CENTRE DE RECHERCHES EN ÉCONOMIE ET DROIT
Paris Center for Law and Economics

CRED WORKING PAPER N^o 2021-3

Bank-Platform Competition in the Credit Market

March 15, 2021

Sara Biancini* and Marianne VERDIER†

*CY Cergy Paris Université, THEMA. Email: sara.biancini@u-cergy.fr

†CRED (TEPP) - Université Paris II and Ecole Nationale Supérieure des Mines de Paris- Centre d'Économie Industrielle (CERNA) Email : marianne.verdier@u-paris2.fr

Bank-Platform Competition in the Credit Market

Sara Biancini*, Marianne Verdier[‡]

March 3, 2021

Abstract

The paper analyzes the equilibrium in the credit market when a bank and a platform compete to offer credit to borrowers. The platform does not manage deposit accounts, but acts as an intermediary between the borrower and the investor, offering a risky contract such that the investor is only reimbursed if the borrower is successful. We first characterize the optimal contract proposed by the platform, depending on the two-sided structure of the market. Then, we study the impact of bank-platform competition on the investor's incentives to fund platform loans and on borrower repayments. We show that the platform business model of financial intermediation may generate unexpected effects in the credit market. The investor participation in the platform may be reduced when the platform attracts borrowers of better quality. In addition, the platform may increase borrower repayments when the bank lowers borrower repayments. We also explain how the presence of the platform impacts the monetary policy transmission mechanism.

Keywords: Bank, Platform, Big Tech, Credit Market, Credit Rationing.

JEL Codes: L1, L5, G2.

1 Introduction

Digital platforms are offering their intermediation services in several sectors of the economy, ranging from the transportation industry (e.g., Uber) to hotel reservations (e.g., Booking, Expedia, and other OTAs), or e-commerce (e.g., Amazon). The financial industry is not an exception. In the retail credit market, since 2006 lending platforms (such as Prosper, Lending Club or Zopa) have started to act as intermediaries between borrowers seeking to

*CY Cergy Paris Université, THEMA. Email: sara.biancini@u-cergy.fr

[†]CRED (TEPP), Université Paris II Panthéon-Assas and Ecole Nationale Supérieure des Mines de Paris - Centre d'Economie Industrielle (CERNA). Email: marianne.verdier@u-paris2.fr.

[‡]We thank seminar participants at the University of Paris 2 (June 2019), the research chair Governance and Regulation of the University Paris Dauphine (November 2020), Telecom ParisTech (December 2020), conference participants to the SKEMA FinTech and Digital Finance conference (Sophia Antipolis, May 2019), the EARIE conference in Barcelona (August 2019).

fund projects and investors. In several countries, such platforms have managed to attract a significant share of the lending market in specific market segments, by both expanding the credit supply to under-served borrowers and by competing with banks for their existing customer base.[1] More broadly, lending platforms are part of the FinTech movement that is reshaping competition in the banking industry.[2]

Many empirical papers have started to study how the entry of lending platforms impacts the availability of credit for retail consumers and the average risk in the retail lending market. However, very little is known from a theoretical perspective about how competition between banks and lending platforms affects the repayments made by borrowers, the investors' behavior, and the profitability of the platforms. This paper aims at answering these research questions.

We show that the platform business model of financial intermediation may generate unexpected effects in the credit market. Investor participation in the platform may be reduced when the platform attracts borrowers of better quality. In addition, the platform may increase borrower repayments when the bank lowers borrower repayments. Our results are due to the presence of crossed-network externalities between investors and borrowers. Moreover, we show that banks and platforms may react in unexpected ways to monetary policy when they compete against each other.

Banks are defined both in the economic literature and by legislation as entities taking deposits and engaging in credit activities. Banks fund term loans with demandable deposits that may be withdrawn before the loan matures. The bank matches the depositors' offer of funds with the lenders' demand for credit. This activity implies the management of two important risks. On the one hand, on the asset side, the bank faces the risk of the borrower defaulting before meeting its repayment obligation. Therefore, the bank needs to find appropriate instruments to select its borrowers, such as the requirement of collateral, the design of efficient techniques to score borrowers and price credit risk. On the other hand, on the lia-

[1] **See Claessens et al. (2018)** for figures. In the United Kingdom, the Cambridge Center for Alternative Finance estimated that marketplace lending contributed to 15% of the lending flow of comparable bank credit to consumers and SMEs.

[2] Over the last ten years, banks have started to compete with alternative finance providers. Those companies use different business models to supply all the services that are traditionally offered by financial intermediaries (e.g., payments, financial advice, lending, asset management...).

bility side, the bank faces the risk that the depositor may withdraw its funds before the loan matures. Since loans and deposits differ in terms of liquidity and maturity, banks perform maturity transformation.[3] A direct consequence of this organization is the vulnerability of banks to credit and liquidity risk, which justifies the need for their regulation (see Rochet, 2008).

Why do lending platforms differ from banks? Typically, a platform posts online information on the project of a borrower that needs some funding. Then, the investor observes the information available on the platform. Using his own information and the platform's analysis, he chooses whether or not to fund the project.[4] If the project is funded, the borrower repays the principal and the interest rates directly to the investor, who is reimbursed only if the project is successful. The investor cannot withdraw its funds before the loan matures, unless the platform has organized a secondary market for loan resales.[5] The contract offered by the platform to the investor differs from the deposit contract in two dimensions. First, the investor faces the default risk of the borrower. He may form expectations about the probability that this risk will materialize relying on the information offered by the platform.[6] This differs from the deposit contract, which is not specifically related to the terms of the lending contract on the asset side of the bank's balance sheet. The depositor does not observe the quality of the bank loan. If the bank is unsolvent, he may also benefit from deposit guarantee schemes up to a certain limit. Second, the investor on the platform may not withdraw its funds before they reach maturity, unlike in the deposit contract, which is a demandable debt contract. Therefore, unlike banks, platforms do not perform maturity transformation. However, as platforms do not bear the default risk of their borrowers, they often offer credit without requiring any collateral (see Galema, 2019, for evidence).[7]

[3] See Diamond and Dybvig, 1983, Gorton and Pennacchi, 1990.

[4] Diversification is often recommended by platforms. However, we do not study this aspect of investors' behavior in our model.

[5] In case the borrower defaults, the platform does not receive the servicing fee from the investor. Therefore, even if the investor bears all the risks, the platform's revenues are risky. Some alternative finance providers called balance sheet lenders fund the loans with their own funds and take on all the risks.

[6] Platforms are often described as information intermediaries, as opposed to credit intermediaries for banks.

[7] Examples of platforms that do not require any collateral from borrowers include October and Prexem in the French market. Galema (2019) documents a lower use of collateral in P2P lending than in bank lending to SMEs and analyzes whether substitutes such as personal or third-party guarantees can fulfill a similar role as collateral. According to other authors (e.g., Gambacorta et al., 2020) big tech platforms, especially in China,

These differences between the bank and the platform model of financial intermediation explain why platforms are not defined as banks in several jurisdictions, though they perform the traditional brokerage function of financial intermediaries (see Havrylchyk and Verdier, 2018).[8] Several regulators do not allow online platforms to manage deposit accounts, forcing them to rely on banks to serve their consumers. The ability to manage deposit accounts is a key difference between both types of intermediaries in various countries and jurisdictions (e.g., Austria, Belgium, Finland, France, European Union). To overcome their limited ability to collect deposits or originate loans, several online platforms partner with banks.[9]

In terms of pricing, platforms are usually compensated with origination and ongoing fees on the borrower side (typically from 1 to 6% of the loan amount) and servicing fees on the investor side (around 1% of principal plus interest).[10] The platform uses asymmetric pricing on both sides to attract both investors and borrowers, who exert externalities on each other. On the one hand, the borrower takes into account the probability of being funded by an investor in its decision to demand a credit on the platform. On the other hand, the investor takes into account the probability of being reimbursed in its choice to fund a loan application.

Finally, the different business models of banks and platforms imply different costs, both for themselves and for their customers (e.g., search costs). On the borrower side, platforms allow consumers to make a credit application online, which reduces the cost of access to credit.[11] Moreover, since online lenders face lighter regulation than banks, it is often argued that their funding costs are lower than the banks' cost of capital. On the other hand, one

use consumer data as collateral. Platforms may use alternative data sources to screen borrowers, thereby serving specific groups of consumers (e.g., students, small businesses) without requiring any collateral nor credit history.

[8]See OECD (2018) for examples of different regulatory frameworks for crowdfunding platforms.

[9]For example, in the United States, Prosper and Lending Club are not allowed by regulation to originate loans. They rely on the origination services offered by WebBank, a FDIC-insured, Utah-chartered industrial bank that originates all loans sold through their marketplaces. After originating the loan, WebBank sells it back to the platform and charges a fee for this operation. Borrowers who seek credit from Lending Club or Prosper need to prove that they have a valid bank account. See the BIS annual report (2019) for other examples of business models for online credit platform (chapter on Big tech in finance, opportunities and risks).

[10]As argued by Wang (2019), several FinTech lenders tend to earn net interest margins as banks.

[11]The cost of seeking credit on the platform includes the cost of registering on the platform's website, the cost of gathering all the information demanded by the platform (such as the proof of citizenship, the legal residence, the proof of bank account ownership, etc...). This cost may also include the cost of finding the relevant platform to apply for a credit. For example, Adam et al. (2017) use survey data to show that only 25% of consumers are aware of online lenders. The cost of seeking credit from a bank includes the transportation cost of going to the nearest bank branch (see Havrylchyk et al., 2018).

could argue that banks have a large stock of intangible capital that entrants do not possess, namely data on their customer base.[12] To describe in a parsimonious way these differences in the costs of banks and platforms, we consider that the platform marginal cost is lower than the one of the bank.

Given their specificities, whether competition between banks and platforms enables a more efficient allocation of credit in specific market segments is an open research question. On the one hand, platforms may be more efficient than banks at offering credit to borrowers either because their cost of processing a credit application online is lower, or because they are able to gather alternative data sources on a targeted group of consumers. Moreover, banks incur high costs of serving borrowers who are not able or willing to pledge collateral.[13] Therefore, platforms could help smaller borrowers who are under-served by banks to have access to credit, relieving the problem of credit rationing that may be more severe for this population. On the other hand, several regulators (such as the Financial Conduct Authority in the United Kingdom) have expressed concerns that platforms could overcharge borrowers for their services. Because of crossed-network externalities, platforms need to attract both borrowers and investors to take off, which, as we shall demonstrate, may not reduce the cost of credit for small retail borrowers.

We build a model to study the equilibrium in the retail credit market when a bank competes with an alternative finance provider organized as a platform. Financial intermediaries have no informational advantage over each other. Ex ante, the financial intermediaries and the investor do not observe the borrower's probability of success. The financial intermediaries and the borrower do not know the investor's taste for liquidity. The borrower and the investor first open an account at a bank, which has a monopoly on deposits. Then, they may borrow or lend respectively at the bank or through a lending platform.

The market is two-sided and the bank and the platform act as intermediaries between the investor and the borrower. On the borrower side, the bank offers a standard debt contract,

[12] An interesting comparison is the entry of shadow banks, defined as the collection of non-bank financial intermediaries that provide services similar to banks but outside the normal banking regulation. Begenau and Landvoigt (2017) show that shadow banks capture a larger share of banking activity due to regulatory arbitrage. Buchak et al. (2018) find that non-banks enter more in US counties with more exposure to fair-lending lawsuits. More recently, Boot et al. (2021) raised the attention to the potential regulatory concerns related to shadow banking, as its development could increase financial system fragility.

[13] See the OECD Report: Enhancing SME access to diversified financing instruments, February 2018.

in which all firms are asked to provide the same amount of collateral. The collateral enables the bank to select a borrower of better quality, while the platform does not ask for collateral. On the investor side, the bank guarantees the return on deposits to the investor while, on the platform, the lender bears all the risk, being reimbursed only in case of success. In this context, we characterize the optimal repayment rates chosen by the bank and the platform and the deriving market structure. If the platform enters the market, the bank attracts the projects with the higher expected return, while the others are served by the lending platform. We analyze the impact of the characteristics of the return on deposits and the borrower repayment to the bank on investor and borrower participation in the platform. Logically, we show that investor participation in the platform decreases with the return on deposits, that is, if investing in the bank becomes more attractive. Interestingly, we show that investor participation in the platform may vary non-monotonically with the borrower repayment to the bank, which determines the average quality of borrowers on the platform. In some cases, investor participation in the platform may even be reduced when the platform attracts borrowers of better quality. On the one hand, the investor values a higher average quality of borrowers on the platform. On the other hand, the platform may extract more surplus from the investor by decreasing the return on investment when the average quality of borrowers increases. The result of these two effects on investor participation depends both on borrower and investor heterogeneity.

Similarly, the borrower repayment to the bank has an ambiguous impact on borrower participation in the platform. Depending on borrower heterogeneity, the platform may choose to raise the borrower repayment when the bank offers a more attractive interest rate to borrowers. This is due to the negative externality that the bank exerts on the quality of the platform's loans. If the bank offers better credit conditions to borrowers, the average quality of bank borrowers decreases, and so does the average quality of platform borrowers. The platform then needs to increase the return offered to investors to ensure their participation. However, since the platform balances its revenues from both sides of the market, in some cases it may choose to increase borrower repayment relatively more than the return offered to the investor. We identify the conditions under which the platform adjusts the price structure in favor of investors, to the detriment of borrowers.

At the first stage of the game, if it anticipates platform entry, the bank chooses the return on deposits so as to equalize the marginal cost and the marginal benefit that the investor will fund a loan on the platform. The marginal borrower is set such that the marginal benefits of in-house lending activities are equal to the marginal profits of outsourcing loans to the platform. Then, we derive the equilibrium of the game. We show that the bank offers a return on deposits that is equal to the return on the risk-free asset plus a premium that depends on the attractiveness of the platform to the investor in terms of liquidity risk. The bank reduces the marginal borrower compared to the monopoly case and renounces to profits on lending transactions to extract surplus from the additional depositors who borrow from the platform. Finally, we discuss how bank-platform competition could impact the transmission of the monetary policy. We identify several effects that are caused by competition with the platform and show that the transmission mechanism of the monetary policy may be either weakened or strengthened.

The remainder of the paper is as follows. In Section 2, we present the literature that is related to our study. In Section 3, we build a model to study the equilibrium on the credit market when a bank competes with a platform. In Section 4, we solve for the equilibrium of the game. In Section 5, we discuss some policy implications of our model, such has the effects of bank-platform competition on the transmission of the monetary policy. Finally, we conclude.

2 Related literature

Our paper contributes to the burgeoning literature on P2P lending platforms (see Morse, 2015, Belleflamme et al., 2016, and Havrylchyk and Verdier, 2018, for surveys). This literature is mostly empirical and we are not aware of any theoretical work in the two-sided market literature on lending platforms.

A strand of the literature focuses on the supply-side by analyzing how platforms select borrowers and price credit risk. Several papers study the determinants of borrower funding on platforms (Butler et al., 2016, **Siegel and Young, 2012**, Hertzberg et al., 2018, Lin et al., 2013), or try to quantify the impact of borrowers' soft information on lending outcomes

(Duarte et al., 2012, Iyer et al., 2016). Other papers analyze the platform's incentives to offer information to investors. Using data from Lending Robot, Vallée and Zeng (2019) show that sophisticated investors select loans differently and tend to outperform less sophisticated ones. However, the outperformance shrinks when the platform reduces the information provision to investors. Other papers study the market design of platforms and, in particular, the efficiency of an auction process compared to a system with posted prices (e.g., **Franks et al., 2018**, Liskovich and Shaton, 2017). Cong et al. (2019) provide evidence of crossed-network externalities between investors and borrowers and show that their magnitude depends on the maturity of the platform.

Our paper is also related to an emerging empirical literature that aims at analyzing competition between banks and platforms. The main research question is whether platform credit is a complement or a substitute for bank credit. In this context, several papers provide empirical evidence that P2P lenders complement banks by offering credit to high-risk borrowers that are usually excluded from the retail credit market (see De Roure et al., 2018, Butler et al., 2016). In particular, Butler et al. show that borrowers who are located in more competitive markets demand lower reservation rates on P2P platforms. Using data from the platforms Prosper and Lending Club in the United States, Havrylckyk et al. (2018) show that P2P platforms have made inroads in counties characterized by a smaller density of bank branches and a lower HHI index.

Several papers concentrate on specific market segments, such as personal loans or revolving accounts and try to measure whether P2P credit is a substitute to bank credit. Balyuk (2018) provides evidence that banks rely on certification by P2P lenders when deciding to increase the amount of credit available on revolving accounts. This increase is larger for borrowers who are more credit constrained. Wolfe and Yoo (2018) analyze the substitution between bank credit and P2P platforms on the personal loan segment in the United-States. They show that the substitution effect occurs most strongly among poor credit borrowers. On the contrary, P2P platforms may complement banks by offering better credit facilities to higher quality credit borrowers. Their study reveals that the intensity of competition between P2P platforms and banks depends on the bank's size and the degree of competition in banking retail markets. Small commercial banks may lose up to 1.8% of their personal loan volume following an increase of one standard deviation of P2P lending activity. Furthermore, banks are more affected by entry in less competitive markets. Focusing also on personal credit, using individual borrower data, Di Maggio and Yao (2018) show that P2P platforms select borrowers who have ex ante good credit scores but who are more likely to default ex post. They show that platforms do not target borrowers who are credit-rationed by banks, but they do target those who tend to be more present-biased and who borrow over their means. Tang (2019) exploits a change in bank lending standards to show that P2P lending is a substitute for bank credit in terms of serving infra-marginal borrowers. At the same time, it complements bank credit with respect to smaller loans.

