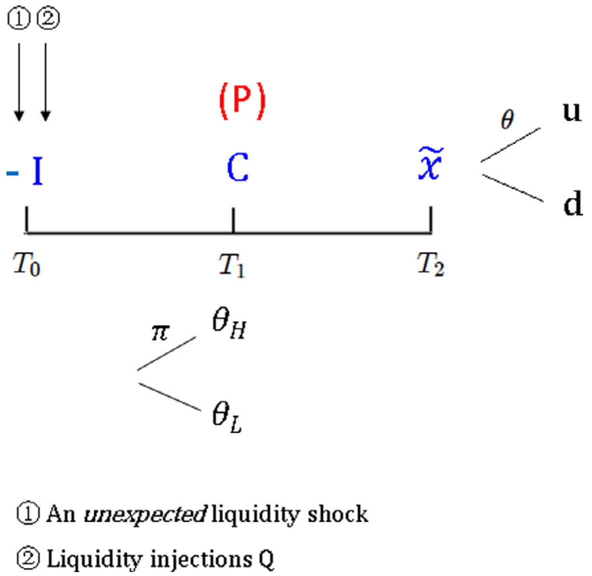

Fig. 1. Main setup of the model. Note: A project was expected to generate a constant cash flow C at T_1 and a stochastic cash flow $\tilde{x}$ at T_2, where $\tilde{x} \in u, d$ and u>d>0. The economy suffers an unexpected aggregate liquidity shock at T_0. An additional amount I at is needed to deliver the cash flow C, where I<C; otherwise zero cash flow at T_1 will be delivered. Delivery of cash flow $\tilde{x}$ will not be affected by the shock. It is common knowledge that entrepreneurs will have heterogeneous beliefs at T_1: High beliefs correspond to $\Pr[\tilde{x} = u] = \theta_H$ and low beliefs to $\Pr[\tilde{x} = u] = \theta_L$, where $\theta_H > \theta_L$. Ex ante, before T_1, the probability of developing high beliefs for an entrepreneur is π. Also denote the true probability of realizing u of $\tilde{x}$ by θ. The project's trading price in the secondary market at T_1 is P. The government chooses an amount of liquidity, Q, to inject into the banking system at T_0.

2.4. Government (policymaker)

After the economy suffers the systemic liquidity shock, the government chooses an amount of liquidity, Q, to inject into the banking system at T_0, where $Q \in \left[0, \overline{Q}\right]$ and $\overline{Q}$ is a constant reflecting the government's constraint in economic stimulus. For simplicity and without loss of generality, we assume that each bank obtains a fixed amount of liquidity, aggregating to Q. All quantities in our model are in 'real' and not 'nominal' terms.

The injected liquidity Q in our model represents loanable funds. As in the literature on unconventional credit policies, we have abstracted away the institution and assumed that the government can directly determine the amount of loanable funds in the banking system. This simplification is to capture the fact that the government can use various policy tools to influence bank credit available to the economy, for example, the policies of direct lending to financial institutions, equity injections to increase bank capital, and so on as were observed in the recent crisis (Bernanke, 2009).

One interpretation of the liquidity injection Q is a fiscal stimulus, such as the credit expansions that many countries have conducted in response to economic crises. For example, the government borrows Q amount of real goods from an unmodeled source (e.g., foreign countries) to support the domestic economy, and the Q amount of borrowing is fully repaid later with the government's revenue (derived from its lending to the domestic banks).

We will specify the objective function of the government later. Fig. 1 summarizes the main setup of the model.

3. Equilibrium of the one-sector economy

An equilibrium of the one-sector economy consists of the following four elements: (i) Entrepreneurs optimize their investment and borrowing choices at T_0 given r; (ii) Banks optimize their lending decisions at T_0 given P and r; (iii) The bank credit market clears at T_0; (iv) The secondary asset market clears at T_1, with the equilibrium asset price being P.

3.1. Solving for the equilibrium

First, we consider the decisions of banks at T_0. As shown earlier, P is the maximum that an entrepreneur can promise to his creditors. If banks rationally anticipate that the collateral value of an entrepreneur's asset will be P at T_1, and given the interest rate r, they would grant a loan to an entrepreneur with a maximum amount $\frac{P}{1+r}$.[8] Hence, the marginal entrepreneur

[8] An individual bank has no incentive to use an interest rate different from r. If it charges an interest rate lower than r, its profits decrease; if it charges an interest rate higher than r, it loses all its customers.

that can undertake the liquidity investment, denoted by B^*, is

$$B^* = \frac{P}{1+r} \tag{1}$$

We will verify, by considering their participation conditions, that entrepreneurs $B \in [0, B^*]$ undertake the liquidity investment while entrepreneurs $B \in (B^*, I]$ do not.

Second, the credit market must clear at T_0. The supply of funds is from banks, which have two sources of funding: the liquidity injection Q and the deposits from the non-investing entrepreneurs. The investing entrepreneurs are the ones demanding funds. Thus, we have

$$\int_{B^*}^{I} (I - B) f(B) dB + Q = \int_0^{B^*} B f(B) dB, \tag{2}$$

which can be equivalently rewritten as $\int_0^I (I - B) f(B) dB + Q = I \cdot F(B^*)$.

Third, we solve for the market equilibrium of the secondary asset market at T_1. Entrepreneurs have different beliefs at T_1. The asset valuation under high beliefs, denoted by $\mathbb{E}^H(\widetilde{x})$, is $\mathbb{E}^H(\widetilde{x}) = u \cdot \theta_H + d \cdot (1 - \theta_H)$. Likewise, the asset valuation under low beliefs, denoted by $\mathbb{E}^L(\widetilde{x})$, is $\mathbb{E}^L(\widetilde{x}) = u \cdot \theta_L + d \cdot (1 - \theta_L)$. Clearly, $\mathbb{E}^H(\widetilde{x}) > \mathbb{E}^L(\widetilde{x})$. The difference in valuation among entrepreneurs motivates them to trade. Also, as in Shleifer and Vishny (1992), only industry participants with previous periods of experience can operate the assets to generate cash flows at T_2. Thus, buyers in the secondary market are entrepreneurs with high beliefs. Buyers can not only use their own funds but also use leverage (i.e., margin) when buying.