Our theoretical paper complements this empirical literature by studying how competition between a bank and a platform impacts borrower repayments. Our assumptions correspond to the empirical results of Tang (2019) or Wolf and Yoo (2018), because we assume that the borrower is financed either by the bank and the platform, but not by the two. As a consequence, the platform serves infra-marginal borrowers. We discuss in our extension section what happens if the bank and the platform lend to the same borrowers, which is closer to the work of Bayulk (2018) on revolving accounts.

There is also scarce emerging theoretical literature on competition between FinTech and banks. Parlour, Rajan, and Zhu (2020) study the impact of competition between FinTech and banks on the disruption of information flows stemming from payments. They show that FinTech competition benefits consumers with weak bank affinity. However, they do not study competition between banks and platforms. Moreover, their paper is focused on the informational advantage of banks over FinTech firms as regards the management of consumers' payment data. Verdier (2021) analyzes competition between banks and a deposit-taking digital provider. She studies how the entry of a digital currency provider may impact banks' cost of liquidity. As banks pass-through their marginal cost of liquidity to their consumers, the presence of a digital currency impacts the price of loans, deposits, and payment card transactions. Unlike the present paper, Verdier (2021) focuses on competition on the liability side of banks' balance sheet and models the complementarity between payments and deposits.

Our paper is also related to a wider strand of the literature that studies SMEs access to finance. An important research question is why SMEs choose to substitute bank credit with alternative funding souces. A literature studies why SMEs resort to venture capital (see Gompers and Lerner, 2011 for a survey). Berger and Schaeck (2010) show that SMEs substitute venture capital for multiple banking relationships and test whether firms use VC to avoid rent extraction from their main banks. In the FinTech environment, Chod and Lyandres (2021) develop a theoretical model to analyze the trade-off of risk-averse entrepreneurs between ICO financing and VC. They derive the conditions under which entrepreneurs prefer VC to ICO financing. The present paper studies both entrepreneurs and investor choices, taking into account the two-sided structure of the market and its consequences.

3 The model

We build a model to study the equilibrium on the credit market when a bank competes with an alternative finance provider organized as a platform. The platform is differentiated from the bank on the borrower side and on the investor side. On the borrower side, the platform offers a credit contract with no collateral and quicker access to credit. On the investor side, the platform enables the investor to choose whether or not to invest in an illiquid debt contract. Our model enables us to study how competition impacts repayment rates on the credit market and investor participation in the platform.

Borrower A risk-neutral borrower needs \$1 of funding to invest in a risky project that yields $y > 1$ with probability $\theta \in [0, 1]$ and 0 otherwise. Initially, the borrower has no monetary wealth and owns a collateral of value $C < 1$. His probability of success θ is private and unobservable by the financial intermediaries and the investor. The returns of the project cannot be modified, so there is no moral hazard.[14] Neither the bank nor the platform has an informational advantage on its competitor as regards to the observation of the borrower's probability of success.[15]

[14]In our paper, the bank's decision to ask for a collateral is exogenous. Our model follows the theories on the ex ante role of collateral (i.e., before the observation of the borrower's risk). Conversely, according to the ex post theories on the role of collateral, a bank is more likely to require riskier borrowers to pledge collateral once it has observed the borrower's risk.

[15]We do not model any information advantage of the bank over the platform and choose to leave this issue for future research. It can be argued that the bank has better information on the borrower's payment

Before asking for a loan, the borrower needs to open an account in the bank, for which the bank charges him a fixed fee F_B. When he opens an account, the borrower does not know his probability of success, that is revealed to him at the second stage. However, the ex ante distribution of θ is common knowledge (i.e., it is also known to the financial intermediaries and the investor). The probability of success θ is distributed on $[0, 1]$ according to the probability density h and the cumulative H.[16]

At the following stage, the borrower may choose to borrow from the bank or from the platform. The bank contract involves a fixed repayment R_B^b in case of success and the payment of the collateral C in case of failure. The platform contract involves a fixed repayment R_B^p in case of success, but no collateral in case of failure. In both contracts, the borrower is protected by limited liability in case of failure.

If the borrower seeks credit from the bank (resp., the platform), he incurs a fixed search cost $s_b \geq 0$ (resp., s_p). We normalize s_p to $s_p = 0$.[17]

If the borrower only seeks credit from the bank, he is funded with certainty provided he is able to supply the collateral. If the borrower seeks credit from the platform, he is not funded with certainty. The borrower forms passive expectations of the probability p_e of being funded on the platform, because he cannot observe the contract offered by the platform to its investor.[18] We assume that the borrower may not obtain credit from the bank if he is not funded by the platform. Therefore, the borrower obtains an expected utility

$$u_B^b(\theta) = \theta(y - R_B^b) - (1 - \theta)C - s_b \tag{1}$$

account. On the other hand, the platform has better information on other characteristics of the borrower. According to Gambacorta et al. (2020), big tech companies use data as collateral, which enables them to supply credit with a much lower amount of collateral than banks.

[16] As in the model of de Meza (2002), we assume that borrowers differ in terms of expected returns. De Meza (2002) explains why this view is more consistent with stylized aspects of SME financing than the model of Stiglitz and Weiss (1981), who assume that borrowers differ in terms of risk.

[17] This does not impact any of the results that we obtain in the paper as long as we assume that the cost of seeking credit from the bank is higher for the borrower, that is, that $s_b - s_p > 0$. If $s_p > 0$, the indifferent borrower between taking a loan on the platform and in the bank depends on the difference in search costs $s_b - s_p$.

[18] This implies that the borrower has fixed expectations of the investor's decision to participate in the platform (see Hagiu and Halaburda, 2014). Therefore, he cannot adjust his expectation regarding investor participation in response to any changes in bank and platform prices. In turn, the bank and the platform treat the borrower's expectations as fixed when they set their prices. Expectations are fulfilled in equilibrium.

if he seeks credit from the bank and an expected utility

$$u_B^p(\theta) = p_e\theta(y - R_B^p) \tag{2}$$

if he seeks credit from the platform. The borrower's reservation utility is equal to zero if he does not borrow. We denote by θ_0 the marginal borrower, i.e., the borrower who is indifferent between borrowing from the bank or the platform.

Investor A risk-neutral investor has $1 of funds and may choose between three investment opportunities: the risk-free asset, which yields a return of $R_f \geq 1$, bank deposits, which yield a return of R_d, and a platform loan, which yields a return of R_I^p.[19]

Investment opportunities are differentiated in terms of risk and liquidity.[20] Bank deposits are perfectly liquid and riskless because of a deposit insurance scheme. Therefore, if he invests in bank deposits, the investor obtains a utility

$$u_I^b(R_d) = R_d - 1. \tag{3}$$

The platform loan is risky and illiquid. The investor obtains the return R_I^p from the platform only if the borrower's project is successful. As he observes the contract that the platform offers to the borrower (but not his probability of success), the investor is able to form responsive expectations of the probability of being reimbursed on the platform, depending on the average probability of success of the borrower if the latter takes a loan on the platform, that is, $p_M(\theta_0)$.[21] The investor incurs some disutility $v \in [\underline{v}, \overline{v}]$ of investing in a platform loan than in bank deposits, materializing his private taste for liquidity. Therefore, if he invests in

[19] The return corresponds to the sum of the principal of the loan, the interest rate, net of the servicing fee.

[20] As there is a single investor in our framework, we focus on modeling an externality between the borrower and the investor. We leave for future research the issue of externalities between investors or between borrowers that are surveyed in Belleflamme et al. (2016).

[21] We do not model screening efforts of investors and leave this aspect of the market for future research. **Murphy (2016)** makes a distinction between the passive and the active investor model. In the active mode, investors select loans which are posted on the platform and participate to the selection process. In the passive model, investors decide to invest according to the average characteristics of the borrower and the maturity of the loan rather than specific loan characteristics (Davis and Murphy, 2016).

a platform loan, the investor obtains the utility

$$u_I^p(v, R_I^p, \theta_0) = p_M(\theta_0) R_I^p - v - 1. \tag{4}$$

Before investing either at the bank or the platform loan, the investor needs to open an account at the bank, for which he pays a fixed fee F_I. The decision to open an account at the bank depends on the return on the risk-free asset R_f and on the surplus that the investor expects to obtain either from bank deposits or investing in the platform.[22] At this stage, neither the investor nor the financial intermediaries are aware of the investor's private taste for liquidity that his revealed to him in the subsequent stage. All players know that the taste for liquidity v is distributed on $[\underline{v}, \overline{v}]$ according to the probability density g and the cumulative G. After opening a bank account, the investor learns his private taste for liquidity and decides whether or not to keep its funds in the bank account or fund a platform loan. The marginal investor, i.e., the investor who is indifferent between lending through the bank or the platform, is denoted by v_0.[23]

The bank The bank offers deposit contracts to borrowers and investors in exchange for fixed fees denoted by F_B and F_I, respectively. It is necessary to open a deposit account in order borrow from the platform or invest in the platform. If the investor keeps its money in the bank instead of lending on the platform, the bank pays him the return on deposits R_d.

The bank offers a lending contract to the borrower that involves the fixed repayment R_B^b in case of success and the payment of the collateral C in case of failure. The costs of proposing the lending contract to its clients is equal to $c_b \geq 0$. We assume that the bank does not price discriminate between borrowers by offering them a different type of contract that does not require collateral.[24]

[22] We do not make any assumption on the type of investor that is funding the loans on the platform. Over the years, institutional investors have taken an increasing share of the platforms' funding sources (see Zhang et al., 2015). Moreover, we do not consider that the investor may invest both in the bank and the platform. The project is indivisible in our setting.

[23] We do not model the risk of platform failure that could also impact the investor's incentives to participate in the platform.

[24] This simplifying assumption can be motivated by the existence of regulatory constraints such as capital requirements. Degryse et al. (2019) show that higher capital requirements imply that banks require loans to be collateralized more often.

The bank chooses the terms of the deposit contracts and the borrower repayment before platform entry.[25] The platform is not allowed by regulation to issue loans, nor to manage deposit accounts. It has to rely on the bank to serve its borrowers and may pay an issuing fee for it. In that case, the platform and the bank are organized as the notary model (see Kirby and Worner, 2015). This is in line with our understanding of the development of the Fintech sector. As Boot et al. (2021) claim, the development of digital platforms could drive a vertical reorganization of the sector, in which banks would increasingly specialize in upwards services providing maturity transformations, while platforms are likely to increase their presence in the downwards market of credit supply. Without loss of generality, we normalize the net revenue of the bank on outsourced loans to zero.[26]

The bank's profit is π^b and it is the sum of the profit made on home borrowers π^b_h (i.e., the borrowers who choose to remain in the bank) and the profit made on loans that are outsourced to the platform π^b_o if the bank issues them.

The platform The platform may offer credit to the borrower if it attracts funds from the investor.[27] The platform offers a lending contract to the borrower that involves the fixed repayment R^p_B in case of success and no collateral in case of failure. The platform shares some risk with the investor who is offered R^p_I if the borrower is successful and zero otherwise.[28] Serving the borrower costs c_p to the platform, where the marginal cost c_p is lower than the bank's marginal cost c_b. The platform's profit is π^p. The platform is not allowed by regulation to manage deposit accounts.[29]

[25] Such an assumption could be justified by the fact that large banks do not modify their contracts frequently, whereas platforms may have the opportunity to change their prices more rapidly because they operate online with lighter internal constraints.

[26] This normalization does not impact our results if this amount is exogenous (e.g., if the issuing fee is regulated or cost-based). Adding an issuing fee a paid by the platform to the bank and an issuing cost k_b for the bank would modify the results only marginally. In practice, this would impact the opportunity cost for the bank of issuing a credit to the platform from R_f, the forgiven risk-free return, to $R_f - (a - k_b)$. In contrast, the costs of the platform to finance a loan are increased by a. When including these modifications, all the qualitative results of the paper are unaffected.

[27] In our framework, we focus on the entry of a monopoly platform. In several markets, there are many P2P lending platforms. However, because of network effects and the need to reach a critical mass of users, there is often one dominant platform in the market that captures a large share of borrowers.

[28] The net-interest margin and the sum of servicing and ongoing fees are equivalent because the loan amount is fixed. We do not model the fixed fee that the platform receives for originating the loan.

[29] We assume that the platform and the bank are distinct financial intermediaries in our paper. However, both players could be integrated. For example, the FinTech lending platform Marcus is owned by Goldman

Assumptions:

(A1) The credit market is covered under duopoly.

To be satisfied, Assumption (A1) implies that at the equilibrium, all borrowers derive a positive utility of taking a loan.

(A2) $y \geq s_b + c_b + R_f$.

Assumption (A2) ensures that there is an interior solution if no investor wishes to fund a loan on the platform. It means that the social value of the project is higher than its costs if the project is riskless.

In the paper, we will use the notations:

- $\underline{E}(\theta_0) = \int_0^{\theta_0} \theta h(\theta) d\theta$ and $\overline{E}(\theta_0) = \int_{\theta_0}^1 \theta h(\theta) d\theta$,
- $\underline{V}(v_0) = \int_{\underline{v}}^{v_0} v g(v) dv$ and $\overline{V}(v_0) = \int_{v_0}^{\overline{v}} v g(v) dv$.

Example: In the paper, we present a simple example in which θ and v are both uniformly distributed on the interval $[0, 1]$.

Timing of the game: The timing of the game is as follows:

- Stage 1: The bank sets the deposit fees for the investor and the borrower, F_I and F_B, respectively. It chooses the repayment of the lending contract R_B^b and the return on deposits R_d.
- Stage 2: The borrower and the investor decide whether or not to open an account at the bank.
- Stage 3: The platform chooses the repayment of the lending contract R_B^p and the return offered to investors R_I^p.
- Stage 4: The borrower learns his private probability of success θ and decides whether or not to borrow from the bank or the platform. The investor learns his private taste for liquidity v and decides to lend to the borrower via the bank or via the platform.

Sachs. Lending Club has recently acquired the bank Radius.

- Stage 5: The project payoffs materialize. If the project is successful, the borrower pays the interest rate to the investor (resp., the bank) if he has borrowed from the platform (resp., the bank). The bank pays the deposit rate to the investor in any case. If the project is not successful, the borrower defaults and the bank seizes the collateral.

4 Competition between the bank and the platform

In this section, we study the equilibrium when a bank competes with a lending platform in the credit market.

4.1 Stage 4: The investor and borrower decisions

Solving the game backwards, we first study the choices of the investor and the borrower at stage 4, following the realizations of parameters v and θ.

4.1.1 The investor's funding decision

At stage 4, the investor decides whether or not to lend to the borrower. If he observes that the borrower is seeking credit from the bank, the investor always agrees to leave its funds in the bank if he obtains at least the return on the safe asset (i.e., if $R_d \geq R_f$). In what follows, we focus on an equilibrium in which the bank offers at least the return on the risk-free asset to the investor, otherwise, the bank does not make any profit.

If he observes that the borrower is seeking credit from the platform, the investor prefers to lend through the platform if and only if

$$u_I^p(v) \geq u_I^b(v) \equiv R_d - 1. \tag{5}$$

Since $R_d \geq R_f$, this implies that, if the investor prefers to lend through the platform, this option is also better than investing in the risk-free asset.

We denote by $v_0(R_I^p, \theta_0, R_d)$ the taste for liquidity that leaves the investor indifferent between leaving his funds in the bank or funding a loan on the platform. From (5), the taste for liquidity of the marginal investor is implicitly defined by $u_I^p(v_0(R_I^p, \theta_0, R_d)) = R_d - 1$.

Therefore, from (4), if $p_M(\theta_0)R_I^p - R_d$ belongs to $(\underline{v}, \overline{v})$, the marginal investor is given by

$$v_0(R_I^p, \theta_0, R_d) \equiv p_M(\theta_0)R_I^p - R_d. \tag{6}$$

If $R_d \geq p_M(\theta_0)R_I^p - \underline{v}$, the marginal investor is given by $v_0(R_I^p, \theta_0, R_d) = \underline{v}$. If $R_d \leq p_M(\theta_0)R_I^p - \overline{v}$, the marginal investor is given by $v_0(R_I^p, \theta_0, R_d) = \overline{v}$.

Investor participation on the platform depends on the return offered by the platform R_I^p. Moreover, it also depends on the marginal borrower θ_0 and the deposit rate R_d. Hence, the bank exerts an externality on the platform in its choice of the borrower repayment and the deposit rate.[30] If $p_M(\theta_0)R_I^p - R_d$ belongs to $(\underline{v}, \overline{v})$, the investor lends through the platform if and only if the expected return offered by the platform is sufficiently high with respect to the deposit rate and if the investor's taste for liquidity is low enough (i.e., if $v \leq v_0(R_I^p, \theta_0, R_d)$). Otherwise, the investor prefers to leave its funds in the bank. If the deposit rate is high enough (i.e., if $R_d \geq p_M(\theta_0)R_I^p - \underline{v}$), the investor never lends on the platform. If the deposit rate is low enough (i.e., if $R_d \leq p_M(\theta_0)R_I^p - \overline{v}$), the investor always prefers to lend on the platform. Since v is distributed according to the probability density g with cumulative G, the probability that the investor wishes to lend on the platform is $G(v_0(R_I^p, \theta_0, R_d))$.