Hence, we have the asset price:

$$P = \begin{cases} \mathbb{E}^H(\widetilde{x}) & \text{if } \Gamma(B^*, r) > \mathbb{E}^H(\widetilde{x}) \\ \Gamma(B^*, r) & \text{if } \Gamma(B^*, r) \in [\mathbb{E}^L(\widetilde{x}), \mathbb{E}^H(\widetilde{x})], \\ \mathbb{E}^L(\widetilde{x}) & \text{if } \Gamma(B^*, r) < \mathbb{E}^L(\widetilde{x}) \end{cases} \tag{3}$$

where

$$\Gamma(B^*, r) = \frac{\pi \left\{ \int_0^{B^*} [C - B(1+r)] f(B) dB + \int_{B^*}^{I} (1+r)(I - B) f(B) dB \right\} + X}{1 - \pi}$$

or $\Gamma(B^*, r) = \frac{\pi [C \cdot F(B^*) - Q(1+r)] + X}{1-\pi}$ by using (2).

In (3), the asset price reflects not only the asset's expected future fundamental value at T_2 but also the current liquidity that buyers can access at T_1. The current liquidity at T_1 available to buyers, which is the numerator of $\Gamma(B^*, r)$, has two components. First, an entrepreneur who made the liquidity investment needs to repay his bank loans resulting in his net liquidity being $C - B(1+r)$; an entrepreneur who did not make the investment can withdraw his deposits from banks resulting in his net liquidity being $(1+r)(I - B)$. As all of the entrepreneurs have experience in managing the assets before T_1, buyers are of total measure π. Thus, the aggregate internal funds of buyers at T_1 are captured by the first term of the numerator of $\Gamma(B^*, r)$.[9] Second, a buyer uses his own asset plus his purchased assets as collateral for borrowing, and he can borrow an amount X against each asset.[10] Hence, the aggregate borrowing of buyers in the economy is X. The denominator of $\Gamma(B^*, r)$ is the quantity of assets put up for sale.

Moreover, the asset price is truncated by upper and lower bounds, reflecting its dependence on the asset's expected future fundamental value at T_2. If the asset price calculated in Γ is higher than $\mathbb{E}^H(\widetilde{x})$, then in equilibrium the asset price is $\mathbb{E}^H(\widetilde{x})$, at which the entrepreneurs with high beliefs are indifferent between buying and not, and some of whom do not participate in buying. A similar argument applies to the other extreme.

In what follows, we denote the pricing function in (3) as $P = p(\widetilde{x}, B^*, C, X, r)$.

Finally, we check entrepreneurs' participation condition at T_0. Given r, if an entrepreneur with internal capital A borrows an amount $B = I - A$ to invest in his project, his payoff is $C - B(1+r)$. Alternatively, the entrepreneur can deposit his internal capital in banks and realize a payoff of $A(1+r)$. Thus, the entrepreneur is willing to invest if and only if

$$C - B(1+r) \geq A(1+r) \quad \Leftrightarrow \quad C - I(1+r) \geq 0. \tag{4}$$

For simplicity, we focus on the set of equilibria in which inequality (4) is satisfied, that is where all entrepreneurs are willing to invest. Proposition 1 follows.

Proposition 1. *The equilibrium of the one-sector economy is characterized by a triplet $\{B^*, P, r\}$, which, given Q, solves Eqs. (1)–(3) and satisfies condition (4).*

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[9] Condition (4) later implies that every investing entrepreneur has sufficient cash to repay his debt at T_1. That is, there is no default.

[10] We focus on the equilibrium where the sellers' funds are large enough to satisfy the buyers' borrowing demand, as in Geanakoplos (2010) and Simsek (2013).

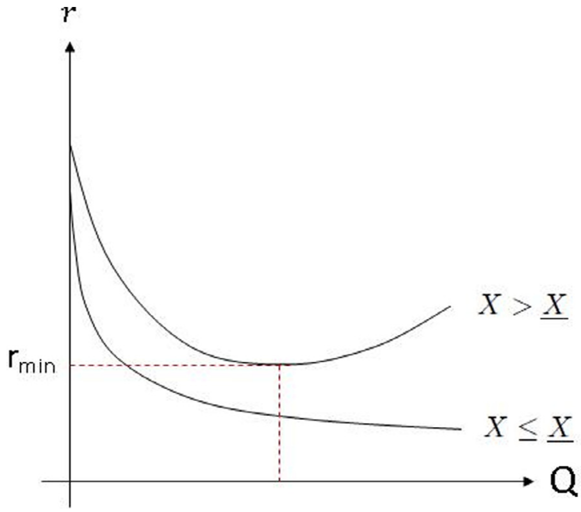

Fig. 2. Equilibrium interest rate for the one-sector economy. Note: The curve with $X \le \underline{X}$ corresponds to higher financing friction and the curve with $X > \underline{X}$ corresponds to lower financing friction.

3.2. Characterizing the equilibrium

First, we examine how liquidity injections affect the asset price P, i.e., the function $P(Q)$.

Lemma 2. *The equilibrium price* Γ *is increasing in* Q *if* $C - I(1+r) > 0$ *in equilibrium.*

Crucially, we need to consider the lower bound of P in (3). Proposition 3 follows.

Proposition 3. *If* $X \le \underline{X}$, *where* $\underline{X}$ *is a (positive) cutoff, the equilibrium asset price* $P(Q)$ *is a constant, equal to* $\mathbb{E}^L(\tilde{x})$, *no matter what size the liquidity injection* Q $(\in [0, \overline{Q}])$ *is. If* $X > \underline{X}$, $P(Q)$ *is (weakly) increasing in* Q *under a sufficiently low* π.[11]

Proposition 3 states that asset specificity X, which captures the financial friction for speculation, plays an important role in determining the asset price. Proposition 3 gives the cleanest case for liquidity injections to have little impact on the asset price.[12] This happens when the financing friction is severe enough (X sufficiently low). If X is low, the buyers cannot use much leverage (i.e., margin financing). Hence, the asset price is low. It is possible that X is so low that the asset price is trapped at the lower bound $\mathbb{E}^L(\tilde{x})$ no matter what Q $(\in [0, \overline{Q}])$ is; in that case, P is not affected by Q.

Next, we examine the equilibrium interest rate, i.e., the function $r(Q)$.

Proposition 4. *If the financing friction is high (i.e.,* $X \le \underline{X}$*), the equilibrium interest rate* $r(Q)$ *is strictly decreasing in* Q $(\in [0, \overline{Q}])$. *For lower financing friction (i.e.,* $X > \underline{X}$*), under some distribution* $f(B)$ *and some parameter values,* $r(Q)$ *is* $\cup$*-shaped in* Q, *that is, there exists a minimum* $r(Q)$, *denoted by* $r_{\min}$, *for an interior* $Q \in (0, \overline{Q})$.

The interest rate equilibrates the effective demand for liquidity, captured by the collateral value (asset price) P, and the supply of liquidity, captured by the threshold B^*, through $1 + r = \frac{P(Q)}{B^*(Q)}$. Proposition 4 delineates two important cases. First, if the asset price is constant, then the interest rate decreases in liquidity injections for certain because the supply of loans increases with liquidity injections. Second, the asset price may increase fast, faster than B^*, in which case the interest rate increases with liquidity injections. In fact, the latter case happens when the density $f(B)$ is thick in some region of B, by noting that the responsiveness of P (versus B^*) to the liquidity injection Q is crucially determined by the total additional funds generated by the liquidity investment, $C \cdot f(B^*)$. Fig. 2 depicts the two cases.

We use Fig. 3(a) and (b) to explain the above mechanisms in the framework of the demand and supply equilibrium. The effective demand of liquidity is a decreasing function of the interest rate (for a given collateral value), i.e., the higher the interest rate, the lower the demand. Thus, an additional supply of liquidity typically causes the equilibrium interest rate to fall, which is the case of Fig. 3(a). However, in equilibrium, the supply may also change the effective demand, i.e., the effective demand curve shifts upward because the collateral value increases. The demand curve may shift out substantially, and hence the equilibrium interest rate is non-monotonic in liquidity supply, which is the case of Fig. 3(b). Formally, in our model, the aggregate supply of liquidity is $Q + \int_{B^*}^{I} (I - B) f(B) dB$ and the aggregate demand is $\int_0^{B^*} B f(B) dB$. By (2), we can

[11] For our purpose, we focus on the set of equilibria in which Γ is lower than and not binding at $\mathbb{E}^H(\tilde{x})$. This can be achieved by assuming that θ_H and thus $\mathbb{E}^H(\tilde{x})$ are sufficiently big, ceteris paribus.

[12] For the benefit of a clean analysis and for our purpose, we have divided X into two regions in the analysis: $X \le \underline{X}$ and $X > \underline{X}$. The merit of the cleanness can be further seen later when we discuss Fig. 3(a) and (b). The results of the paper however hold generally (for some $\overline{Q}$).

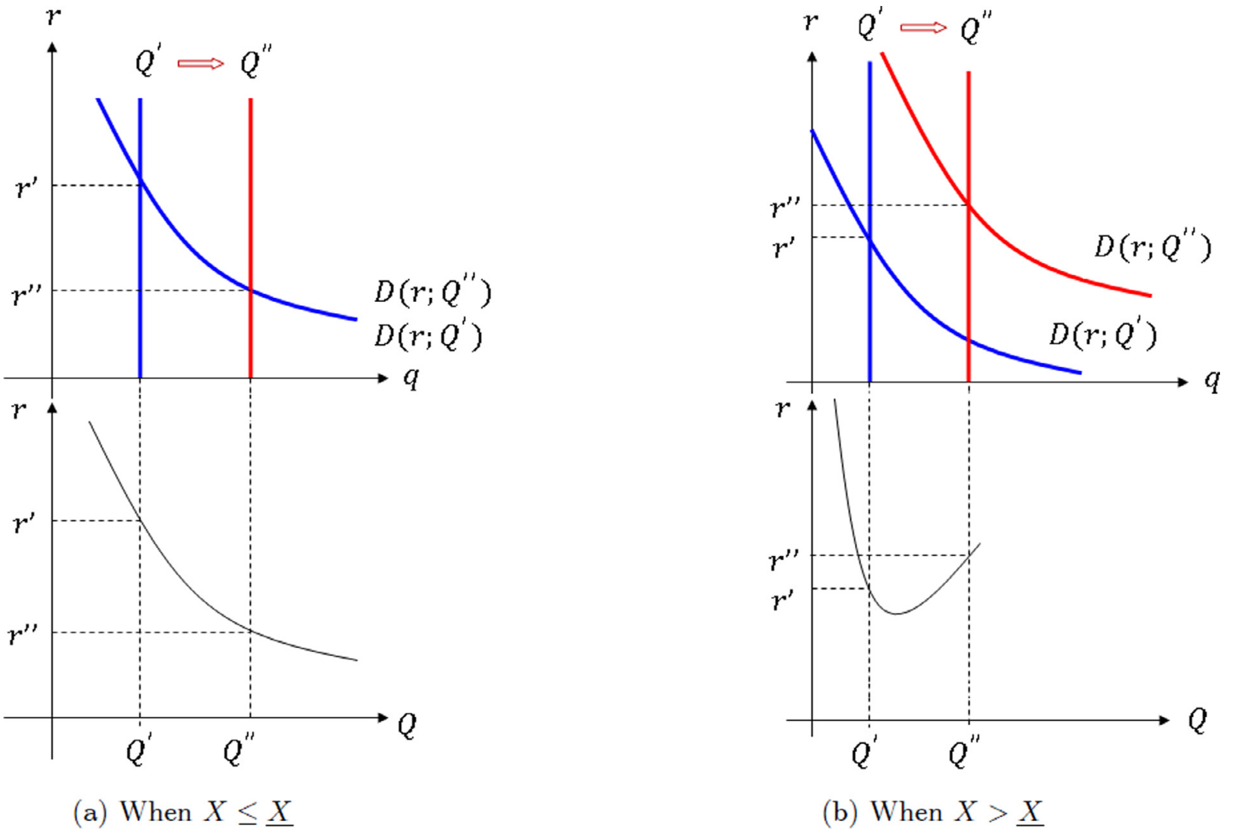

Fig. 3. One-sector liquidity market equilibrium. Note: The left panel with $X \leq \underline{X}$ corresponds to higher financing friction and the right panel with $X > \underline{X}$ corresponds to lower financing friction.

equivalently rewrite the supply as $S(Q) = Q + \int_0^I (I - B) f(B) dB$ and the demand as $D(r;\, Q) = I \cdot F\left(\frac{P(Q)}{1+r}\right)$, where both supply and demand are functions of Q. In Fig. 3(a) $P(Q)$ is a constant while $P(Q)$ is increasing in Q in Fig. 3(b). In the next section when we study the two-sector economy, the two cases of $r(Q)$ correspond to the two sectors.