4.1.2 The borrower's demand for credit

At stage 4, the borrower decides whether or not to seek credit from the bank or the platform, if his expected utility of taking a loan on the platform is positive. The borrower seeks credit from the bank if and only if he obtains a higher expected utility of doing so, that is, if and only if

$$u_B^b(\theta) \geq u_B^p(\theta). \tag{7}$$

Suppose that neither the bank nor the platform captures the entire market and that the borrower anticipates being funded with probability $p_e > 0$ on the platform. Replacing $u_B^b(\theta)$ and $u_B^p(\theta)$ into Eq. (7) gives the indifferent consumer θ_0 between the bank and the platform,

[30] In France, in February 2017, the consumer association UFC Que Choisir argued that despite high advertised returns, the realized net returns for investors on French platforms could be lower than the return on the risk-free bank deposit asset after taxation and default. This view has been challenged by French platforms. In our model, we consider that investors are able to make rational expectations on their expected probability of receiving the return on their investment.

that is,

$$\theta_0 = \frac{C + s_b}{y(1 - p_e) + C - R_B^b + p_e R_B^p}. \tag{8}$$

The marginal borrower depends on the differentiation between the contracts offered by both financial intermediaries (through the collateral), the differentiation in quality (in terms of search costs) and the respective probabilities of being funded by the bank and the platform. Finally, note that either the bank or the platform can capture the entire lending market depending on the amount of collateral for the bank loan.[31] If $p_e = 0$, the borrower never takes a loan from the platform and we have $\theta_0 = \theta_{0B}$ given in Appendix A.[32]

If $\theta_0 \in (0, 1)$, the platform attracts the infra-marginal borrowers (i.e., such that $\theta \leq \theta_0$) and the bank attracts the borrowers such that $\theta \geq \theta_0$. Since θ is distributed according to the probability density h with cumulative H, if the market is covered, the demand for credit on the platform is given by $H(\theta_0)$ and the demand for credit at the bank is given by $1 - H(\theta_0)$.

From (8), the platform obtains a higher share of consumers when the amount of collateral demanded by the bank increases, when the quality advantage of the platform (in terms of search costs) increases, when the difference in repayment rates decreases or when consumers anticipate a higher probability of being funded.

4.2 Stage 3: Platform prices

Suppose the bank chooses a borrower repayment such that the borrower may wish to borrow from the platform (i.e., $\theta_0 \in (0, 1)$), and a return on deposits such that the investor may wish to fund a loan on the platform (i.e., the return on deposits R_d belongs to $(p_M(\theta_0)R_I^p - \overline{v}, p_M(\theta_0)R_I^p - \underline{v})$). At stage 2, the platform chooses the return R_I^p given to investors and the borrower repayment R_B^p that maximize its expected profit given by

$$\pi^p = G(v_0(R_I^p, \theta_0, R_d)) \int_0^{\theta_0} (\theta(R_B^p - R_I^p) - c_p)h(\theta)d\theta. \tag{9}$$

[31] The bank captures the entire market if $y < R_B^p$. The platform captures the entire market if $C + s_b \geq y(1 - p_e) + (C - R_B^b) + p_e R_B^p$.

[32] We detail in Appendix A the bank's behavior if the platform does not enter the market. If the borrower anticipates that he will not be funded on the platform (i.e., $p_e = 0$), he does not get any utility of taking a loan on the platform. Therefore, he trades off between taking a loan from the bank and not borrowing.

If the platform offers the return R_I^p to the investor, for a given marginal borrower is θ_0, there is a probability $G(v_0(R_I^p, \theta_0, R_d))$ that the investor wishes to lend on the platform. The platform attracts the infra-marginal borrowers (i.e., such that $\theta \leq \theta_0$). In case of success, with probability θ the platform obtains the loan repayment R_B^p and offers the return R_I^p to the investor.[33] The platform's margin $R_B^p - R_I^p$ corresponds to the sum of the fees paid by the borrower and the investor each time a borrower repays a loan (servicing+ongoing fees). In all cases, the platform incurs the cost c_p of serving the borrower.

Substituting the average probability of success $p_M(\theta_0) = (\int_0^{\theta_0} \theta h(\theta) d\theta)/H(\theta_0)$ into (9), the platform's profit is given by

$$\pi^p = G(v_0(R_I^p, \theta_0, R_d))H(\theta_0)((R_B^p - R_I^p)p_M(\theta_0) - c_p). \tag{10}$$

In Proposition 1, we give the platform's best-responses $\widehat{R_B^p}$ and $\widehat{R_I^p}$ to the marginal borrower θ_0 chosen by the bank if there is an interior solution to the platform's profit-maximization problem.[34] For this purpose, we use the following notations:

- ε_I the elasticity of investor demand to the return R_I^p,
- ε_B the elasticity of borrower demand to the repayment R_B^p,
- μ_P the elasticity of the platform's expected revenue $p_M(\theta_0)R_B^p$ to the repayment R_B^p.

We assume that the second-order conditions of profit-maximization hold. In Appendix B-2, we show that this is the case with our uniform distributions.

Proposition 1 *Suppose that there exists an equilibrium in which the platform enters the market and shares the lending market with the bank. For a given marginal borrower θ_0 and a deposit rate R_d chosen by the bank, if there is an interior solution to the platform's profit-maximization problem, the platform chooses a return for investors such that*

$$\frac{(\widehat{R_B^p} - \widehat{R_I^p})p_M(\theta_0) - c_p}{p_M(\theta_0)\widehat{R_I^p}} = \frac{1}{\varepsilon_I}, \tag{11}$$

[33] This is equivalent to a direct repayment from the borrower to the investor.

[34] There is a corner solution if either i) the investor never funds a loan on the platform, ii) the investor always funds a loan on the platform, iii) the borrower always prefers to borrow from the platform, iv) the borrower never borrows from the platform. See Appendix B-1 for the details.

and the price structure such that

$$\frac{\widehat{R_I^p}}{\widehat{R_B^p}} = \frac{\mu_P \varepsilon_I}{\varepsilon_B}. \tag{12}$$

Proof. See Appendix B-1. ∎

On the investor side, the platform trades off between increasing the return offered to the investor, which generates a higher volume of transactions, and lowering it to increase its margin in case of success. For a given quality of the bank's lending portfolio (represented by the marginal borrower), the platform chooses its mark-up on its marginal cost according to the Lerner formula. All else being equal, the higher the elasticity of investor demand to the return R_I^p, the lower the platform's mark-up on its marginal cost.

On the borrower side, the platform trades off between increasing the loan repayment, as it increases its margin, and lowering the loan repayment, to increase the quality of borrowers who seek credit on the platform. A higher average quality has a positive marginal impact on investor demand. The platform chooses the repayment on the borrower side such that the marginal gain from a higher repayment exactly compensates the marginal loss from the surplus that is extracted from the marginal borrower and the marginal investor.

In Lemma 1, the ratio $\widehat{R_I^p}/\widehat{R_B^p}$ corresponds to the price structure mentioned in the literature on platform markets (see Rochet and Tirole, 2003). The price structure is equal to the ratio of the elasticity of the investor demand to the return R_I^p, divided by the elasticity of the marginal borrower to the repayment R_B^p, weighted by the elasticity of the platform's revenue to the repayment. Since the platform earns revenues from both sides of the market, it adjusts the price structure to account for the differences in demand elasticities between both sides. However, our model differs from Rochet and Tirole (2003) because the platform's revenue is uncertain. This explains why, in Proposition 1, the price structure is weighted by μ_P, the elasticity of the platform's expected revenue to the borrower repayment.[35]

In practice, lending platforms often charge asymmetric rates on both sides of the market. In particular, there is empirical evidence that platforms may exert their market power by increasing the interest rates charged to borrowers, without paying high interest rates to

[35] Remark that for an equilibrium in which the platform enters the market to exist, it must be that, at the platform's best-responses $\widehat{R_B^p}$ and $\widehat{R_I^p}$, the marginal borrower obtains a positive utility of taking a loan on the platform and the marginal investor obtains a positive utility of funding a loan on the platform.

investors. For example, in July 2018, the Financial Conduct Authority in the United Kingdom expressed the concern that platforms may overcharge borrowers on the mortgage residential market, showing that in some cases investors would only receive a 3% return while borrowers pay an interest rate exceeding 30%. De Roure et al. (2018) document for a German P2P lender that P2P loans have higher interest rates, while being riskier and less profitable.

An example: If there is an interior solution, in our example, we find that

$$\widehat{R_B^p}(\theta_0, R_d) = 2(C + s_b + p_e(c_p + R_d))/(3\theta_0 p_e), \tag{13}$$

and

$$\widehat{R_I^p}(\theta_0, R_d) = (C + s_b - 2p_e(c_p - 2R_d))/(3\theta_0 p_e). \tag{14}$$

In the special case of a uniform distribution, the price structure $\widehat{R_I^p}/\widehat{R_B^p}$ is independent of θ_0.

Investor participation in the platform: Competition between the bank and the platform impacts the investor's decision to fund a loan on the platform. Investor participation in the platform depends both on the average probability of success of borrowers who demand a credit on the platform (i.e., the quality of borrowers) and the return offered by the platform in case of success. Therefore, the investor internalizes a share of the risk borne by the platform in its decision to fund a loan on the platform. Moreover, investor participation depends on the deposit rate chosen by the bank.

In Corollary 1, we give the implicit definition of the marginal investor $\widehat{v}_0$ as a function of the marginal borrower θ_0 and the deposit rate R_d when the platform chooses the prices that maximize its profit. We define $\widehat{v}_0$ as $\widehat{v}_0(\theta_0, R_d) \equiv v_0(\widehat{R_I^p}, \theta_0, R_d)$. For this purpose, let $\eta(\theta_0) \equiv p_M(\theta_0) R_B^p / \underline{\varepsilon}(\theta_0, R_B^p)$, where $\underline{\varepsilon}(\theta_0, R_B^p) = -(R_B^p/\underline{E}(\theta_0))(d\underline{E}(\theta_0)/dR_B^p)$ denotes the elasticity of the expected probability of success $\underline{E}(\theta_0)$ to the repayment R_B^p. In Appendix B-3, we prove that $\underline{\varepsilon}(\theta_0, R_B^p) = \theta_0^3 h(\theta_0) R_B^p / (\beta \underline{E}(\theta_0))$, where, if $p_e > 0$,

$$\beta \equiv (C + s_b)/p_e. \tag{15}$$

Therefore, we have

$$\eta(\theta_0) = \beta p_M(\theta_0)\underline{E}(\theta_0)/\theta_0^3 h(\theta_0). \tag{16}$$

Corollary 1 *Suppose that $p_e > 0$. If $R_d \geq \overline{R_d}(\theta_0) \equiv \theta_0\eta(\theta_0)/(\theta_0 - p_M(\theta_0)) - (c_p + \underline{v})$, the investor never lends on the platform and the marginal investor is given by $\widehat{v}_0(\theta_0, R_d) = \underline{v}$.*
If $R_d \leq \underline{R_d}(\theta_0) \equiv (\theta_0\eta(\theta_0) - 1/g(\overline{v}))/(\theta_0 - p_M(\theta_0)) - (c_p + \overline{v})$, the investor always lends on the platform and the marginal investor is given by $\widehat{v}_0(\theta_0, R_d) = \overline{v}$.
If $R_d \in (\underline{R_d}(\theta_0), \overline{R_d}(\theta_0))$, the marginal investor on the platform $\widehat{v}_0(\theta_0, R_d)$ is implicitly defined by

$$\widehat{v}_0(\theta_0, R_d) = \frac{\theta_0}{(\theta_0 - p_M(\theta_0))}\left(\eta(\theta_0) - \frac{G(\widehat{v}_0(\theta_0, R_d))}{g(\widehat{v}_0(\theta_0, R_d))}\right) - (c_p + R_d).$$

Proof. See Appendix B-3. ■

If the average probability of success is very elastic to the choice of the marginal borrower (i.e., if $\eta(\theta_0)$ given in Eq. (16) is low), there is a higher probability that no investor wishes to fund a loan on the platform, reflecting the fact that loans on the platforms are riskier than deposit accounts.

In Corollary 2, we express the platform's profit at the profit-maximizing prices as a function of the marginal borrower θ_0 chosen by the bank and the return on deposits R_d.

Corollary 2 *For a given marginal borrower θ_0 and a return on deposits R_d chosen by the bank, the platform makes a profit*

$$\pi^p(\theta_0, R_d) = H(\theta_0)\frac{G^2(\widehat{v}_0(\theta_0, R_d))}{g(\widehat{v}_0(\theta_0, R_d))}.$$

An example - uniform distributions: If v and θ are uniformly distributed on $[0, 1]$, we have $\eta(\theta_0) = \beta/4$ and $\beta = (C + s_b)/p_e$. If $R_d \in (\beta/2 - c_p - 3, \beta/2 - c_p)$, the marginal investor is given by $\widehat{v}_0(\theta_0, R_d) = (\theta_0/2)\widehat{R_I^p}(\theta_0, R_d) - R_d$, that is, we have

$$\widehat{v}_0(\theta_0, R_d) = \frac{C + s_b - 2p_e(R_d + c_p)}{6p_e}. \tag{17}$$

In the uniform distribution case, the marginal investor does not depend on θ_0.

From Corollary 2, the platform's profit is given by $\pi^p(\theta_0, R_d) = \theta_0(\widehat{v}_0(\theta_0, R_d))^2$. Substituting $\widehat{v}_0(\theta_0, R_d)$ given in Eq. (17), we find that

$$\pi^p(\theta_0, R_d) = \frac{\theta_0(C + s_b - 2p_e(R_d + c_p))^2}{36(p_e)^2}. \tag{18}$$

The impact of bank prices on investor participation: We analyze how bank prices (i.e., R_d and R_B^b) impact the investor's decision to fund a loan on the platform (i.e., $\widehat{v}_0$). Investor participation in the platform decreases with the return on deposits. Logically, if the return on deposits becomes more attractive, the investor chooses not to fund a loan on the lending platform. More interestingly, investor participation in the platform may vary non-monotonically with the borrower repayment to the bank, or equivalently, the quality of the marginal borrower θ_0. In some cases, investor participation may even decrease when the platform attracts a marginal borrower of better quality. This ambiguous impact of the borrower repayment to the bank on investor participation is caused by two effects. On the one hand, the investor values a higher average quality of borrowers on the platform when the borrower repayment to the bank increases. On the other hand, in some cases, the platform may decrease the return offered to the investor when the average quality of borrowers increases, as the platform may decide to extract more surplus from the investor. This second effect depends on the distribution of the probability of success and the distribution of the investor's taste for liquidity. In Appendix B-4, we show that $\partial\widehat{v}_0/\partial\theta_0$ has the sign of

$$\theta_0(\theta_0 - p_M(\theta_0))\eta'(\theta_0) + (\theta_0 p_M^{'}(\theta_0) - p_M(\theta_0))\left(\eta\theta_0 - \frac{G(\widehat{v}_0)}{g(\widehat{v}_0)}\right).$$

We have that $\theta_0 - p_M(\theta_0) \geq 0$ and $\eta(\theta_0) - \dfrac{G(v_0)}{g(v_0)} \geq 0$. The sign of $\theta_0 p_M^{'}(\theta_0) - p_M\theta_0$ and the sign of η' are ambiguous and depend on the distribution of the probability of success. In our uniform distribution case, since $p_M(\theta_0) = \theta_0/2$ and $\eta(\theta_0) = \beta/4$, $\widehat{v}_0$ is independent of θ_0. In the general case, $\widehat{v}_0$ depends on θ_0 and its variation with θ_0 reflects the platform's trade-off between increasing the repayment for borrowers to make more profit and lowering the repayment to increase investor and borrower participation in the platform. It can be either positive or negative depending on the shape of the distribution of θ on the interval

$[0,1]$. We give examples in Appendix B-5 of distributions such that investor participation in the platform becomes lower when the platform attracts borrowers of better quality.

The impact of bank prices on platform prices and borrower participation: In Lemma 2, we analyze how changes in the marginal borrower and the return on deposits impact the borrower repayment, the return offered to the investor and the price structure.

Lemma 1 *Assume that* $(\underline{v}+\rho)(G/g)'(\underline{v}) \leq c_p$. *The borrower repayment* $\widehat{R_B^p}$, *the return offered to the investor* $\widehat{R_I^p}$ *and the price structure* $\widehat{R_I^p}/\widehat{R_B^p}$ *increase with the return on deposits* R_d.

If $\partial\widehat{v}_0/\partial\theta_0 \leq 0$, *the borrower repayment* $\widehat{R_B^p}$, *the return offered to the investor* $\widehat{R_I^p}$ *and the price structure* $\widehat{R_I^p}/\widehat{R_B^p}$ *decrease with* θ_0. *If* $\partial\widehat{v}_0/\partial\theta_0 \geq 0$, $\widehat{R_I^p}$ *and* $\widehat{R_B^p}$ *may either increase or decrease with* θ_0 *and the price structure* $\widehat{R_I^p}/\widehat{R_B^p}$ *increase with* θ_0.

Proof. See Appendix B-6. ■

When the bank increases the return on deposits, the platform raises the return offered to the investor and the borrower repayment. Therefore, borrower participation in the platform is reduced. Moreover, the platform offers a relatively higher increase on the return offered to the investor than the repayment asked to the borrower.

The variations of the marginal borrower have a non-monotonic impact on the return offered to the investor and the platform's borrower repayment (and therefore, on borrower participation). They also have an ambiguous impact on the price structure that depends on the relationship between the marginal investor and the marginal borrower. Therefore, if the bank lowers the borrower repayment (or equivalently reduces θ_0), the platform may react by increasing the borrower repayment. Hence, competition between the bank and the platform may not lower repayment rates on the borrower side of the platform.

In Appendix B-7, we analyze how the platform's profit varies with the return on deposits, the marginal borrower and the level of collateral for a given expected probability that the investor will participate in the platform.

4.3 Stage 2: Bank accounts

The borrower (resp., the investor) decides to open an account at the bank if his expected surplus of borrowing (resp., investing) exceeds the deposit fee charged by the bank. We denote by $ES_B(R_B^b, R_d, \widehat{R_I^p}, \widehat{R_B^p})$ (resp., $ES_I(R_B^b, R_d, \widehat{R_I^p}, \widehat{R_B^p})$) the borrower's (resp., the investor's) expected surplus of leaving his money in a bank account. The borrower's participation constraint is given by

$$F_B \leq ES_B(R_B^b, R_d, \widehat{R_I^p}, \widehat{R_B^p}), \tag{19}$$

where

$$ES_B(R_B^b, R_d, \widehat{R_I^p}, \widehat{R_B^p}) = \int_0^{\theta_0} u_B^p(\theta)h(\theta)d\theta + \int_{\theta_0}^1 u_B^b(\theta)h(\theta)d\theta.$$

The borrower obtains the surplus $u_B^p(\theta)$ if he borrows from the platform (i.e., if $\theta \leq \theta_0$) and the surplus $u_B^b(\theta)$ if he borrows from the bank (i.e., if $\theta \geq \theta_0$). The investor's participation constraint is given by

$$F_I \leq ES_I(R_B^b, R_d, \widehat{R_I^p}, \widehat{R_B^p}), \tag{20}$$

where

$$\begin{aligned} ES_I(R_B^b, R_d, \widehat{R_I^p}, \widehat{R_B^p}) &= H(\theta_0)\left(\int_{\underline{v}}^{\widehat{v_0}} (u_I^p(v) - (R_f - 1))g(v)dv + (1 - G(\widehat{v_0}))(R_d - R_f)\right) \\ &\quad +(1 - H(\theta_0))(R_d - R_f). \end{aligned}$$

With probability $H(\theta_0)$, the borrower seeks credit from the platform. If the investor wishes to fund the loan (that is, if $v \leq \widehat{v_0}$), he obtains a surplus of $u_I^p(v) - (R_f - 1)$. If the investor does not wish to fund the loan (i.e., if $v > \widehat{v_0}$), he keeps his money in his bank account and obtains a surplus $R_d - R_f$. With probability $1 - H(\theta_0)$, the borrower does not seek credit from the platform and the investor also obtains a surplus $R_d - R_f$.

4.4 Stage 1: Bank prices

At the first stage, the bank chooses the deposit fees, the loan repayment and the return on deposits that maximize its profit. Suppose that there exists an equilibrium in which the platform enters the market.[36] The bank's profit is given by $\pi^b = F_B + F_I + \pi_h^l + \pi_o^l$, where π_h^l corresponds to the profit on in-house lending activities and π_o^l to the profit on lending activities that are outsourced to the platform. Note that we include in the profit on in-house lending activities the profit that the bank makes from investing in the risk-free asset if the borrower is funded neither by the bank nor by the platform.

As shown in Appendix C-ii, the bank can extract the maximum surplus from depositors through the deposit fees F_I and F_B. The total profit $\pi_h = \pi_h^d + \pi_h^l$ that the bank obtains from in-house lending activities is given by

$$\pi_h(\theta_0) = \int_{\theta_0}^{1} (\theta y - s_b - c_b - R_f) h(\theta) d\theta. \tag{21}$$

The total profit $\pi_o = \pi_o^d$ that the bank obtains from outsourcing loans to the platform is given by

$$\pi_o(\theta_0, R_d) = \int_0^{\theta_0} \widehat{u}_B^p(\theta, \theta_0, R_d) h(\theta) d\theta + H(\theta_0) \int_{\underline{v}}^{\widehat{v_0}} (u_I^p(v) - (R_f - 1)) g(v) dv, \tag{22}$$

where $\widehat{u}_B^p(\theta, \theta_0, R_d) = p_e \theta (y - \widehat{R_B^p}(\theta_0, R_d))$ is the borrower's utility of taking a loan on the platform and $u_I^p(v) = p_M(\theta_0) \widehat{R_I^p}(\theta_0, R_d) - v - 1$ is the investor's utility of lending through the platform. The bank's total profit is therefore given by

$$\pi^b(\theta_0, R_d) = \pi_h(\theta_0) + \pi_o(\theta_0, R_d). \tag{23}$$

The bank's profit depends on the interest rate R_B^b only through the choice of the indifferent borrower θ_0. Therefore, it is equivalent for the bank to maximize its profit with respect to R_B^b or θ_0. We assume that the second-order conditions hold when the bank maximizes its profit with respect to θ_0 and R_d.[37] We denote the profit-maximizing marginal borrower and return on deposits by $\widehat{\theta_0}$ and $\widehat{R}_d$, respectively. We also denote by:

- $F_I^p(\theta_0, R_d) \equiv \int_{\underline{v}}^{\widehat{v_0}} (u_I^p(v) - (R_f - 1)) g(v) dv$ the expected surplus of investors who fund

[36] Such an equilibrium may not exist as we discuss in the following subsection, where we determine whether the bank prefers to accommodate platform entry, in case entry is not blockaded.

[37] In the Appendix, we show that the second-order conditions hold in our example with uniform distributions.

a loan on the platform,

- $\widehat{u}_B^p(\theta, \theta_0, R_d) = p_e\theta(y - \widehat{R_B^p}(\theta_0, R_d))$ the borrower's utility of taking a loan on the platform.

In Proposition 2, we explain how the bank chooses the return on deposits $\widehat{R}_d$ and the profit-maximizing marginal borrower $\widehat{\theta}$, if it accommodates platform entry.

Proposition 2 *Suppose that there exists an equilibrium with platform entry. If there is an interior solution, the bank chooses the deposit rate so as to equalize the marginal cost and the marginal benefit that the investor funds a loan on the platform, that is, we have*

$$\widehat{R}_d = R_f + \frac{(\widehat{\theta}_0 G(\widehat{v}_0) - p_M(\widehat{\theta}_0)p_e)(G/g)'(\widehat{v}_0)}{(\widehat{\theta}_0 - p_M(\widehat{\theta}_0))g(\widehat{v}_0)}, \tag{24}$$

where $\widehat{v}_0 = \widehat{v}_0(\widehat{\theta}_0, \widehat{R}_d)$. The bank chooses the marginal borrower such that the marginal profits on in-house lending activities are equal to the marginal profits of outsourcing loans to the platform, that is, at $R_d = \widehat{R}_d$ and $\theta_0 = \widehat{\theta}_0$, we have

$$\widehat{\theta}_0 = \frac{(c_b + s_b + R_f)}{y} + \frac{\overline{u}_B^p + \overline{F}_I^p}{y} + \frac{\frac{\partial \pi_o}{\partial v_0}\frac{\partial \widehat{v}_0}{\partial \theta_0} - p_e\underline{E}(\widehat{\theta}_0)\frac{\partial \widehat{R_B^p}}{\partial \theta_0}}{yh(\theta_0)}, \tag{25}$$

where $\overline{u}_B^p = \widehat{u}_B^p(\widehat{\theta}_0, \widehat{\theta}, \widehat{R}_d)$ and $\overline{F}_I^p = F_I^p(\widehat{\theta}, \widehat{R}_d)$.

Proof. See Appendix C. ■

If there is an equilibrium with platform entry, the bank chooses the return on deposits so as to equalize the marginal cost and the marginal benefit of increasing the probability that the investor will fund a loan on the platform (see Eq. (24)). If the bank raises the return on deposits, the investor is less likely to fund a loan on the platform because the return offered by the platform becomes less attractive, which implies that the bank's marginal benefit increases by $R_d - R_f$. The bank also takes into account the impact of its choice on the platform's prices at the next stage of the game. As shown in Lemma 2, a higher return on deposits increases the borrower repayment on the platform, which reduces the surplus that the bank extracts from the borrower-depositor who takes a loan on the platform.[38] A higher return on deposits increases the return offered to the investor on the platform and, therefore, the bank extracts a higher surplus from the investor-depositor who lends through the platform.

We now analyze the choice of the marginal borrower in Eq. (25). An increase in the marginal borrower has two effects on the bank's profit. First, it reduces the probability that a borrower will seek credit from the bank. The bank marginally loses the rents that it extracts from the marginal lender (see the left-hand side of Eq. (25)). Second, the probability that a borrower will seek credit from the platform increases. The bank gains the marginal revenues that it extracts from the marginal borrower and the investor who funds a loan on the platform through the deposit fees (see the right-hand side of Eq. (25)). The expected utility of the marginal borrower who seeks credit on the platform increases and investor participation in the platform becomes higher. Therefore, the bank extracts higher rents from lending transactions on the platform (i.e., $\overline{u}_B^p$) and higher rents from the deposits of investors who fund a loan on the platform (i.e., $\overline{F}_I^p$). The bank also takes into account the impact of its choice on the platform's prices, which is reflected by the last term of Eq. (25). However, as shown in Corollary 1, the marginal investor and the platform's prices may vary non-monotonically with the marginal borrower and, therefore, this effect is ambiguous.

The equilibrium if the platform enters the market: If there exists an equilibrium in which the platform enters the market, this equilibrium is defined by the marginal borrower θ_0^*, the return on deposits R_d^*, the borrower repayment on the platform $(R_B^p)^*$, and the return offered to the investor on the platform $(R_I^p)^*$, such that the consumer makes rational expectations of the probability of being funded. Since the consumer makes rational expectations of the probability of being funded, at the equilibrium, we have $p_e = G(\widehat{v}_0)$ if $\widehat{v}_0 \in (\underline{v}, \overline{v})$. We denote by $\widehat{v}_0{}^* = \widehat{v}_0(\theta_0^*, R_d^*)$. From Proposition 2, at the equilibrium, the return on deposits is implicitly defined by

$$R_d^* = R_f + \tau(\widehat{v}_0{}^*), \tag{26}$$

[38] The bank loses $-(p_M(\widehat{\theta}_0)p_e)(G/g)'(\widehat{v}_0)/((\widehat{\theta}_0 - p_M(\widehat{\theta}_0))g(\widehat{v}_0))$. This term corresponds to the marginal loss of surplus from the borrower-depositor.

where $\tau(x) = (G/g)(x)(G/g)'(x)$. The bank offers a return on deposits that is equal to the return on the risk-free asset plus a premium that depends on the attractiveness of the platform for the investor in terms of liquidity.[39] From Proposition 2, we show in Appendix C-vi) that the marginal borrower is implicitly defined by

$$y\theta_0^* = c_b + s_b + R_f + \overline{u}_B^p + \overline{F}_I^p + G(\widehat{v_0}^*)(\theta_0^* - p_M(\theta_0^*))(R_B^p)^*. \tag{27}$$

From Proposition 1, the borrower repayment on the platform $(R_B^p)^*$ and the return offered to the investor on the platform $(R_I^p)^*$ are implicitly defined by Eq. (11) and (12) evaluated at $\theta = \theta_0^*$ and $R_d = R_d^*$. This completes the definition of the equilibrium with platform entry, provided that such an equilibrium exists. Notice that, since $\theta_0^* \geq p_M(\theta_0^*)$, the average quality of the bank's lending portfolio increases following platform entry, that is, we have $\theta_0^* \geq \theta_{0B}$ given in Appendix A. At the equilibrium of the game, if the platform enters the market, the bank makes a profit given by

$$\pi^b(\theta_0^*, R_d^*) = \pi_h(\theta_0^*) + \pi_o(\theta_0^*, R_d^*). \tag{28}$$

We provide the necessary conditions such that there exists an equilibrium in which the platform enters the market. Such an equilibrium exists if the borrower obtains a positive utility of taking a loan on the platform, that is, if $y > \widehat{R_B^p}(\theta_0^*, R_d^*)$, and if the investor obtains a positive utility of funding a loan on the platform, that is, if $\widehat{v}_0(\theta_0^*, R_d) \geq \underline{v}$. Moreover, the bank should obtain a higher profit if the platform enters the market than if it does not under monopoly, that is, $\pi_o(\theta_0^*, R_d^*) + \pi_h(\theta_0^*) \geq \pi_h(\theta_{0B})$.[40]

An example: In our uniform distributions example, if there is an equilibrium with platform entry, rational expectations imply that the consumer anticipates being funded with

[39]Since we assumed that (G/g) is concave, the higher the marginal investor on the platform at the equilibrium, the higher the return on deposits. Indeed, the function τ is increasing.

[40]In Appendix D, we show that the bank can always deter entry, but may not always prefer to do so. The bank prefers to accommodate platform entry if the additional rents extracted from the deposit market compensate for a potential loss in revenues from lending transactions.

probability $p_e^* = \widehat{v_0}^*$, where

$$\widehat{v_0}^* = \frac{1}{8}(\sqrt{(R_f + c_p)^2 + 8(C + s_b)} - (R_f + c_p). \tag{29}$$

The equilibrium is implicitly defined by

$$R_d^* = R_f + \widehat{v_0}^*.$$

$$\theta_0^* = \frac{c_b + s_b + R_f}{y} + \overline{u}_B^p + \overline{F}_I^p + \widehat{v_0}^*(\theta_0^*/2)(R_B^p)^*$$

$$(R_I^p)^* = \frac{(C + s_b) + 2p_e^*(2p_e^* + 2R_f - c_p)}{3p_e^*\theta_0^*},$$

and

$$(R_B^p)^* = \frac{2(C + s_b + p_e^*(c_p + R_f + p_e^*))}{3p_e^*\theta_0^*}.$$

This interior solution holds if some types of investors and borrowers are willing to go the bank and other types on the platform. It is therefore necessary for the repayment asked by the platform to be lower than the value of the project, that is, that $(R_B^p)^* < y$ (otherwise the borrower will never participate in the platform). Moreover, the marginal borrower θ_0^* has to be strictly included in $(0, 1)$. Finally, the bank should obtain a higher profit with platform entry than under monopoly (which the bank can obtain choosing a sufficiently high R_d^*). For instance, if $R_f = 1$, all these conditions hold for intermediate values of the cost of the bank c_b.[41] If c_b is too small, than the bank monopolizes the investor side and $\widehat{v_0}^* = 0$. On the other hand, if c_b is too large, the platform monopolizes the market and $\theta_0^* = 1$. For intermediate values of the cost c_b the interior equilibrium exists.[42]

5 Discussion and policy implications

We discuss two policy implications of our model. First, we analyze whether competition between the bank and the platform could impact the monetary policy transmission mech-

[41] The necessary condition is $\frac{(15-36C-100s_b+49\sqrt{1+8(C+s_b)}}{64} < c_b < \frac{9-\sqrt{1+8(C+s_b)})8y-(69-12C-5\sqrt{1+8(C+s_b)}}{64}$.

[42] Simulations show that under the same condition the profit of the bank is higher under duopoly, so that the bank would not deter entry.

anism. Second, we study whether a regulation of the deposit rate could impact platform entry. Third, we discuss how our results are impacted if the bank and the platform lend to the same borrowers.

5.1 Bank-platform competition and monetary policy

The changes in the financial industry induced by new technologies is likely to affect monetary policy transmission and implementation. In particular, platform entry in the credit market can have an impact on the pass-trough of policy rates to lending conditions and deposit rates, which is a very relevant policy issue (see Boot et al., 2021). In principle, an increase in the return on the risk-free interest rate (i.e., a tightening monetary policy) should be passed through by banks and platforms to borrowers into higher repayment rates. Our model shows that the impact of bank-platform competition on the pass-through is not straightforward.

As shown in Eq. (26), an increase in the return on the risk-free asset has a direct positive effect on the return on deposits. There is also a direct positive effect on the marginal borrower, which implies that the bank reduces its credit supply.[43] However, there is an indirect effect that depends on competition between the bank and the platform. Anticipating that the platform might become more competitive if the bank increases the marginal borrower, the bank might decide not to tighten its credit supply as much as it would do without the platform.

In the paper's online Appendix, we show that the impact of competition has four additional effects on the pass-through of the return on the risk-free asset on the marginal borrower, as compared with the impact observed in the absence of platform competition. Two effects depend on the impact of an increase of the return of the risk-free asset on the localization and on the rents that the bank can extract from the marginal investor on the platform. An increase of the return on the risk-free asset decreases both the marginal investor and its rent. These two negative effects thus reduce the pass-through. The other two effects depend on the localization and on the rent that the bank can extract from the marginal borrower on the platform. These effects are due to the internalization of the platform's

[43] At the equilibrium, this is not necessarily the case because of the indirect effect of the bank's choice of the borrower repayment on the platform's price.

reaction at the next stage and have an ambiguous sign. The addition of the four effects may be either positive or negative depending on the distributions of θ and v. As we also show in the online appendix, they are generally negative in the uniform distribution case. Therefore, the presence of the platform may either weaken or strengthen the transmission of the monetary policy.

The platform also responds to changes in the monetary policy. The platform's best-response is indirectly related to the return on the risk-free asset through the return on deposits and the marginal borrower.[44] We have shown in Lemma 2 that the borrower repayment on the platform increases with the return on deposits, which is positively related to the return on the risk-free asset (at least by the direct effect). Hence, we obtain the standard effect that a higher return on the risk-free asset increases the borrower repayment on the platform. However, the effect that goes through the marginal borrower is less obvious, as we have also shown in Lemma 2, borrower repayment to the platform may be reduced when the bank increases its interest rate on loans. This implies that an increase in the return on the risk-free asset could also lead paradoxically to lower repayments on the platform. Our model shows that financial intermediaries organized as platforms may respond in non-trivial ways to changes in the monetary policy, depending on the magnitude of externalities between borrowers and investors (as modeled by investor and borrower heterogeneity in our setting).

One implication of our model is that central banks should carefully try to measure whether competition between banks and alternative finance providers may impact the transmission mechanism of the monetary policy, if platforms were to attract a more significant share of the retail credit market.

5.2 Deposit rate regulation and platform entry

Another relevant issue may be the impact of a regulation on the return on deposits. We have shown that platform entry in the market cannot occur if the rate of return on deposits chosen by the bank is sufficiently high. In our model, the bank does not need to modify market coverage on the borrower side to avoid entry of the platform, as long as it can adjust both

[44] The platform's best-response would also be directly related to the return on the risk-free asset if we did not assume that the market is covered on the investor side.

the return on deposit and the deposit fee to keep the monopoly profit constant. However, regulatory constraints on the deposit market, such as a cap on the return on bank deposits, could complicate the optimal strategies of banks in response to potential entry, making the entry of platforms in the credit market more likely. More generally, the reaction of banks to platform entry could be affected by a strengthening of a regulation of the deposit rate, which imposes an additional constraint on their behavior. This may induce them to choose a tariff structure that alters their market coverage, just to avoid or reduce platform entry. This is another policy issue that could be investigated more deeply in further research.