4. Two-sector economy

We now consider the equilibrium with two sectors, so that we can study the distribution of liquidity and the possible misallocation of credit, the goal of our study. The difference in financial friction for speculation across sectors, originating in asset specificity, results in heterogeneity in speculative activities across those sectors. This heterogeneity leads to asymmetric responses of collateral prices to liquidity injections across the two sectors. As the two sectors compete for loans (liquidity) in the same bank credit market, the crowding-out effect can occur.

4.1. Two-sector equilibrium: the crowding-out effect

In order to highlight the key mechanism underlying the crowding-out effect, at this stage we assume that the two sectors differ only in their asset specificity (the term X). Sector 1 has higher friction, i.e., a lower X denoted by X_1, where $X_1 \leq \underline{X}$, while Sector 2 has lower friction, i.e., a higher X denoted by X_2, where $X_2 > \underline{X}$.[13] Note that the (exogenous) X determines asset leverage in speculation at T_1 while the (endogenous) B^* measures corporate leverage in a sector at T_0.

The government can decide the aggregate liquidity to inject into the economy but cannot control the allocation of the liquidity across the two sectors in the economy, which is determined by banks based on market forces. Market forces mean that: (i) Banks make loans based only on entrepreneurs' repaying ability or collateral values (no matter which sector en-

[13] For cleanness, we consider the case where $X_2 > \underline{X} \geq X_1$. When $X_2 > X_1 \geq \underline{X}$, the result in this section (i.e., the unique optimal level of liquidity injection as will be shown in Propositions 6, 8 and 10) still holds. However, a stricter condition is required, that is, the maximum amount of allowed liquidity injection $\overline{Q}$ cannot be too large. The reason is that when $X_2 > X_1 > \underline{X}$, the interest rates in both sectors might be increasing in the liquidity inflow when the liquidity inflow is sufficiently high. Hence, the crowding-out effect occurs only when $\overline{Q}$ is not too large.

trepreneurs are from); and (ii) there is a single interest rate in the economy (for both sectors). Also, the government cannot control the (real) interest rate directly (Blinder, 1998).

We solve for the two-sector economy equilibrium: for a given Q, how the liquidity is allocated and distributed across the two sectors ($i = 1$ and 2). The equilibrium is given by:

$$r = \frac{P_i}{B_i^*} - 1 \tag{5a}$$

$$\int_{B_i^*}^{I} (I - B) f(B) dB + Q_i = \int_0^{B_i^*} B f(B) dB \tag{5b}$$

$$P_i = p(\widetilde{x}, B_i^*, C, X_i, r) \tag{5c}$$

$$C - I(1 + r) \geq 0 \tag{5d}$$

$$Q = \sum_i Q_i. \tag{5e}$$

In (5a)–(5e), the variables with superscript i denote the variables for sector i, where $i = 1$ and 2. In particular, Q_i is defined as the *net* amount of outside-sector liquidity entering sector i, or the *net* liquidity inflow into sector i. Eqs. (5a), (5b) and (5c) and condition (5d) correspond, in order, to the respective Eqs. (1), (2) and (3) and condition (4) of the one-sector economy. The three Eqs. (5a) through (5c) and condition (5d) give the equilibrium within each sector. The interaction between the two sectors is given by (5a) and (5e). Eq. (5a) states that there is a single interest rate, in equilibrium, for the two sectors; (5e) reflects that the aggregate outside-sector liquidity of the two sectors must sum to Q.

In the two-sector economy, there is an integrated bank credit market at T_0, through which capital can flow across sectors. That is, a non-investing entrepreneur in one sector saves his spare internal capital in banks and can actually become an ultimate liquidity provider to investing entrepreneurs in the other sector. In fact, in (5a)–(5e), even when $Q = 0$, Q_i might not be equal to zero, in which case, it measures the liquidity flow across the two sectors. In contrast, the secondary asset markets for Sectors 1 and 2 at T_1 are segmented. That is, only industry participants active in a particular sector can buy assets from their peers in the same sector. We will relax the assumption of asset market segmentation in Section 5.

Under certain parameter conditions, (5a)–(5e) have a unique solution. We can think that there are two steps in solving for the two-sector equilibrium in (5a)–(5e). First, given Q_i for each sector, solve for the equilibrium within each sector; that is, solve for the triplet $\{B_i^*, P_i, r_i\}$. In particular, we obtain the function $r_i(Q_i)$. Second, by considering the link between the two sectors, (5a) and (5e), we can work out Q_i (for $i = 1$ and 2) for a given Q. That is, by considering $r_1(Q_1) = r_2(Q_2) = r$ and $Q_1 + Q_2 = Q$, we obtain the unique Q_1 and Q_2, and r. Proposition 5 follows.

Proposition 5. *The (market) equilibrium of the two-sector economy is characterized by a set $\{B_i^*, P_i, Q_i, r\}$ where $i = 1$ and 2, which, given Q, solves the system of Eqs. (5a), (5b), (5c) and (5e), and satisfies condition (5d). If $r_1(Q_1)$ is strictly decreasing in Q_1 and $r_2(Q_2)$ is $\cup$-shaped in Q_2, there is a unique equilibrium for the two-sector economy.*

We conduct comparative static analysis on $Q_1(Q)$, and have Proposition 6.