5.3 Complementarity between bank and platform credit

In our model, platform credit is a substitute for bank credit for borrowers who have an intermediate probability of success. Since $\theta_0^* \geq \theta_{0B}$, for given repayments charged by the bank and the platform, some borrowers who would normally go to the bank for credit, were it not for the platform, decide to switch to platform credit. However, the platform serves the borrowers who have a low probability of success and who would not be served under monopoly. Hence, the platform expands the credit supply to those borrowers of lower quality.[45] This assumption corresponds to the empirical results of Tang (2019) or Wolfe and Yoo (2018), who show that platforms serve infra-marginal borrowers.

However, in our setting, the borrower cannot get a loan both from the platform and the bank. In other words, there is single-homing, both on the borrower side and the investor side. We can discuss the other extreme case in which platform credit is always bundled to bank credit. In that case, the borrower always multi-homes and there is perfect complementarity between bank credit and platform credit. This could happen if the bank funds only a share x of the project, leaving the remaining amount $1 - x$ to the platform. In practice, in some market segments, several banks redirect their consumers to platforms for some aspects of the projects that they are unable to fund (i.e., intangible assets). To fix ideas, we can start considering a simple framework in which this share x is fixed and exogenous, depending

[45] Since borrowers borrow a constant amount from one financial intermediary (but not both), we do not capture in our framework the complementarities generated by higher volume of credit obtained from both intermediaries (as in Balyuk, 2018). Furthermore, we do not model the role of adverse selection caused by the fact that banks may be better informed on their borrowers due to their long-term relationships.

on the type of investment to be financed (only a share x of the borrower's project has the characteristics to be eligible for a standard bank credit contract backed by a collateral). Some results of the model become different in this context, because both the bank and the platform will lend to high-quality borrowers. The logic of the model remains similar. The borrower gets a loan from the bank and the platform if and only if

$$\theta \geq \frac{s_b + xC}{y(x + p_e(1-x)) - (xR_B^b + (1-x)p_e R_B^p) + xC} \equiv \theta_1.$$

The investor accepts funding the share $1-x$ of the project through the platform if and only if

$$xR_d + (1-x)p_M(\theta_1)R_I^p - (1-x)v - 1 \geq R_d - 1,$$

that is, if and only if $p_M(\theta_1)R_I^p - R_d \geq v$, where $p_M(\theta_1) = (\int_{\theta_1}^1 \theta h(\theta)d\theta)/(1 - H(\theta_1))$. The platform's profit is obtained by replacing θ_1 for θ_0 in Eq. (10). The result of Proposition 1 is unchanged. The elasticity of the expected probability of success is now simply calculated for high-quality borrowers. The definition of the marginal investor in Corollary 1 is identical (with θ_1 instead of θ_0), but the coefficient β of Eq. (15) is now given by $\beta = (xC + s_b)/(p_e(1-x))$. Since both the bank and the platform lend to borrowers of high quality, one part of the results of Lemma 2 may change. Investor participation in the platform may still vary non-monotonically with the borrower repayment to the bank. In addition, investor participation in the platform may also vary non-monotonically with the return on deposits. As bank credit and platform credit are perfect complements, the investor may also benefit from an increase in the return on deposits.

6 Conclusion

Competition between banks and platforms with asymmetric business models is likely to generate non-trivial effects in the retail credit market. The resulting impact on repayment rates for borrowers and returns for investors depends on the degree of heterogeneity between borrowers and investors. If platforms need to rely on banks for their activities, banks have incentives to open the retail credit market to competition, as long as the rents that they extract from depositors compensate for lower revenues from lending transactions. In the future, our work could be extended by taking into account the impact of platform competition on borrower repayments.

References

Adam, R., Dore, T., Greene, C., Mach, T., Premo, J. (2017). U.S. Consumers' Awareness and Use of Market Place Lending. Federal Reserve Bank of Boston. Current Policy Perspectives N.17-7.

Balyuk, T. (2018). Financial innovation and borrowers: Evidence from peer-to-peer lending. Rotman School of Management Working Paper.

Begenau, J., Landvoigt, T., 2018. Financial Regulation in a Quantitative Model of the Modern Banking System. Working Paper.

Belleflamme, P., Omrani, N., Peitz, M., 2016. The Economics of Crowdfunding Platforms. CESIfo DICE Report, Volume 14.

Berger, A. N. and Schaeck, K. 2010. Small and Medium-Sized Enterprises, Bank Relationship Strength, and the Use of Venture Capital. Journal of Money, Credit, and Banking, Vol. 43, pp. 461-490.

Boot, A., Hoffmann, P., Laeven, L., Ratnovski, L. (2021). Fintech: what's old, what's new?. Journal of Financial Stability, 53, 100836.

Buchak, G., G. Matvos, T. Piskorski, and A. Seru. 2018. FinTech, Regulatory Arbitrage, and the Rise of Shadow Banks. Journal of Financial Economics, December 2018, Vol. 130, Issue 3, Pages 453-483.

Butler, A. W., J. Cornaggia, and U. G. Gurun. 2016. Do local capital market conditions affect consumers' borrowing decisions? Management Science 63:4175–4187.

Chod, J., and Lyandres, E. 2021. A theory of icos: Diversification, agency, and information asymmetry. Management Science, forthcoming.

Cong, Lin and Miao, Qi and Tang, Ke and Xie, Danxia, Survival Scale: Marketplace Lending and Asymmetric Network Effects (October 2019). Available at SSRN: https://ssrn.com/abstract=3461893.

Davis, K. T., and Murphy, J. (2016). Peer to Peer lending: structures, risks and regulation. JASSA: The Finsia Journal of Applied Finance, 2016, 3-37.

Degryse, H. and Karapetyan, A. and Karmakar, S. (2019). To Ask or not to Ask: Collateral Vs. Screening in Lending Relationships. Bank of England Working Paper No. 778, 2019.

De Meza, D. (2002). Overlending?. The Economic Journal, 112(477), F17-F31.

de Roure, C., Pelizzon, L. and Thakor, A.V., 2018. P2P lenders versus banks: Cream skimming or bottom fishing?. Working Paper.

Di Maggio, M. and Yao, V. W. (2018). FinTech Borrowers: Lax-Screening or Cream-Skimming?. Available at SSRN: https://ssrn.com/abstract=3224957.

Diamond, D. W. and P. H. Dybvig, 1983. Bank runs, deposit insurance, and liquidity, Journal of Political Economy 91(3):401–419.

Duarte, J., Siegel S., Young, L. Trust and Credit: The Role of Appearance in Peer-to-peer Lending. The Review of Financial Studies, Volume 25, Issue 8, August 2012, Pages 2455–2484.

Franks, J., Serrano-Velarde, N., Sussman, O., 2018. Marketplace Lending, Information Agregation and Liquidity. Working Paper.

Galema, R., 2019. The Role of Collateral and its Substitutes in Crowdfunding for SMEs. Working Paper.

Gambacorta, L. and Huang, Y. and Li, Z. and Qiu, H. and Chen, S., 2020. Data vs Collateral. CEPR Discussion Paper No. DP15262.

Gompers, P., and Lerner, J.. 2001. "The Venture Capital Revolution." Journal of Economic Perspectives, 15 (2): 145-168.

Gorton, G., and Pennacchi, G. 1990. Financial intermediaries and liquidity creation. The Journal of Finance, 45(1), 49-71.

Hagiu, A., and Hanna H. "Information and Two-Sided Platform Profits." International Journal of Industrial Organization 34 (May 2014): 25–35.

Havrylchyk, O. and M. Verdier, 2018. The financial intermediation role of the P2P lending platforms. Comparative Economic Systems, 60(1), 115-130.

Hertzberg, A., Liberman, A. and Paravisini, D., 2018. Screening on loan terms: evidence from maturity choice in consumer credit. The Review of Financial Studies, pp. 3532–3567.

Iyer, R., A. I. Khwaja, E. F. P. Luttmer and K. Shue, 2016. Screening Peers Softly: Inferring the Quality of Small Borrowers, Management Science 62:6, 1554-1577.

Kirby, E., Worner, S. 2014. Crowd-funding: An Infant Industry Growing Fast. Staff Working Paper of the IOSCO Research Department. SWP3.

Lin, M., Prabhala, N. R., and Viswanathan, S. 2013. Judging Borrowers By The Company They Keep: Friendship Networks and Information Asymmetry in Online Peer-to-Peer Lending. Management Science, 59(1): 17-35.

Liskovich, I., Shaton, M. 2017. "Borrowers in Search of Feedback : Evidence from Consumer Credit Markets," Finance and Economics Discussion Series 2017-049, Board of Governors of the Federal Reserve System (US).

Morse, A., 2015.). Peer-to-peer crowdfunding: Information and the potential for disruption in consumer lending. Annual Review of Financial Economics, 7, 463-482.

OECD Report, 2018. Enhancing SME access to diversified financing instruments, February.

Parlour, C. A. and Rajan, U. and Zhu, H. (2020). When FinTech Competes for Payment Flows. Available at SSRN: https://ssrn.com/abstract=3544981.

Ravina, E. 2019. Love & Loans: The Effect of Beauty and Personal Characteristics in Credit Markets. Available at SSRN: https://ssrn.com/abstract=1107307.

Rochet, J. C. 2008. Liquidity regulation and the lender of last resort. Financial Stability Review, 11, 45-52.

Rochet, J-C., Tirole, J. 2003. Platform Competition in Two-Sided Markets, Journal of the European Economic Association, Volume 1, Issue 4, 1 June 2003, Pages 990–1029.

Tang, H., 2019. Peer-to-Peer Lenders versus Banks: Substitutes or Complements? The Review of Financial Studies, Volume 32, Issue 5, May 2019, Pages 1900–1938.

The Economist, 2013. Lenders are turning to social media to assess borrowers; Feb 9th 2013

Stiglitz, J., and A. Weiss. 1981. Credit rationing in markets with imperfect information. American Economic Review 71 (3): 393-410.

Vallee, B. and Zeng, Y., 2019. Marketplace Lending: A New Banking Paradigm?. The Review of Financial Studies, Volume 32, Issue 5, May 2019, Pages 1939–1982.

Verdier, M., 2021. Digital Currencies and Bank Competition. Available at SSRN: https://ssrn.com/abstract=3673958.

Wang. 2019. Technology, the Nature of Information, and FinTech Marketplace Lending. Federal Reserve Bank of Boston. Current Policy Perspectives. N.18-3.

Wolfe, B., and Yoo, W. 2018. Crowding out banks: Credit substitution by peer-to-peer lending.

Zhang, B., P. Baeck, Ziegler,T., J.Bone and K. Garvey, 2015. Pushing boundaries. The 2015 UK alternative finance industry report.

Appendix

Appendix A: Monopolistic Bank In this appendix, we study the equilibrium on the credit market if a monopolistic bank offers a contract to the borrower that requires the supply of a collateral. The bank chooses the interest rate that maximizes its profit subject to the participation constraint of the borrower and the investor. A borrower asks for credit from the bank if and only if $u_B^b(\theta) \geq 0$, where $u_B^b(\theta)$ is given by (1). From the participation constraint of the borrower, we denote by

$$\theta_{0B} \equiv (C + s_b)/(y - R_B^b + C) \tag{30}$$

the indifferent consumer between borrowing and not borrowing. The bank lends to borrowers who have a high probability of success and uses the collateral as a selection device. The participation constraints of the borrower and the investor in the deposit market are respectively given by

$$F_B \leq \int_{\theta_{0B}}^{1} u_B^b(\theta)h(\theta)d\theta, \tag{31}$$

and

$$R_f \leq R_d - F_I. \tag{32}$$

The borrower opens an account if and only if his expected utility of borrowing exceeds the cost of the deposit fee (see Eq. (31)). The investor opens an account if and only if he expects to earn at least the return on the risk-free asset (see Eq. (32)). The bank's profit under monopoly is given by

$$\pi^b = F_B + F_I + \int_{\theta_{0B}}^{1} (\theta R_B^b + (1-\theta)C - R_d - c_b)h(\theta)d\theta + \int_{0}^{\theta_{0B}} (R_f - R_d)h(\theta)d\theta. \tag{33}$$

The bank's profit in Eq. (33) is the sum of the deposit fees and the bank's net return on investment. If the borrower seeks credit from the bank, the bank obtains a random return that depends on the probability of success of the project. If the borrower does not seek credit from the bank, the bank invests in the risk-free asset and obtains the return R_f. In all cases, the bank pays the return R_d to depositors.

We give the profit-maximizing marginal borrower θ_{0B} chosen by a monopolistic bank and the corresponding profit-maximizing repayment $(R_B^b)^m$.

A monopolistic bank chooses a repayment given by

$$(R_B^b)^m = y + C - \frac{y(C + s_b)}{s_b + c_b + R_f}. \tag{34}$$

The bank is indifferent to the choice of the deposit rate $R_d \geq R_f$ and completely extracts the surplus of the marginal borrower, the latter being given by

$$\theta_{0B} = (s_b + c_b + R_f)/y. \tag{35}$$

It makes a profit given by $(\pi^b)^m = y\overline{E}(\theta_{0B}) - (s_b + c_b + R_f)(1 - H(\theta_{0B}))$.

The bank completely extracts the surplus of the marginal borrower through the deposit fee and chooses the marginal borrower such that the marginal benefits of granting a loan are equal to the marginal costs for the bank and the borrower. The marginal benefits correspond to the expected return for the borrower $y\theta_{0B}$ and the marginal costs correspond to the cost of searching for credit for the borrower s_b, the opportunity cost of renouncing investment in the risk-free asset for the bank R_f, and the bank's marginal cost of serving the borrower c_b. There is an infinity of credit contracts defined by a collateral and an interest rate that yield the same level of risk and the same profit for the bank. Moreover, there is an infinity of combinations of deposit fees and returns on deposits that leave the investor indifferent between leaving his money in a bank account and investing in the risk-free asset.

Since the participation constraints are satiated, the bank's profit is given by

$$\pi^b = \int_{\theta_{0B}}^{1} (y\theta - s_b - c_b - R_f)h(\theta)d\theta.$$

The bank is able to extract the expected surplus that the borrower and the investor obtain from the lending transaction through the deposit fees. It is equivalent for the bank choosing its interest rate on loans R_B^b and the indifferent borrower θ_{0B}. Solving for the first-order condition of profit-maximization, we find that

$$\frac{d\pi^b}{d\theta_{0B}} = (R_f + s_b + c_b - y\theta_0)h(\theta_{0B}).$$

Therefore, the bank completely extracts the rents of the lending transaction made by the marginal borrower, which is given by $\theta_{0B} = (s_b + c_b + R_f)/y$.

Appendix B -1: Proof of Proposition 1 Assume that the marginal borrower θ_0 belongs to $(0,1)$ and that the bank chooses a return on deposits R_d such that the investor may wish to fund a loan on the platform. We denote the platform's margin by $m_p = (R_B^p - R_I^p)p_M(\theta_0) - c_p$. Solving for the first-order conditions of profit-maximization gives

$$\frac{\partial \pi^p}{\partial R_I^p} = p_M(\theta_0)g(v_0(R_I^p,\theta_0,R_d))H(\theta_0)m_P - G(v_0(R_I^p,\theta_0,R_d))p_M(\theta_0)H(\theta_0), \qquad \text{(FOC-PF1)}$$

and

$$\frac{\partial \pi^p}{\partial R_B^p} = \frac{d\theta_0}{dR_B^p}(g(v_0)p_M^{'}(\theta_0)R_I^p H(\theta_0)m_P + G(v_0)H(\theta_0)(R_B^p - R_I^p)p_M^{'}(\theta_0) + m_P h(\theta_0)G(v_0)) + p_M(\theta_0)H(\theta_0)G(v_0). \qquad \text{(FOC-PF2)}$$

We assume that the second-order conditions hold (i.e., the Hessian matrix is semi-definite negative) such that there is an interior solution to the platform's profit-maximization problem. The first equation yields

$$m_P = G(v_0(R_I^p,\theta_0,R_d))/g(v_0(R_I^p,\theta_0,R_d)). \qquad \text{(FOC-PF1-Bis)}$$

Replacing this equation into (FOC-PF2), since $g(v_0)m_P = G(v_0(R_I^p,\theta_0,R_d))$, we find that (FOC-PF2) can be rewritten as

$$G(v_0)\left[\frac{d\theta_0}{dR_B^p}(H(\theta_0)R_B^p p_M^{'}(\theta_0) + m_P h(\theta_0)) + p_M(\theta_0)H(\theta_0)\right] = 0. \qquad \text{(FOC-PF2-Bis)}$$

Replacing the elasticity of investor demand with respect to the interest rate R_I^p given by $\varepsilon_I = (dG(v_0(R_I^p,\theta_0,R_d))/dR_I^p)(R_I^p/G(v_0(R_I^p,\theta_0,R_d)))$ into (FOC-PF1-Bis), we find that

$$\frac{m_P}{p_M(\theta_0)R_I^p} = \frac{1}{\varepsilon_I}.$$

Therefore, we have

$$\frac{(R_B^p - R_I^p)p_M(\theta_0) - c_p}{p_M(\theta_0)R_I^p} = \frac{1}{\varepsilon_I}.$$

This equation corresponds to the Lerner formula.