Proposition 6. *If $r_1(Q_1)$ is strictly decreasing in Q_1 and $r_2(Q_2)$ is $\cup$-shaped in Q_2, there is a unique Q, denoted by Q^*, that maximizes Q_1 (or B_1^*).*

Fig. 4 shows the intuition for determining the unique Q^*. In the figure, $Q^* = Q_1 + Q_2$. If the liquidity injection exceeds this level, any additional liquidity will flow to Sector 2 and, further, some of the liquidity in Sector 1 will actually be squeezed out due to the increased interest rate. Therefore, overall, the liquidity in Sector 2 will increase while that in Sector 1 will decrease. In fact, if Q increases above Q^*, Sector 1 cannot attract more liquidity as there is otherwise no interest rate at which the credit market across the two sectors can clear; thus Sector 2 must attract more liquidity, which will certainly increase the interest rate as we move along the increasing part of the liquidity curve of Sector 2.

It is important to examine the process by which the new equilibrium is reached when some additional amount of liquidity (beyond Q^*) is injected. In Fig. 4, in which an additional $\Delta Q = (Q_1' + Q_2') - (Q_1 + Q_2)$ of liquidity is injected, we examine how Q_1 reaches Q_1'. Suppose that initially all additional liquidity, ΔQ, enters Sector 2; this would drive up the interest rate; the higher interest rate would squeeze some liquidity out of Sector 1, which means that more liquidity would flow into Sector 2, driving up the interest rate further, and so on in a spiral. Essentially, there is a spiral in reaching the new equilibrium. From the perspective of Sector 2, the spiral results in a multiplier $\frac{Q_2' - Q_2}{\Delta Q} > 1$; that is, although the additional (aggregate) liquidity injection is ΔQ, the increment of liquidity in Sector 2 is actually more than ΔQ; the leap is at the expense of Sector 1, causing a liquidity drain out of Sector 1. In short, one sector enters a liquidity-asset price ‘inflationary’ cycle while the other enters a ‘deflationary’ cycle, and the two cycles reinforce each other.

In sum, we can divide the support of liquidity injection, Q, into two regions: $Q \leq Q^*$ and $Q > Q^*$. Proposition 7 follows.

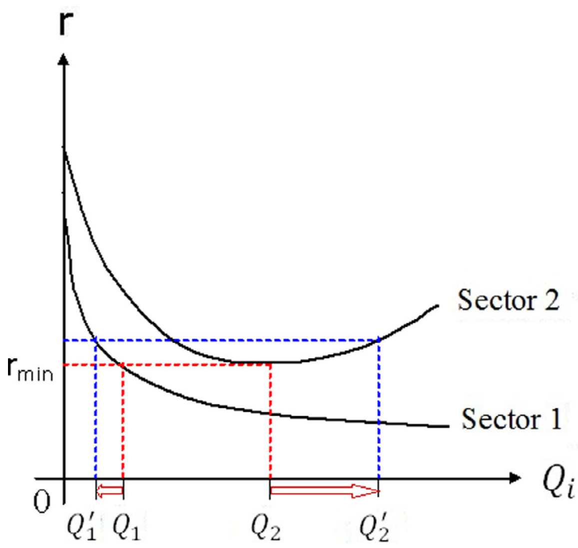

Fig. 4. Crowding-out effect in the two-sector economy equilibrium. Note: Sector 1 with $X_1 \leq \underline{X}$ corresponds to higher financing friction and Sector 2 with $X_2 > \underline{X}$ corresponds to lower financing friction.

Proposition 7. *When $Q \leq Q^*$, there is an 'allocation' effect, i.e., liquidity in both sectors increases with liquidity injections but Sector 1 obtains (weakly) less liquidity than Sector 2. When $Q > Q^*$, there is a 'crowding-out' effect, i.e., more liquidity injected increases liquidity in Sector 2 but reduces it in Sector 1; the crowding-out occurs in a self-reinforcing spiral.*

Although the liquidity investments in the two sectors have the same surplus (i.e., $C - I$), the liquidity is unevenly distributed across the two sectors. In particular, if too much liquidity is injected into the economy, Sector 1 can actually suffer a liquidity outflow (deficit). As long as the collateral value (asset price) increases faster in one sector than in the other, crowding-out can potentially occur.

Proposition 7 implies that the crowding-out effect is accompanied by a rising interest rate. However, our model framework also shows that the crowding-out effect can be accompanied by a falling interest rate. See the online appendix (Fig. B1) for such an equilibrium.

4.2. Government decision and credit misallocation

Now we examine the decision of the government. To make the problem interesting and relevant, we assume that the two sectors differ in both their cash flow at T_1 and their asset specificity while all other aspects are the same. Specifically, we assume that $C_1 > C_2$ and $X_1 < X_2$, where C_i and X_i are, respectively, the cash flow at T_1 and the asset specificity for sector i, and $i = 1$ and 2. That is, Sector 1 has a higher cash flow and higher asset specificity.

The market equilibrium of the two-sector economy for a fixed Q is given by (6a)-(6e), where (6a), (6b) and (6e) are identical to (5a), (5b) and (5e), respectively, and

$$P_i = p\left(\widetilde{x}, B_i^*, C_i, X_i, r\right) \tag{6c}$$

$$C_i - I(1+r) \geq 0, \tag{6d}$$

with $i = 1$ and 2. Similar to Proposition 5, we show that under certain conditions the equilibrium given by (6a)-(6e) exists and is unique.

We model two alternative government objective functions, which deliver qualitatively equivalent results. That is, there is an optimal level of liquidity injection for the government, and the liquidity injection should not be too large. The first objective function is that the government targets to maximize the number of projects in Sector 1 to undertake the liquidity investment. This is because $C_1 > C_2$, which means that projects in Sector 1 should receive liquidity injection from the efficiency perspective. This may also be because the government cares more about outcomes such as employment (e.g., small and medium-sized businesses) than purely about firms' profits. If Sector 1, relative to Sector 2, is disproportionately more important in these aspects, the government may make Sector 1 its first priority when providing economic stimulus. The government's optimization problem is:

$$\begin{aligned} &\max_{Q} Q_1 \\ &\text{s.t.} \quad (6a) - (6e). \end{aligned} \qquad \text{Program1}$$

In Program1, maximizing Q_1 is equivalent to maximizing B_1^*. The government chooses a Q to maximize the objective function subject to the two-sector market equilibrium given by (6a)–(6e). Similar to Propositions 6 and 7, we have Proposition 8.

Proposition 8. *When π is sufficiently small and $f(B)$ is sufficiently high in some region of B, ceteris paribus, Program1 has a unique interior optimal Q ($\in (0, \overline{Q})$), denoted by Q^*. The properties in Proposition 7 carry over.*

Proposition 8 implies that excessive liquidity injections lead to a *misallocation of liquidity* in the economy: the sector with lower-surplus projects (i.e., $C_2 - I$) obtains more liquidity while the sector with higher-surplus projects (i.e., $C_1 - I$) *loses* liquidity. In fact, the optimal resource allocation requires the marginal product (return) of investment to be equalized across sectors (Hsieh and Klenow, 2009; Restuccia and Rogerson, 2008). In our model, the marginal return on investment in sector i is a constant $\frac{C_i}{I}$, and Sector 1 has a higher marginal return (i.e., $\frac{C_1}{I} > \frac{C_2}{I}$). Hence liquidity should be allocated to Sector 1.

It is helpful to examine the return on capital in the aggregate economy, denoted by $\bar{R}$, which is given by

$$\bar{R} = \frac{C_1 \cdot F\left(B_1^*\right) + C_2 \cdot F\left(B_2^*\right)}{I \cdot F\left(B_1^*\right) + I \cdot F\left(B_2^*\right)}.$$

It is easy to show that $\bar{R} = R_1\omega + R_2(1-\omega)$, where $R_i \equiv \frac{C_i}{I}$ is the capital return for sector $i = 1$ and 2, and $\omega = \frac{F(B_1^*)}{F(B_1^*)+F(B_2^*)}$, Sector1's share of liquidity investment. That is, the return on capital in the aggregate economy is the weighted average of the returns on capital across the two sectors, weighted by their shares of liquidity investment. Clearly, ω is decreasing in Q for $Q > Q^*$ due to the crowding-out effect. Corollary 9 follows.

Corollary 9. *$\bar{R}$ is decreasing in Q for $Q \geq Q^*$.*

Despite a constant return on capital in each individual sector, the aggregate economy exhibits a decreasing return on capital when $Q > Q^*$. This is because a larger liquidity injection results in a more severe misallocation of credit across sectors when $Q > Q^*$.

The second objective function is that the government is to maximize the aggregate surplus of liquidity investments in the economy. The aggregate surplus is given by

$$W = (C_1 - I) \cdot F(B_1^*) + (C_2 - I) \cdot F(B_2^*).$$

By using (2), it is easy to show that W can be rewritten as $W = C_1 \cdot F\left(B_1^*\right) + C_2 \cdot F\left(B_2^*\right) - 2\int_0^I (I - B) f(B) dB - Q$, where the first two terms are the aggregate cash income at T_1 in the economy, and the last two terms are the funding cost. The aggregate surplus W is, in the end, divided among the different parties (see the proof of Proposition 10).

In general, it is difficult to conduct welfare analysis on models with heterogeneous beliefs (see, e.g., Brunnermeier et al., 2014). However, this is not the case with our model. In our model, we assume that the cash flow $\tilde{x}$ at T_2 (over which entrepreneurs develop heterogeneous beliefs) and the distribution of beliefs (i.e., the probability π) are identical across the two sectors. More importantly, the asset, which generates cash flow $\tilde{x}$, is in place at T_0; liquidity injections do not affect $\tilde{x}$. Liquidity injections only impact the liquidity investment I and the cash flow C subsequently. As a result, we can conduct the welfare analysis by calculating the aggregate surplus of liquidity investments in the economy.

Under the alternative objective function, the government's optimization problem is:

$$\begin{aligned} &\max_Q W \\ &\text{s.t.} \quad (6a) - (6e). \end{aligned} \qquad \text{Program2}$$

Proposition 10. *When π is sufficiently small and $f(B)$ is sufficiently high in some region of B, under some parameter values, Program2 has a unique interior optimal Q.*

The intuition behind Proposition 10 is as follows. We can decompose the aggregate income of the economy at T_1 into

$$C_1 \cdot F(B_1^*) + C_2 \cdot F(B_2^*) = [C_1 \cdot F(B_1^*(Q_1^*)) + C_2 \cdot F(B_2^*(Q_2^*))]$$
$$+ \left[\underbrace{C_2 \cdot \begin{pmatrix} F\left(B_1^*(Q_1)\right) + F\left(B_2^*(Q_2)\right) \\ -F\left(B_1^*\left(Q_1^*\right)\right) - F\left(B_2^*\left(Q_2^*\right)\right) \end{pmatrix}}_{\text{additional injected liquidity entering Sector 2}} - \underbrace{(C_1 - C_2) \cdot (F(B_1^*(Q_1^*)) - F(B_1^*(Q_1)))}_{\text{some liquidity moving out of Sector 1 to Sector 2}} \right],$$

where Q_i^* is the net liquidity inflow for Sector i when $Q = Q^*$ in Proposition 8. An increase in Q above Q^* has two opposite forces on income: additional injected liquidity entering Sector 2 increases income, but a larger liquidity injection also causes more liquidity to leave Sector 1 for Sector 2, reducing income because $C_1 > C_2$. Under certain conditions, the second force dominates the first when Q is too high, and therefore there exists an optimal Q.

5. Robustness of the model

In this section, we discuss several aspects of model robustness.

5.1. Segmentation of asset markets

In the main model, we assumed that the secondary asset markets for Sectors 1 and 2 at T_1 are segmented. We can alternatively assume that the secondary asset markets are not completely segmented. Specifically, we can assume that entrepreneurs from Sector 1 (e.g., the real sector) can trade in both asset markets, while entrepreneurs from Sector 2 (e.g., the real estate or financial sector) can only trade in asset market 2. We show that under this alternative assumption our model results do not change qualitatively.

Intuitively, under the alternative assumption, Sector 2 will end up with more speculators while Sector 1 will lose some of its speculators to Sector 2. As a result, the asset price in Sector 2 is boosted further while that in Sector 1 remains trapped at the lower bound. In particular, the asset price in Sector 2 is still increasing in the liquidity injection (that is, Propositions 3 and 4 still hold).

Formally, to examine the impact of imperfect asset market segmentation, we explore three alternative scenarios regarding agents' beliefs: (1) Beliefs of an entrepreneur are perfectly correlated in the two asset markets; (2) Beliefs of an entrepreneur are not perfectly correlated in the two asset markets; 3) There exist no heterogeneous beliefs among entrepreneurs and thus no speculative trade in Sector 1 while there does in Sector 2. Lemma 11 follows.