Dividing Eq. (FOC-PF2-Bis) by $H(\theta_0)G(v_0) > 0$, we find that

$$\frac{d\theta_0}{dR_B^p}(p_M^{'}(\theta_0)R_B^p + \frac{h(\theta_0)}{H(\theta_0)}m_P) + p_M(\theta_0) = 0.$$

Therefore, multiplying this equation by $(R_B^p/p_M(\theta_0))$ gives

$$\frac{R_B^p}{p_M(\theta_0)}\frac{d(p_M(\theta_0)R_B^p)}{dR_B^p} + \frac{R_B^p}{p_M(\theta_0)}\frac{d\theta_0}{dR_B^p}\frac{h(\theta_0)}{H(\theta_0)}m_P = 0.$$

Replacing $\varepsilon_B = -(h(\theta_0)R_B^p/H(\theta_0))(d\theta_0/dR_B^p)$ and $\mu_P = (d(R_B^p p_M(\theta_0))/dR_B^p)(R_B^p/p_M(\theta_0)R_B^p)$, we find that

$$R_B^p\mu_P - \frac{\varepsilon_B}{p_M(\theta_0)}m_P = 0.$$

This implies that we have

$$\frac{m_P}{p_M(\theta_0)R_B^p} = \frac{\mu_P}{\varepsilon_B},$$

that is,

$$\frac{(R_B^p - R_I^p)p_M(\theta_0) - c_p}{p_M(\theta_0)R_B^p} = \frac{\mu_P}{\varepsilon_B}.$$

Dividing this equation by the first equation of the FOC gives the price structure, that is,

$$\frac{R_I^p}{R_B^p} = \frac{\mu_P\varepsilon_I}{\varepsilon_B}.$$

This completes the proof of Proposition 1.

Appendix B-2: Second-Order conditions in the uniform case The platform's profit admits a local maximum at $(\widehat{R_I^p}, \widehat{R_B^p})$ if

$$\left.\frac{\partial^2\pi^p}{\partial^2 R_I^p}\right|_{(\widehat{R_I^p},\widehat{R_B^p})} < 0,$$

and

$$\left.\frac{\partial^2\pi^p}{\partial R_I^p\partial R_B^p}\right|^2_{(\widehat{R_I^p},\widehat{R_B^p})} - \left.\frac{\partial^2\pi^p}{\partial^2 R_I^p}\right|_{(\widehat{R_I^p},\widehat{R_B^p})}\left.\frac{\partial^2\pi^p}{\partial^2 R_B^p}\right|_{(\widehat{R_I^p},\widehat{R_B^p})} < 0.$$

In our uniform distribution example, we have

$$\left.\frac{\partial^2 \pi^p}{\partial^2 R_I^p}\right|_{(\widehat{R_I^p},\widehat{R_B^p})} = -\frac{\theta_0^3}{2} < 0,$$

and

$$\left.\frac{\partial^2 \pi^p}{\partial R_I^p \partial R_B^p}\right|^2_{(\widehat{R_I^p},\widehat{R_B^p})} - \left.\frac{\partial^2 \pi^p}{\partial^2 R_I^p}\right|_{(\widehat{R_I^p},\widehat{R_B^p})} \left.\frac{\partial^2 \pi^p}{\partial^2 R_B^p}\right|_{(\widehat{R_I^p},\widehat{R_B^p})} = \frac{-\theta_0^6(C + s_b - 2p_e(c_p + R_d))^2}{48(C + s_b)^2} < 0.$$

Therefore, if there is an interior solution, the conditions such that there is a local maximum at the profit-maximizing prices chosen by the platform are verified with our uniform distributions.

Appendix B-3: The platform's best-responses in the general case: From (FOC-PF1), we have that $m_P = G/g$. Therefore, given θ_0, R_d and R_I^p, the repayment of the borrower is given by

$$R_B^p = R_I^p + (1/p_M(\theta_0))(c_p + G(v_0(R_I^p, \theta_0, R_d))/g(v_0(R_I^p, \theta_0, R_d)) \qquad (36)$$

Replacing $p_M^{'}(\theta_0)H(\theta_0) = h(\theta_0)(\theta_0 - p_M(\theta_0))$ into (Eq. FOC-PF2), we find that at an interior solution

$$\frac{d\theta_0}{dR_B^p} h(\theta_0)(R_B^p(\theta_0 - p_M(\theta_0)) + p_M(\theta_0)(R_B^p - R_I^p) - c_p) + p_M(\theta_0)H(\theta_0) = 0.$$

Replacing $\underline{E}(\theta_0) = p_M(\theta_0)H(\theta_0)$ and rearranging the terms, we obtain

$$\underline{E}(\theta_0) + \frac{d\theta_0}{dR_B^p} h(\theta_0)(\theta_0(R_B^p - R_I^p) - c_p + (\theta_0 - p_M(\theta_0))R_I^p) = 0.$$

Since $d\theta_0/dR_B^p = -(\theta_0)^2/\beta$, where $\beta = (C + s_b)/p_e$, replacing R_B^p given by the (Eq-RBp), we have that

$$(\theta_0 - p_M(\theta_0))R_I^p = (c_p) + \frac{\beta \underline{E}(\theta_0)}{h(\theta_0)(\theta_0)^2} - (\theta_0/p_M(\theta_0))(c_p + (G/g)(v_0(R_I^p, \theta_0, R_d))).$$

We denote by $\underline{\varepsilon}(\theta_0, R_B^p) = -(R_B^p/\underline{E}(\theta_0))(d\underline{E}(\theta_0)/dR_B^p)$ the elasticity of the expected probability of success of the borrower repayment. We have

$$\frac{d\underline{E}(\theta_0)}{dR_B^p} = \theta_0 h(\theta_0)\frac{d\theta_0}{dR_B^p}.$$

Since $d\theta_0/dR_B^p = -\theta_0^2/\beta$, we have

$$\underline{\varepsilon}(\theta_0, R_B^p) = \frac{-R_B^p d\underline{E}(\theta_0)}{\underline{E}(\theta_0)dR_B^p} = \frac{\theta_0^3 h(\theta_0)R_B^p}{\beta\underline{E}(\theta_0)}.$$

Since $\eta(\theta_0) = p_M(\theta_0)R_B^p/\underline{\varepsilon}(\theta_0, R_B^p)$ and $\underline{\varepsilon}(\theta_0, R_B^p) = \theta_0^3 h(\theta_0)R_B^p/(\beta\underline{E}(\theta_0))$, the return chosen for investors $\widehat{R_I^p}$ is implicitly defined by

$$\widehat{R_I^p} = \frac{\theta_0}{p_M(\theta_0)(\theta_0 - p_M(\theta_0))}\left[\eta(\theta_0) - (G/g)(v_0(\widehat{R_I^p}, \theta_0, R_d))\right] - \frac{c_p}{p_M(\theta_0)}. \tag{37}$$

Since $\widehat{v}_0(\theta_0, R_d) = v_0(\widehat{R_I^p}, \theta_0, R_d)$ and $v_0(\widehat{R_I^p}, \theta_0, R_d) = p_M(\theta_0)\widehat{R_I^p} - R_d$, the marginal investor is implicitely defined by

$$\widehat{v}_0(\theta_0, R_d) = \frac{\theta_0}{(\theta_0 - p_M(\theta_0))}\left(\eta(\theta_0) - \frac{G(\widehat{v}_0(\theta_0, R_d))}{g(\widehat{v}_0(\theta_0, R_d))}\right) - c_p - R_d. \tag{38}$$

We now derive the necessary conditions such that there is an interior solution (i.e., the marginal investor $\widehat{v}_0(\theta_0, R_d) \in (\underline{v}, \overline{v})$). Let

$$Z(v) \equiv v - \frac{\theta_0}{(\theta_0 - p_M(\theta_0))}\left(\eta(\theta_0) - (G/g)(v)\right) + c_p + R_d. \tag{39}$$

The function Z is twice differentiable on the segment $[\underline{v}, \overline{v}]$. For all $v \in [\underline{v}, \overline{v}]$, we have

$$Z'(v) = 1 + \frac{\theta_0}{(\theta_0 - p_M(\theta_0))}(G/g)'(v).$$

Since G/g is increasing in v, for all $v \in [\underline{v}, \overline{v}]$, we have that $Z'(v) \geq 0$. Therefore, Z is increasing in v. If $Z(\overline{v}) \leq 0$, for all $v \in [\underline{v}, \overline{v}]$, we have $Z(v) \leq 0$ and the investor always lends on the platform. If $Z(\underline{v}) \geq 0$, for all $v \in [\underline{v}, \overline{v}]$, we have $Z(v) \geq 0$ and the investor never lends on the platform. If $Z(\overline{v}) > 0$ and $Z(\underline{v}) < 0$, there exists a unique $\widehat{v}_0(\theta_0, R_d) \in (\underline{v}, \overline{v})$

such that $Z(\widehat{v}_0(\theta_0, R_d)) = 0$. Replacing $Z(\overline{v})$ and $Z(\underline{v})$ given by Eq. (39) gives the result of Corollary 1.

Appendix B-4: Variations of the marginal investor, the borrower repayment on the platform and the return offered to the investor with bank prices:

- Variation of the marginal investor with θ_0:

Taking the derivative of (38) given in Appendix B-3 with respect to θ_0, we find that

$$\frac{\partial \widehat{v}_0}{\partial \theta_0}(1+\frac{\theta_0 (G/g)'(\widehat{v}_0)}{(\theta_0 - p_M(\theta_0))}) = \frac{\theta_0 \eta'(\theta_0)}{(\theta_0 - p_M(\theta_0))} + \frac{\theta_0 p_M^{'}(\theta_0) - p_M(\theta_0)}{(\theta_0 - p_M(\theta_0))^2}\left(\eta(\theta_0) - \frac{G(\widehat{v}_0)}{g(\widehat{v}_0)}\right).$$

Since $(G/g)'(\widehat{v}_0) \geq 0$ and $\theta_0 - p_M(\theta_0) \geq 0$, $\partial \widehat{v}_0/\partial \theta_0$ has the sign of

$$\theta_0(\theta_0 - p_M(\theta_0))\eta'(\theta_0) + (\theta_0 p_M^{'}(\theta_0) - p_M(\theta_0))\left(\eta(\theta_0) - \frac{G(\widehat{v}_0)}{g(\widehat{v}_0)}\right).$$

As $\widehat{v}_0 \geq 0$, it must be that $\eta(\theta_0) - \dfrac{G(\widehat{v}_0)}{g(\widehat{v}_0)} \geq 0$. Moreover, we have that

$$-p_M(\theta_0) + \theta_0 p_M^{'}(\theta_0) = \frac{-\underline{E}(\theta_0) + \theta_0 h(\theta_0)(\theta_0 - p_M(\theta_0))}{H(\theta_0)}.$$

We also have that $\theta_0 - p_M(\theta_0) \geq 0$. If $-p_M(\theta_0) + \theta_0 p_M^{'}(\theta_0) \geq 0$ and $\eta'(\theta_0) \geq 0$, the sign of $\partial \widehat{v}_0/\partial R_d$ is positive. Hence, a higher probability of success of the marginal borrower increases the marginal investor. However, in the general case, it is impossible to conclude that $\partial \widehat{v}_0/\partial \theta_0 \geq 0$.

- Variation of the borrower repayment and the return offered to investors with θ_0:

As for $\partial \widehat{v}_0/\partial \theta_0$, it is impossible to conclude that $\partial \widehat{R_I^p}/\partial \theta_0$ and $\partial \widehat{R_B^p}/\partial \theta_0$ have a constant sign in the general case. Since $\widehat{R_I^p} = (\widehat{v}_0 + R_d)/p_M(\theta_0)$, we have

$$\frac{\partial \widehat{R_I^p}}{\partial \theta_0} = \frac{1}{p_M(\theta_0)}\frac{\partial \widehat{v}_0}{\partial \theta_0} - \frac{p_M'(\theta_0)}{p_M(\theta_0)}\widehat{R_I^p}. \tag{40}$$

From (36), since $\widehat{R_I^p} = (\widehat{v}_0 + R_d)/p_M(\theta_0)$, we have

$$\frac{\partial \widehat{R_B^p}}{\partial \theta_0} = \frac{1}{p_M(\theta_0)} \frac{\partial \widehat{v}_0}{\partial \theta_0}(1 + (G/g)'(\widehat{v}_0)) - \frac{p'_M(\theta_0)}{p_M(\theta_0)} \widehat{R_B^p}. \tag{41}$$

Since $p_M^{'}(\theta_0) \geq 0$ and $(G/g)'(\widehat{v}_0)$, if $\partial \widehat{v}_0/\partial \theta_0 \leq 0$, $\widehat{R_I^p}$ and $\widehat{R_B^p}$ are decreasing with θ_0. If $\partial \widehat{v}_0/\partial \theta_0 \geq 0$, $\widehat{R_I^p}$ and $\widehat{R_B^p}$ may either increase or decrease with θ_0.

In our uniform distribution example, from Eq. (13) and (14), the borrower repayment and the return offered to investors are both decreasing with θ_0 because the marginal investor is independent of θ_0.

- Variation of the marginal investor with R_d:

Taking the derivative of (38) given in Appendix B-3 with respect to R_d, we find that

$$\frac{\partial \widehat{v}_0}{\partial R_d}(1 + \frac{\theta_0 (G/g)^{'}(\widehat{v}_0)}{(\theta_0 - p_M(\theta_0))}) = -1.$$

Therefore, we have that

$$\frac{\partial \widehat{v}_0}{\partial R_d} = \frac{-(\theta_0 - p_M(\theta_0))}{\theta_0 - p_M(\theta_0) + \theta_0 (G/g)'(\widehat{v}_0)}.$$

Since $\theta_0 - p_M(\theta_0) \geq 0$ and $(G/g)^{'} \geq 0$, the marginal investor is decreasing with the deposit rate.

- Variation of the return offered to investors $\widehat{R_I^p}$ with the deposit rate:

Taking the derivative of (37) with respect to R_d, we find that

$$\frac{\partial \widehat{R_I^p}}{\partial R_d} = -\frac{\partial \widehat{v}_0}{\partial R_d} \frac{\theta_0 (G/g)^{'}(\widehat{v}_0)}{p_M(\theta_0)(\theta_0 - p_M(\theta_0))}. \tag{42}$$

Since $\partial \widehat{v}_0/\partial R_d \leq 0$, $(G/g)^{'} \geq 0$ and $\theta_0 - p_M(\theta_0) \geq 0$, the return offered to investors is increasing with the deposit rate.

- Variation of the borrower repayment rate $\widehat{R_B^p}$ with the deposit rate:

Taking the derivative of (36) with respect to R_d, we find that

$$\frac{\partial \widehat{R_B^p}}{\partial R_d} = \frac{\partial \widehat{R_I^p}}{\partial R_d} + \frac{\partial \widehat{v}_0}{\partial R_d} \frac{(G/g)'(\widehat{v}_0)}{p_M(\theta_0)}.$$

Replacing $\partial \widehat{R_I^p}/\partial R_d$, we find that

$$\frac{\partial \widehat{R_B^p}}{\partial R_d} = -\frac{\partial \widehat{v}_0}{\partial R_d} \frac{(G/g)'(\widehat{v}_0)}{(\theta_0 - p_M(\theta_0))}. \tag{43}$$

Since $\partial \widehat{v}_0/\partial R_d \leq 0$, $(G/g)' \geq 0$ and $\theta_0 - p_M(\theta_0) \geq 0$, the borrower repayment rate is increasing with the deposit rate.

- Variation of the marginal investor with the level of collateral C:

We have

$$\frac{d\widehat{v}_0(\theta_0, R_d)}{dC} = \frac{\theta_0}{(\theta_0 - p_M(\theta_0))} \frac{d\beta}{dC} \frac{\underline{E}(\theta_0)}{h(\theta_0)(\theta_0)^2} + \frac{\partial \widehat{v}_0(\theta_0, R_d)}{\partial \theta_0} \frac{d\theta_0}{dC}.$$

An increase in the level of collateral has two effects on the marginal investor. Since $d\beta/dC \geq 0$, a higher level of collateral increases the elasticity of the probability of success to the borrower repayment, which raises the marginal investor. Since $d\theta_0/dC \geq 0$, a higher level of collateral increases the probability of success of the marginal borrower. If $\partial \widehat{v}_0(\theta_0, R_d)/\partial \theta_0 \geq 0$, this implies that investor participation in the platform increases, and therefore, that the overall effect is an increase of the marginal investor. If $\partial \widehat{v}_0(\theta_0, R_d)/\partial \theta_0 \leq 0$, investor participation in the platform decreases, and the overall effect is ambiguous.

Appendix B-5: Examples of distributions In our supplementary online appendix we consider the family of beta distributions, to illustrate the impact of different distributions of θ. As is well known, the shape of the beta distribution varies with the two characteristic parameters and many common distributions can be obtained as special cases. For example, if the two parameters of the beta distributions are equal to one, the beta corresponds to the uniform distribution and the marginal investor is independent of the marginal borrower. By varying the parameters of the beta distribution we provide examples in which the $h(\theta)$ can be increasing, decreasing or non-monotone. In these examples we find the following. If the distribution of θ is increasing on the interval $[0,1]$ or U-shaped, then the marginal investor is decreasing on the marginal borrower. This happens, for instance, if both parameters are equal to 1/2 and the beta distribution coincides with the arcsin distribution. If instead the beta distribution is decreasing on the interval $[0,1]$ or is unimodal, then the marginal investor is increasing with the marginal borrower.