Lemma 11. *If the secondary asset markets are not completely segmented, Propositions 3 and 4 hold.*

5.2. Alternative borrowing constraints

The borrowing-constraint setup in our model is consistent with the one in Kiyotaki and Moore (1997), where the borrowing in the current period depends on the asset price in the next period. This is also true in our model. In fact, we can rewrite the asset price in (3) as $\Gamma \cdot (1-\pi) = e + b$ with $b \le X \cdot (1-\pi)$, where $e = \pi[C \cdot F(B^*) - Q(1+r)] + \pi X$. The borrowing at T_1 (the term b) depends on the "asset price" at T_2 (the term X).[14] Under the alternative assumption that the borrowing in the current period depends on the asset price in the current period, our model results do not change qualitatively. In this case, Γ in (3) would be written as $\Gamma \cdot (1-\pi) = e_c + (\Gamma\lambda)\pi + (\Gamma\lambda) \cdot (1-\pi)$ where $e_c = \pi[C \cdot F(B^*) - Q(1+r)]$ (which is increasing in Q by Lemma 2) and λ is the margin leverage ratio. Hence $\Gamma = \frac{e_c}{1-\pi-\lambda}$, which implies $\frac{\partial^2 \Gamma}{\partial \lambda \partial Q} > 0$, meaning that the higher the λ, the more sensitive the response of Γ to liquidity injection Q. Hence, Propositions 3 and 4 still hold.

5.3. Different interest rates across sectors

Within the model, there is no reason for banks to charge entrepreneurs from different sectors different interest rates (between T_0 and T_1). This is because there is no default of bank loans in equilibrium in our model, and thus no differential riskiness of bank loans across sectors. In other words, the interest rate on bank loans in our model is in fact the real risk-free interest rate, which of course is a single one economy-wide.

If we consider the real world outside the model, the frictions that our model does not study and abstracts away, such as adverse selection, might lead to different risky interest rates across sectors reflecting different risk premia across sectors. Nevertheless, even if we relax our original assumption by allowing for differences in interest rates across the two sectors but with some extent of co-movement, our model results do not change qualitatively. Specifically, we can assume that $r_1 - r_2 = \Delta r$, where r_i is the interest rate on bank loans (between T_0 and T_1) in sector $i = 1$ and 2, and Δr is a constant spread; that is, there is a constant spread in interest rates on bank loans between the two sectors (for exogenous reasons). We prove that our model results do not change qualitatively under this new assumption (see the proof in the online appendix).

5.4. Alternative sources of heterogeneity across sectors

Several other dimensions of heterogeneity documented empirically are endogenous in our model. For example, heterogeneity in corporate leverage, recovery rate, and secondary market trading across sectors is endogenous in our model. While alternative sources of heterogeneity might also generate the misallocation of liquidity, clearly formalizing the underlying mechanism may not be straightforward. In particular, our model shows the effect of two ranges of liquidity injection Q: When $Q \le Q^*$, there is an 'allocation' effect; when $Q > Q^*$, there is a 'crowding-out' effect.

6. Empirical evidence

In this section, we discuss empirical evidence in support of our model.

[14] Because our model is a finite-horizon model, the asset price at the final date T_2 is equal to the collectable or contractible part of "dividends" at that date, which is the asset specificity term X.

6.1. Evidence on asset specificity

A key mechanism of our model is to link asset specificity, secondary market trading, and corporate leverage. In our model, the cash flow X — the recovery part of cash flow in the event of default — measures asset specificity. Our model assumes asset specificity heterogeneity across sectors and implies: (i) The lower the asset specificity, the higher the recovery rate; (ii) The lower the asset specificity, the higher the trading amount in the secondary asset market;[15] (iii) The lower the asset specificity, the higher the corporate leverage. All these are strongly supported by empirical evidence (see, e.g., Kim and Kung, 2017).[16] Table 1 below shows asset redeployability across industries, where asset redeployability is the measure of asset specificity in the literature. Lower redeployability corresponds to higher asset specificity.

Table 1
Asset redeployability by industry. Source: (Kim and Kung, 2017).

Panel A: Descriptive statistics

	N Industries	Mean	SD	Min	Q1	Median	Q3	Max
Redeployability	9	0.222	0.061	0.109	0.185	0.221	0.274	0.293

Panel B: Most and least redeployable industries based on one-digit SIC codes

Most redeployable		Least redeployable	
Redeployability	industry	Redeployability	industry
0.293	Financial	0.109	Mining
0.277	Wholesale Trade	0.175	Transportation
0.274	Construction	0.185	Agriculture
0.262	Retail Trade	0.201	Manufacturing
0.221	Services		

Note: Asset redeployability is the measure of asset specificity in the literature. Lower redeployability corresponds to higher asset specificity.

6.2. Shadow banking activities in China

While the formal banking system in China is tightly regulated (for example, regulation of interest rates on deposits and credit quota in commercial banks), the last decade has witnessed an explosive growth of unregulated shadow banking activities in China.[17] According to a Moody's report (2013), by the end of 2012, the total value of shadow banking products in China was 39% of GDP.

An important part of China's shadow banking activities is the re-lending business (Du et al., 2016) and broadly entrusted loans (Allen et al., 2015; Chen et al., 2016a). The re-lending activity consists of non-financial firms with good access to formal finance acting as de facto financial intermediaries, i.e., borrowing from banks and lending to credit-constrained firms. In fact, such re-lending activities grew to large scale in Japan in the late 1980s and were an important force behind the boom-bust cycle of the Japanese economy (see Hattori et al., 2009 for detailed evidence). The re-lending business in China is a natural outcome of financial repression whereby large privileged enterprises have access to formal finance with favorable conditions but small and medium-sized enterprises can hardly access formal finance (Du et al., 2016). In examining the re-lending business in China, Du et al. (2016) document empirical evidence to answer two broad questions: who lends and who borrows. They find that: (1) State-controlled companies that have better access to financial markets are particularly active in re-lending; (2) Real-estate and construction firms, and small and medium-sized businesses (SMBs) are the main borrowers.