Appendix B-6: Variations of the price structure with bank prices: From (Eq-RBp), we have

$$\frac{\widehat{R^p_B}}{\widehat{R^p_I}} = 1 + \frac{1}{p_M(\theta_0) R^p_I}\left(c_p + \frac{G(\widehat{v}_0)}{g(\widehat{v}_0)}\right).$$

Since $\widehat{v}_0 = p_M(\theta_0)\widehat{R^p_I} - R_d$, we have

$$\frac{\widehat{R^p_B}}{\widehat{R^p_I}} = 1 + \frac{1}{\widehat{v}_0 + R_d}\left(c_p + \frac{G(\widehat{v}_0)}{g(\widehat{v}_0)}\right).$$

Taking the derivative of this equation with respect to θ_0, we find that

$$\left(\frac{\widehat{R^p_B}}{\widehat{R^p_I}}\right)'(\theta_0) = \frac{1}{(\widehat{v}_0 + R_d)^2}\frac{d\widehat{v}_0}{d\theta_0}\left(-(c_p + \frac{G(\widehat{v}_0)}{g(\widehat{v}_0)}) + (\widehat{v}_0 + R_d)\left(\frac{G}{g}\right)'(\widehat{v}_0)\right).$$

To determine the sign of the parenthesis, we study the function

$$T(x) = -(c_p + \frac{G(x)}{g(x)}) + (x + R_d)\left(\frac{G}{g}\right)'(x)$$

for $x \in (\underline{v}, \overline{v})$. We have $T'(x) = (x + R_d)(G/g)''(x)$. Since G/g is concave, $(G/g)''$ is negative. This implies that $T'(x) \leq 0$ and that T is decreasing on $(\underline{v}, \overline{v})$. Since $G(\underline{v}) = 0$, we have $T(\underline{v}) = -c_p + (\underline{v} + R_d)(G/g)'(\underline{v})$. Since $(\underline{v} + R_d)(G/g)'(\underline{v}) \leq c_p$ from (A4), we have $T(\underline{v}) \leq 0$. Therefore, for any $x \in (\underline{v}, \overline{v})$, we have $T(x) \leq 0$. This implies that $\left(\widehat{R^p_B}/\widehat{R^p_I}\right)'(\theta_0)$ has the same sign as $-\partial\widehat{v}_0/\partial\partial\theta_0$. If the marginal investor $\widehat{v}_0$ decreases (resp., increases) with the marginal borrower θ_0, the ratio $\widehat{R^p_B}/\widehat{R^p_I}$ increases (resp., decreases) with the marginal borrower. The price structure $\widehat{R^p_I}/\widehat{R^p_B}$ increases (resp., decreases) with the marginal borrower when the marginal investor increases (resp., decreases with the marginal borrower).

Finally, as $\widehat{v}_0 + R_d$ is independent of R_d, the variation of the price structure with the deposit rate as the same sign as $(G/g)'(\widehat{v}_0)(\partial\widehat{v}_0/\partial R_d)$. Since $(G/g)' \geq 0$ and $(\partial\widehat{v}_0/\partial R_d) \leq 0$, the ratio $\widehat{R^p_B}/\widehat{R^p_I}$ is decreasing with the deposit rate. The price structure $\widehat{R^p_I}/\widehat{R^p_B}$ is increasing with the marginal borrower.

Appendix B-7: Comparative statics - platform profit:

- Variation of the platform's profit with the marginal borrower:

We have

$$\frac{d\pi_P}{d\theta_0} = h(\theta_0)\frac{G^2(\widehat{v}_0(\theta_0, R_d))}{g(\widehat{v}_0(\theta_0, R_d))} + H(\theta_0)G(\widehat{v}_0(\theta_0, R_d))\left(\frac{\partial\widehat{v}_0}{\partial\theta_0}\right)\left(\frac{2g^2 - Gg'}{g^2}\right).$$

Since (G/g) is increasing, we have $2g^2 - Gg' \geq 0$. Therefore, if $\partial\widehat{v}_0/\partial\theta_0 \geq 0$, the platform's profit is increasing with the marginal borrower.

- Variation of the platform's profit with the deposit rate:

$$\frac{d\pi_P}{dR_d} = H(\theta_0)G(\widehat{v}_0(\theta_0, R_d))\left(\frac{\partial\widehat{v}_0}{\partial R_d}\right)\left(\frac{2g^2 - Gg'}{g^2}\right).$$

Since $\partial\widehat{v}_0/\partial R_d \leq 0$, the platform's profit is decreasing with the deposit rate.

- Variation of the platform's profit with the level of collateral:

We have

$$\frac{d\pi^p}{dC} = \frac{d\pi^p}{d\theta_0}\frac{d\theta_0}{dC} + \frac{d\widehat{v}_0}{dC}H(\theta_0)G(\widehat{v}_0)\left(\frac{2g - Gg'}{g}\right)(\widehat{v}_0).$$

Appendix C: The bank's profit-maximizing prices i) The participation constraints of depositors:

We denote by π^d_h the maximum surplus that the bank may extract from depositors thanks to its in-house lending activities. We have

$$\pi^d_h = \int_{\theta_0}^1 u^b_B(\theta)h(\theta)d\theta + (1 - H(\theta_0))(R_d - R_f) + (1 - G(v_0))H(\theta_0)(R_d - R_f). \tag{44}$$

The first term of Eq. (44) corresponds to the expected utility of the borrower if he takes a loan from the bank. The second term of Eq. (44) corresponds to the revenues that the bank extracts from the investor if the latter does not lend on the platform.

We denote by π_o^d the maximum surplus that the bank may extract from depositors who decide to invest in the platform. We have

$$\pi_o^d = \int_0^{\theta_0} \widehat{u}_B^p(\theta, \theta_0, R_d)h(\theta)d\theta + H(\theta_0)\int_{\underline{v}}^{\widehat{v}_0} (u_I^p(v) - (R_f - 1))g(v)dv. \tag{45}$$

where $\widehat{u}_B^p(\theta, \theta_0, R_d) = p_e\theta(y - \widehat{R_B^p}(\theta_0, R_d))$ and $u_I^p(v) = p_M(\theta_0)\widehat{R_I^p}(\theta_0, R_d) - v - 1$. The first term of Eq. (45) corresponds to the expected utility of the borrower if he takes a loan from the platform. The second term of Eq. (45) corresponds to the expected surplus of the investor if the latter funds a loan on the platform.

From (19), (20), (44) and (45), the sum of the participation constraints of depositors can be rewritten as

$$F_I + F_B \leq \pi_h^d + \pi_o^d.$$

ii) The bank's profit from lending activities:

If a consumer of type $\theta \geq \theta_0$ borrows from the bank, the bank always funds it and obtains an expected revenue equal to $\theta R_B^b + (1-\theta)C$. The bank also incurs the cost of funding the loan by deposits at a rate R_d and the marginal cost c_b. Since $u_B^b(\theta) = \theta y - (\theta R_B^b + (1-\theta)C) - s_b$, the bank's expected margin of lending to a consumer of type θ is given by $\theta y - u_B^b(\theta) - s_b - c_b - R_d$. If a borrower of type $\theta \leq \theta_0$ wishes to borrow from the platform, there is a probability $1 - G(\widehat{v}_0)$ that the investor refuses to fund the loan. In that case, the bank will refuse to fund the loan and instead invest in the risk-free asset. The bank obtains a return $R_f - R_d$. Since there is a probability $H(\theta_0)$ that the borrower is of type $\theta \leq \theta_0$ and a probability $1 - G(\widehat{v}_0)$ that the loan is not funded, the bank's expected return from investment in the risk-free asset is given by $(1 - G(\widehat{v}_0))H(\theta_0)(R_f - R_d)$. Therefore, the bank's profit on in-house lending activities is given by

$$\pi_h^l = \int_{\theta_0}^{1} (\theta y - u_B^b(\theta) - s_b - c_b - R_d)h(\theta)d\theta + (1 - G(\widehat{v}_0))H(\theta_0)(R_f - R_d). \tag{46}$$

iii) The bank's profit:

The bank has a monopoly on deposits and can therefore extract the maximum surplus of depositors through the deposit fees. Therefore, the participation constraints of depositors are binding and we have $F_I + F_B = \pi_h^d + \pi_o^d$. Since $\pi^b = \pi_h^l + \pi_o^l + F_I + F_B$, we have

$$\pi^b = \pi_h^l + \pi_o^l + \pi_h^d + \pi_o^d.$$

We denote by $\pi_h = \pi_h^l + \pi_h^d$ the total profit that the bank obtains from in-house lending activities, and by $\pi_o = \pi_o^d$ the total profit that the bank obtains from depositors financing loans on the platform.

Since $\pi_h = \pi_h^d + \pi_h^l$, from Eq. (44) and Eq. (46), we have

$$\pi_h(\theta_0) = \int_{\theta_0}^{1} (\theta y - s_b - c_b - R_f) h(\theta) d\theta. \tag{47}$$

Since $\pi_o = \pi_o^d$, from Eq. (45), we have

$$\pi_o(\theta_0, R_d) = \int_0^{\theta_0} \widehat{u}_B^p(\theta, \theta_0, R_d) h(\theta) d\theta + H(\theta_0) \int_{\underline{v}}^{\widehat{v_0}} (u_I^p(v) - (R_f - 1)) g(v) dv). \tag{48}$$

The bank's profit depends on the interest rate R_B^b only through the choice of the indifferent borrower θ_0. Therefore, it is equivalent for the bank maximizing its profit with respect to R_B^b or through θ_0.

iv) Solving for the first-order condition of profit-maximization, we find that

$$\frac{\partial \pi^b}{\partial \theta_0} = \frac{\partial \pi_h}{\partial \theta_0} + \frac{\partial \pi_o}{\partial \theta_0} + \frac{\partial \pi_o}{\partial R_I^p} \frac{\partial \widehat{R_I^p}}{\partial \theta_0} + \frac{\partial \pi_o}{\partial R_B^p} \frac{\partial \widehat{R_B^p}}{\partial \theta_0}, \tag{FOC-B-ThetaTild}$$

and

$$\frac{\partial \pi^b}{\partial R_d} = \frac{\partial \pi_h}{\partial R_d} + \frac{\partial \pi_o}{\partial R_d} + \frac{\partial \pi_o}{\partial R_I^p} \frac{\partial \widehat{R_I^p}}{\partial R_d} + \frac{\partial \pi_o}{\partial R_B^p} \frac{\partial \widehat{R_B^p}}{\partial R_d}. \tag{FOC-B-DepositRate}$$

We start by solving (FOC-B-DepositRate). From (47), we have $\partial \pi_h / \partial R_d = 0$. Since $\widehat{u}_B^p(\theta, \theta_0, R_d) = p_e \theta (y - \widehat{R_B^p})$, we have $\partial \pi^b / \partial R_B^p = -p_e \underline{E}(\theta_0)$. From (48), since $u_I^p(v) =$

$p_M(\theta_0)R_I^p - v - 1$, we have $\partial\pi_o/\partial R_I^p = p_M(\theta_0)H(\theta_0)G(\widehat{v}_o)$. Therefore, we have

$$\frac{\partial\pi^b}{\partial R_d} = \frac{\partial\widehat{v}_o}{\partial R_d}H(\theta_0)g(\widehat{v}_o)(u_I^p(\widehat{v}_o) - (R_f - 1)) + p_M(\theta_0)H(\theta_0)G(\widehat{v}_o)\frac{\partial\widehat{R_I^p}}{\partial R_d} - p_e\underline{E}(\theta_0)\frac{\partial\widehat{R_B^p}}{\partial R_d}.$$

Since $u_I^p(\widehat{v}_o) = R_d - 1$ and $\underline{E}(\theta_0) = p_M(\theta_0)H(\theta_0)$, we have

$$\frac{\partial\pi^b}{\partial R_d} = H(\theta_0)(\frac{\partial\widehat{v}_o}{\partial R_d}g(\widehat{v}_o)(R_d - R_f) + p_M(\theta_0)(G(\widehat{v}_o)\frac{\partial\widehat{R_I^p}}{\partial R_d} - p_e\frac{\partial\widehat{R_B^p}}{\partial R_d})).$$

Therefore, there are three cases. In the first case, there is an interior solution such that $H(\theta_0) > 0$. If $H(\theta_0) > 0$ and $\partial\widehat{v}_o/\partial R_d \neq 0$, the profit-maximizing deposit rate is implicitely defined by

$$\widehat{R}_d = R_f + \frac{p_M(\theta_0)(-G(\widehat{v}_o)(\partial\widehat{R_I^p}/\partial R_d) + p_e(\partial\widehat{R_B^p}/\partial R_d))}{(\partial\widehat{v}_o/\partial R_d)g(\widehat{v}_o)}.$$

Replacing $(\partial\widehat{R_I^p}/\partial R_d)$ and $(\partial\widehat{R_B^p}/\partial R_d)$ given respectively by Eq. (42) and Eq. (43), since $p_M(\theta_0) = \underline{E}(\theta_0)/H(\theta_0)$, the deposit rate is implicitely defined by

$$\widehat{R}_d = R_f + \frac{1}{(\theta_0 - p_M(\theta_0))g(\widehat{v}_o)}(\theta_0 G(\widehat{v}_o) - p_e p_M(\theta_0))(G/g)'(\widehat{v}_o). \tag{49}$$

In the second case, there is a corner solution such that the bank covers the market and chooses θ_0 such that no investor wishes to lend on the platform or no borrower wishes to borrow from the platform. We study this solution in Appendix D. The third and last possibility is that the bank chooses the deposit rate that minimizes the value of the marginal investor on the platform, that is, if there exists such a solution, we have $\partial\widehat{v}_o/\partial R_d = 0$. From Appendix B-4, we have $\partial\widehat{v}_o/\partial R_d = 0$ if and only if $\theta_0 = p_M(\theta_0)$, which is impossible.

We turn to the resolution of (FOC-B-ThetaTild). We have

$$\frac{d\pi^b}{d\theta_0} = \frac{\partial\pi_h}{\partial\theta_0} + \frac{\partial\pi_o}{\partial\theta_0} + \frac{\partial\pi_o}{\partial R_I^p}\frac{\partial\widehat{R_I^p}}{\partial\theta_0} + \frac{\partial\pi_o}{\partial R_B^p}\frac{\partial\widehat{R_B^p}}{\partial\theta_0}. \tag{50}$$

Taking the derivative of Eq. (47) with respect to θ_0, we find that

$$\frac{\partial\pi_h}{\partial\theta_0} = -h(\theta_0)(\theta_0 y - s_b - c_b - R_f). \tag{51}$$

Since $F_I^p(\theta_0, R_d) = \int_{\underline{v}}^{\widehat{v_0}} (u_I^p(v) - (R_f - 1))g(v)dv$, $F_I^p(\theta_0, R_d)$ only depends on θ_0 through $\widehat{v_0}$. Moreover, Eq. (48) only depends on $\widehat{R_I^p}$ through the choice of $\widehat{v_0}$. Taking the derivative of Eq. (48) with respect to θ_0, we find that

$$\frac{\partial \pi_o}{\partial \theta_0} + \frac{\partial \pi_o}{\partial R_I^p}\frac{\partial \widehat{R_I^p}}{\partial \theta_0} + \frac{\partial \pi_o}{\partial R_B^p}\frac{\partial \widehat{R_B^p}}{\partial \theta_0} \tag{52}$$

$$= h(\theta_0)(\widehat{u}_B^p(\theta_0, \theta_0, R_d) + F_I^p(\theta_0, R_d)) + \frac{\partial \pi_o}{\partial v_0}\frac{\partial \widehat{v_0}}{\partial \theta_0} - p_e \underline{E}(\theta_0)\frac{\partial \widehat{R_B^p}}{\partial \theta_0}. \tag{53}$$

Replacing Eq. (51) and (52) into (50) gives

$$\frac{\partial \pi^b}{\partial \theta_0} = h(\theta_0)(-(\theta_0 y - s_b - c_b - R_f) + \overline{u}_B^p + \overline{F}_I^p)$$
$$+\frac{\partial \pi_o}{\partial v_0}\frac{\partial \widehat{v_0}}{\partial \theta_0} - p_e \underline{E}(\theta_0)\frac{\partial \widehat{R_B^p}}{\partial \theta_0}.$$

Therefore, if there is an interior solution $\widehat{\theta_0}$ to the bank's profit-maximization, it is chosen such that

$$y\widehat{\theta_0} - c_b - s_b - R_f = \overline{u}_B^p + \overline{F}_I^p + (\frac{\partial \pi_o}{\partial v_0}\frac{\partial \widehat{v_0}}{\partial \theta_0} - p_e \underline{E}(\widehat{\theta_0})\frac{\partial \widehat{R_B^p}}{\partial \theta_0})/h(\widehat{\theta_0}) = 0. \tag{54}$$

This completes the proof of Proposition 2.

v) Second-order conditions

The bank's profit admits a local maximum at $(\theta_0, \widehat{R_d})$ if

$$\left.\frac{\partial^2 \pi^b}{\partial \theta_0^2}\right|_{(\widehat{\theta_0}, \widehat{R_d})} < 0,$$

and

$$\left.\frac{\partial^2 \pi^b}{\partial \theta_0 \partial R_d}\right|^2_{(\widehat{\theta_0}, \widehat{R_d})} - \left.\frac{\partial^2 \pi^b}{\partial \theta_0^2}\right|_{(\widehat{\theta_0}, \widehat{R_d})} \left.\frac{\partial^2 \pi^b}{\partial R_d^2}\right|_{(\widehat{\theta_0}, \widehat{R_d})} < 0.$$

In our uniform distribution example, we have

$$\left.\frac{\partial^2 \pi^b}{\partial \theta_0^2}\right|_{(\widehat{\theta_0}, \widehat{R_d})} = -\frac{5}{9}\theta_0 < 0,$$

and

$$\left.\frac{\partial^2 \pi^b}{\partial \theta_0 \partial R_d}\right|^2_{(\widehat{\theta_0}, \widehat{R_d})} - \left.\frac{\partial^2 \pi^b}{\partial \theta_0^2}\right|_{(\widehat{\theta_0}, \widehat{R_d})} \left.\frac{\partial^2 \pi^b}{\partial R_d^2}\right|_{(\widehat{\theta_0}, \widehat{R_d})} = -\frac{5}{9}\theta_0(1-p_e)y < 0.$$

Therefore, if there is an interior solution, the conditions such that there is a local maximum at the profit-maximizing prices chosen by the bank are verified with our uniform distributions.

vi) The equilibrium with rational expectations:

Since $p_e = G(\widehat{v_0}^*)$, from Proposition 2, we have

$$\widehat{R}_d = R_f + (G/g)(\widehat{v_0}^*))(G/g)'(\widehat{v_0}^*).$$

We now turn to the computation of the marginal borrower at the equilibrium. We have

$$\left.\frac{\partial \pi_o}{\partial v_0}\right|_{R_d = \widehat{R}_d} = H(\theta_0)(g(\widehat{v_0})(\widehat{R}_d - R_f) + G(\widehat{v_0})).$$