The findings of Du et al. (2016) and others on China's shadow banking generally support the mechanism of our model. That is, the lenders in the shadow banking sector—the privileged enterprises (notably large central state-owned enterprises) that have access to formal finance with favorable conditions—correspond to “banks” in our model, while the two main borrowers—SMBs and the real estate sector —correspond to Sector 1 and Sector 2, respectively, in our model. When China implemented its credit expansion, a large volume of credit went to privileged enterprises that de facto acted as financial intermediaries and conducted re-lending. As the total volume of re-lending loans increased, it contributed to the overheating of one sector (i.e., the real-estate and construction sector) while liquidity in the other sector (i.e., SMBs) was crowded out through the channel of rising real interest rates. In fact, after China conducted its credit expansion in 2008–2009, one pronounced phenomenon was the surge in real estate prices, with a 50% increase within one year in many cities.[18] Asset prices were also climbing in other asset classes, like commodities. In contrast, SMBs in China had an even harder time obtaining

[15] Based on Eq. (3) in our model, lower asset specificity (a higher X) corresponds to higher asset sales (the numerator of Γ), which is confirmed by Kim and Kung (2017) (see Panel B of Table 8 in their paper).

[16] For evidence on asset specificity, margins, and margin-based asset pricing, see, e.g., Gorton and Metrick (2012), Adrian and Shin (2010), Almeida and Campello (2007), Gârleanu and Pedersen (2011), and Frazzini and Pedersen (2011). Asset prices can be depressed and exhibit features of "flight to quality" phenomena (Caballero and Krishnamurthy (2008)).

[17] See Allen et al. (2015), Elliott et al. (2015), Acharya et al. (2016), Chen et al. (2016a), Chen et al. (2016b), Du et al. (2016), Hachem and Song (2016), and Wang et al. (2016).

[18] See Fang et al., 2015.

corporate liquidity following the economic stimulus.[19] The underground interest rate reached 30% in some regions.[20] The People's Daily wrote: "Massive funds pulled out the real sector and flowed into the real estate sector, crowding out the real economy."[21] Chen et al. (2017) provide evidence that the crowding-out effect led to substantial capital misallocation.[22]

6.3. Misallocation of capital flows in EU countries

Reis (2013) argues that financial integration without the necessary financial deepening in some of the EU's peripheral countries since the late 1990s led to massive foreign credit, mainly through domestic banks (serving as intermediaries), pouring into relatively unproductive firms in the nontradables sector at the expense of more productive tradables firms.[23] The misallocation of abundant capital flows from abroad explains the poor economic performance of these countries even before the global financial crisis of 2007–2009. Reis (2013) documents that in the period of 2000–2006 the shares of the tradables sectors (such as manufacturing) declined in terms of employment and nominal value added in the Portuguese economy while the shares of the nontradables sectors (such as real estate, wholesale and retail trade, community services) increased. Ireland and Spain had similar features. The share of the construction sector in Spain's economy also rose significantly.

The misallocation of capital flows documented by Reis (2013) might be accounted for in our framework. From Table 1, the industries of financial services, construction, and wholesale and retail trade exhibit lower asset specificity; they are also coincidentally the less tradable industries in the framework of Reis (2013). In contrast, the industries of manufacturing and transportation have higher asset specificity and are also among the more tradable industries. Based on our model (see Proposition 7), when the capital flow to an economy is not large, there is an 'allocation' effect: liquidity in both sectors increases but the sector with higher friction obtains less liquidity than the sector with lower friction, and the real interest rate drops. The 'allocation' effect implies that the sector with lower friction will grow faster than the sector with higher friction, and hence its share in the economy will expand.[24]

6.4. Japan's experience in the 1980s

One would expect a negative relation between liquidity supply and interest rates: a lower supply of liquidity should increase interest rates. The Japanese experience during the 1980s, however, is a stark example of a tightening policy accompanying a (slight) decrease in real interest rates. In fact, the tightening policy in Japan in the second half of 1980s was followed by a fall in asset prices and thus a reduction in the collateral values of firm assets; the reduction in the creditworthiness of Japanese corporations at least in part contributed to lower demand for credit, driving down interest rates. Bernanke and Gertler (1995) write: "the crash of Japanese land and equity values in the latter 1980s was the result (at least in part) of monetary tightening; …[T]his collapse in asset values reduced the creditworthiness of many Japanese corporations and banks…". What happened recently in China can be regarded as the same sort of problem the Japanese faced, but in the opposite direction. That is, the massive liquidity injections and credit expansion in China created overheating in some sectors (e.g., the real estate sector), which led to the effective demand for credit shooting up, in turn causing real interest rates to rise.

7. Concluding remarks

Our paper proposes a new channel for credit misallocation that links credit misallocation to credit expansion (or capital inflows). The study suggests that unconventional credit policy can have limited effectiveness in stimulating economic growth. While financial intermediaries have an (informational) advantage/expertise in allocating capital to firms, market frictions also mean that implementation of credit policy through financial intermediaries is imperfect. The paper implies that credit policy in conjunction with fiscal policy to target some specific sectors/industries may have better effects in economic stimulus. Regulation on the leverage level in more speculative industries when other industries are in distress may help reduce the crowding-out effect.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at 10.1016/j.jmoneco.2017.09.012.

[19] See, e.g., the Citibank-CCER report of "Financing and growth of small and medium-sized businesses in China" (available in Chinese only at http://www.ccstock.cn/stock/jinrongjigou/2011-07-21/A516377.html).

[20] http://finance.ifeng.com/bank/pjrz/20100813/2507661.shtml (the article is only available in Chinese). There are plenty of news reports on this on Chinese websites.

[21] http://www.chinanews.com/estate/2011/12-09/3519315.shtml (the article is only available in Chinese).

[22] See also Cong et al. (2017) and Huang et al. (2017).

[23] See also Benigno and Fornaro (2014), Giavazzi and Spaventa (2011), and Gopinath et al. (2017). Reinhart and Kaminsky (1999) provide historical evidence on capital inflows, bank credit, and crises.

[24] In our model, the crowding-out effect under $Q \geq Q^*$ is a sufficient but not necessary condition for a decreasing return to capital of the aggregate economy (see Corollary 9). In other words, when $Q < Q^*$, the 'allocation' effect may also cause a decreasing return to capital of the aggregate economy.

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