Therefore, we have

$$\left.\frac{\partial \pi_o}{\partial v_0}\right|_{R_d = \widehat{R}_d} = H(\theta_0)G(\widehat{v_0})(1 + (G/g)'(\widehat{v_o})). \tag{C-6-1}$$

Since $p_e = G(\widehat{v_0})$, $\underline{E}(\widehat{\theta_0})/p_M(\theta_0) = H(\theta_0)$ and

$$\frac{\partial \widehat{R^p_B}}{\partial \theta_0} = \frac{1}{p_M(\theta_0)}\frac{\partial \widehat{v_0}}{\partial \theta_0}(1 + (G/g)'(\widehat{v_0})) - \frac{p'_M(\theta_0)}{p_M(\theta_0)}\widehat{R^p_B},$$

at $R_d = \widehat{R}_d$, we have

$$p_e \underline{E}(\widehat{\theta_0})\frac{\partial \widehat{R^p_B}}{\partial \theta_0} = G(\widehat{v_0})H(\theta_0)\left[\frac{\partial \widehat{v_0}}{\partial \theta_0}(1 + (G/g)'(\widehat{v_0})) - p'_M(\theta_0)\widehat{R^p_B}\right]. \tag{C-6-2}$$

Replacing (C-6-1) and (C–6-2), at $R_d = \widehat{R}_d$ and $\theta_0 = \widehat{\theta}$, we have

$$\frac{\partial \pi_o}{\partial v_0}\frac{\partial \widehat{v_0}}{\partial \theta_0} - p_e \underline{E}(\widehat{\theta_0})\frac{\partial \widehat{R^p_B}}{\partial \theta_0} = G(\widehat{v_0})H(\widehat{\theta})p'_M(\widehat{\theta_0})\widehat{R^p_B}.$$

Replacing this expression into Eq. (54) gives

$$y\widehat{\theta}_0 - c_b - s_b - R_f = \overline{u}_B^p + \overline{F}_I^p + G(\widehat{v}_0)H(\widehat{\theta}_0)p_M'(\widehat{\theta})\widehat{R_B^p}/h(\widehat{\theta}_0).$$

Since $p_M^{'}(\theta_0)H(\theta_0) = h(\theta_0)(\theta_0 - p_M(\theta_0))$ and replacing the marginal borrower under monopoly given by Eq. (35), we have

$$y\widehat{\theta}_0 = y\theta_{0B} + \overline{u}_B^p + \overline{F}_I^p + (\widehat{\theta}_0 - p_M(\widehat{\theta}_0))G(\widehat{v}_0)\widehat{R_B^p}.$$

This implies that at the equilibrium with rational expectations, we have

$$y\theta_0^* = y\theta_{0B} + \overline{u}_B^p + \overline{F}_I^p + (\theta_0^* - p_M(\theta_0^*))G(\widehat{v}_0{}^*)(R_B^p)^*.$$

Appendix D: Platform entry We determine the conditions such that the platform enters the market. We proceed in different steps. In i), we determine the minimum return on deposits that deters platform entry on the investor side and the minimum return on deposits that deters platform entry on the borrower side. We analyze the conditions under which there is blockaded entry. In ii), we assume that entry is not blockaded and determine whether the bank prefers to accommodate or deter platform entry.

i) On the investor side, from Corollary 1, for a given indifferent consumer θ_0, the minimum return on the deposit that deters platform entry is defined by $\overline{R_d}(\theta_0)$. On the borrower side, the marginal borrower obtains a negative utility of borrowing on the platform if the platform's best-response to R_d and θ_0 is such that $\widehat{R_B^p}(R_d, \theta_0) \geq y$. Let $\widehat{R_B^p}(\overline{\overline{R_d}}(\theta_0), \theta_0) \equiv y$. From Lemma 2, since $\widehat{R_B^p}$ is increasing with R_d, if $R_d \geq \overline{\overline{R_d}}(\theta_0)$, the borrower obtains a negative utility of borrowing on the platform and the platform does not enter the market. This implies that if for any θ_0 belonging to $(0, 1)$ we have $\max(\overline{\overline{R_d}}(\theta_0), \overline{R_d}(\theta_0)) \leq R_f$, there is blockaded entry. The bank always chooses a return on deposits such that the platform does not enter the market.

ii) Assume that entry is not blockaded (i.e., if there exists θ_0 belonging to $(0, 1)$ such that $\max(\overline{\overline{R_d}}(\theta_0), \overline{R_d}(\theta_0)) > R_f$). If the bank chooses the same marginal borrower as under monopoly (i.e., θ_{0B}), the minimum return on deposits that deters platform entry on the investor side is given by $\rho_I^m = \overline{R_d}(\theta_{0B})$. The minimum return on deposits that deters platform entry on the borrower side is given by $\rho_b^m = \overline{\overline{R_d}}(\theta_{0B})$. The bank can deter platform entry (both on the borrower side and on the investor side) and keep its monopoly profit. To do so, it is sufficient for the bank to choose R_d such that $\max(\rho_b^m, \rho_I^m, R_f) \leq R_d$ and the marginal borrower under monopoly. Indeed, from Lemma 1, there is an infinite combination of deposit fees and return on deposits that yields the same profit for the bank. Therefore, the bank does not need to change the marginal borrower that it chooses under monopoly to deter platform entry. However, the bank has to choose between entry deterrence and entry accommodation. The bank prefers to accommodate platform entry if and only if its profit is higher under duopoly than under monopoly, that is, if and only if $\pi_o(\theta_0^*, R_d^*) + \pi_h(\theta_0^*) \geq \pi_h(\theta_{0B})$. Otherwise, it prefers to deter entry.

ONLINE APPENDIX:

In this Online Appendix, we give parts of the proofs that have been omitted from the paper 'Bank-Platform Competition in the Credit Market,' by Sara Biancini and Marianne Verdier.

Examples of distributions

To study the impact of different distributions of type θ we consider the family of beta distributions. The shape of the beta distribution varies with the two characteristic parameters and many common distributions can be obtained as special cases. For example, if the two parameters of the beta distributions are equal to one, the beta corresponds to the uniform distribution. If both parameters are equal to 1/2 the beta distribution is U-shaped and coincides with the arcsin distribution. The distribution can also be increasing or decreasing on the full $[0, 1]$ support, describing alternative situations in which the probability of success of the borrower is more likely to be high or low.

We thus assume that θ is distributed following a Beta$[a, b]$ on the $[0, 1]$ interval.

$$h(\theta) = \frac{\theta^{a-1}(1-\theta)^{b-1}}{B_\theta[a,b]},$$

where $B_\theta[a,b] = \int_0^1 t^{a-1}(1-t)^{b-1}dt$. For simplicity, we keep instead the assumption that v is distributed uniformly on $[0,1]$. From corollary 1, we have

$$\hat{v}_0(\theta_0) = \frac{\theta_0(R_d - \eta + c_p) - p_M(\theta_0)(R_d + c_p)}{p_M(\theta_0) - 2\theta_0}.$$

Replacing $p_M(\theta_0)$ and $\eta(\theta_0)$ we obtain that

$$\hat{v}_0 = \frac{\theta_0(R_d + c_p) - \frac{B_\theta(a+1,b)}{B_\theta(a,b)}\left(\frac{(1-\theta_0)\theta_0^{-a-1}(1-\theta_0)^{-b}(c-s_p)B_\theta(a+1,b)}{p_e} + R_d + c_p\right)}{\frac{B_\theta(a+1,b)}{B_\theta(a,b)} - 2\theta_0}.$$

The sign of $\frac{\partial \hat{v}_0}{\partial \theta_0}$ depends on the parameters of the Beta distribution, a, b. The shape of the derivative also depends on p_e and R_d. We cannot explicitly compute the full equilibrium, but we simulated the shape of $\hat{v}_0$ for given admissible values of $p_e \in (0,1)$ and $R_d \geq 1$ such that $\hat{v}_0 \in (0,1)$ (interior solutions). For all these values we obtain the following.

- For values of (a,b) such that the density $h(\theta)$ is increasing (or U-shaped), the marginal investor $\hat{v}_0$ is decreasing in the marginal borrower θ_0. An example is illustrated in figure 1. This example is plotted for $a = 2$, $b = 2/3$, so that $h(\theta)$ is increasing in $[0,1]$. The same qualitative shape is obtained when $h(\theta)$ is U-shaped. In the plotted example $C = 0.3$, $s_b = 0$, $s_p = 0$, $R_f = 1$, $c_p = 0$, $R_d = 1.1$ and $p_e = 0.1$. Modifying the value of these parameters with other values compatible with an interior solution does not modify the qualitative shape of $\hat{v}_0$ in all our simulations.

  FIGURE 1 HERE

- For values of (a,b) such that the density $h(\theta)$ is decreasing (or unimodal), the marginal investor $\hat{v}_0$ is increasing in the marginal borrower θ_0. An example is illustrated in figure 2. This example is plotted for $a = 1$, $b = 3/2$, so that $h(\theta)$ is increasing in $[0,1]$. The same qualitative shape is obtained when $h(\theta)$ is unimodal (inverse U-shaped). In the plotted example $C = 0.3$, $s_b = 0$, $s_p = 0$, $R_f = 1$, $c_p = 0$, $R_d = 1.1$ and $p_e = 0.1$. Modifying the value of these parameters with other values compatible with an interior solution does not modify the qualitative shape of $\hat{v}_0$ in all our simulations.

FIGURE 2 HERE

Discussion on the impact of the return on the risk-free asset on the equilibrium

We denote by a_{ij} the coefficients of the Hessian matrix H associated with the second-order conditions of bank profit maximization for $i = 1, 2$ and $j = 1, 2$. We have

$$a_{11} = \left.\frac{\partial^2 \pi^b}{\partial R_d^2}\right|_{(\widehat{\theta_0}, \widehat{R_d})} < 0,$$

$$a_{22} = \left.\frac{\partial^2 \pi^b}{\partial \theta_0^2}\right|_{(\widehat{\theta_0}, \widehat{R_d})} < 0,$$

$$a_{12} = a_{21} = b = \left.\frac{\partial^2 \pi^b}{\partial \theta_0 \partial R_d}\right|_{(\widehat{\theta_0}, \widehat{R_d})} > 0.$$

and $\det H = -b^2 + a_{12}a_{22} > 0$. We denote by

$$\gamma_1 = \left.\frac{\partial^2 \pi^b}{\partial R_f \partial R_d}\right|_{(\widehat{\theta_0}, \widehat{R_d})} = -H(\widehat{\theta_0})\frac{\partial \widehat{v_0}}{\partial R_d} g(\widehat{v_0}) > 0,$$

and

$$\gamma_2 = \left.\frac{\partial^2 \pi^b}{\partial R_f \partial \theta_0}\right|_{(\widehat{\theta_0}, \widehat{R_d})} = h(\widehat{\theta_0})(1 - G(\widehat{v_0})) > 0.$$

From the implicit function theorem, we have

$$\frac{d\widehat{R_d}}{dR_f} = \frac{-a_{22}\gamma_1 + b\gamma_2}{\det H} > 0,$$

and

$$\frac{d\widehat{\theta_0}}{dR_f} = \frac{b\gamma_1 - a_{11}\gamma_2}{\det H} > 0.$$

This shows that at stage 1, the bank's choice variables are increasing with the return on the risk-free asset. Therefore, a higher return on the risk-free asset increases the return on deposits and the probability of success of the marginal borrower (i.e., the bank reduces its credit supply). However, in equilibrium, we also need to take into account the impact of the return on the risk-free asset on the borrower's expectations on the probability of being funded on the platform.

How does the presence of the platform impact the transmission of the risk-free asset to the credit market and the deposit market compared to our benchmark?

First, we see from the previous analysis that the bank's choice variables at the first stage are still increasing with the return on the risk-free asset, as in our monopolistic benchmark. However, the effects are very different (and may be softened).

In our monopolistic benchmark, we have $\gamma_1 = 0$, because the risk-free asset does not impact the deposit rate. We also have $\gamma_2 = h(\theta_{0B})$. Hence, compared to our benchmark, there are two effects. First, the deposit rate is now positively impacted by the return on the risk-free asset. This is because, in our benchmark, investors are homogeneous with respect to their utility of investing in the bank. When the bank competes with the platform, a higher return on the risk-free asset provides the bank with incentives to increase the return offered to depositors, as it competes with the platform to attract investors. Second, the impact of the risk-free asset on the bank's repayment rate is softened compared to our benchmark (because now, in γ_2, the coefficient $h(\widehat{\theta}_0)$ is multiplied by $(1 - G(\widehat{v}_0)))$. In the limit case where the investor would always be willing to fund a loan on the platform (i.e., $G(\widehat{v}_0) = 1$), the second effect that is present in the monopolistic benchmark (and the only effect in the monopolistic benchmark) would be cancelled completely.

In equilibrium, we also need to take into account the impact of the return on the risk-free asset on the borrower's expectations of the probability of being funded (i.e., the marginal investor) on the platform. Therefore, we have

$$\frac{dR_d^*}{dR_f} = \left.\frac{d\widehat{R_d}}{dR_f}\right|_{p_e^*} + \left.\frac{\partial \widehat{R_d}}{\partial p_e}\right|_{p_e^*} \frac{dp_e^*}{dR_f},$$

and

$$\frac{d\theta_0^*}{dR_f} = \left.\frac{d\widehat{\theta}_0}{dR_f}\right|_{p_e^*} + \left.\frac{\partial\widehat{\theta}_0}{\partial p_e}\right|_{p_e^*} \frac{dp_e^*}{dR_f}.$$

The sign of the first effect is positive, because we have shown that the bank's choice variables are increasing with the return on the risk-free asset. However, the sign of the second effect may be either positive or negative. Indeed, the impact of the return on the risk-free asset on the marginal investor (i.e., the sign of dp_e^*/dR_f) is not obvious, because on the one hand, the marginal investor decreases with the return on deposits, and on the other hand, the marginal investor may either increase or decrease with the marginal borrower. Similarly, also using the implicit function theorem, it can be shown that the sign of $\left.\frac{\partial\widehat{R}_d}{\partial p_e}\right|_{p_e^*}$ and $\left.\frac{\partial\widehat{\theta}_0}{\partial p_e}\right|_{p_e^*}$ may be either positive or negative. Hence, the impact of the return on the risk-free asset on the borrower repayments when a bank competes with a platform is not easy to assess.

In the uniform distribution case, the marginal investor is decreasing with the return on the risk-free asset. Therefore, in that case, the higher the return on the risk-free asset, the lower the probability that an investor wishes to fund a loan on the platform.

Since $R_d^* = R_f + \tau(\widehat{v_0}^*)$, we have

$$\frac{dR_d^*}{dR_f} = 1 + \tau'(\widehat{v_0}^*)\frac{d\widehat{v_0}^*}{dR_f}.$$

Since $\tau' > 0$ and $d\widehat{v_0}^*/dR_f < 0$, the pass-through of the return on the risk-free asset to the deposit rate is lower than one. The sensitivity of the deposit rate to the return on the risk-free asset depends on the sensitivity of the marginal investor to the return on the risk-free asset.

In the uniform distribution case, we have

$$\theta_0^* = \theta_{0B} + \frac{\widehat{v_0}^*}{y}\left(\overline{u}_B^p + \overline{F}_I^p + (\theta_0^*/2)(R_B^p)^*\right),$$

and

$$(R_B^p)^* = \frac{2(C + s_b + p_e^*(c_p + R_f + p_e^*))}{3p_e^*\theta_0^*},$$

Therefore, we have

$$\frac{d\theta_0^*}{dR_f} = \frac{d\theta_{0B}}{dR_f} + \frac{1}{y}\frac{d\widehat{v_0}^*}{dR_f}(\overline{u}_B^p + \overline{F}_I^p) + \frac{\widehat{v_0}^*}{y}(\frac{d\overline{u}_B^p}{dR_f} + \frac{d\overline{F}_I^p}{dR_f} + \frac{d(\widehat{v_0}^*(\theta_0^*/2)(R_B^p)^*)}{dR_f}).$$

- The first effect (i.e., $d\theta_{0B}/dR_f$) corresponds to the pass-through of the risk-free asset under monopoly.

Therefore, to analyze whether competition with the platform increases or decreases the pass-through of the return on the risk-free asset, we need to study the sign of the other additional effects that we obtain when the bank competes with the platform.

- The second effect is negative and reduces the pass-through, because the marginal investor is decreasing with the return on the risk-free asset.

- The third effect (i.e., $d\overline{u}_B^p/dR_f$) corresponds to the impact of the return on the risk-free asset on the rents that the bank extracts from the marginal borrower. Its sign is ambiguous: it may either increase or decrease the pass-through.

- The fourth effect (i.e., $d\overline{F}_I^p/dR_f$) corresponds to the impact of the return on the risk-free asset on the rents that the bank extracts from the marginal investor. This effect is negative (the bank extracts lower rents from the marginal investor when the return on the risk-free asset increases).

- The last effect (i.e., $d(\widehat{v_0}^*(\theta_0^*/2)(R_B^p)^*)/dR_f$) corresponds to the impact of the return on the risk-free asset on the adjustment of the marginal borrower that is due to the platform's reaction at the next stage. The sign of the last effect may be also ambiguous in general, but is positive in the uniform distribution case. Indeed, we have

$$\begin{aligned}\frac{d(\widehat{v_0}^*(\theta_0^*/2)(R_B^p)^*)}{dR_f} &= \frac{p_e^*}{3} + \frac{dp_e^*}{dR_f}\frac{c_p + R_f + 2p_e^*}{3} \\ &= \frac{\sqrt{(R_f + c_p)^2 + 8(C + s_b)} - (R_f + c_p)}{32\sqrt{(R_f + c_p)^2 + 8(C + s_b)}} > 0.\end{aligned}$$

Because of the two ambiguous terms, the presence of a platform can increase or decrease the pass-through with respect to monopoly. Under uniform distribution, however, the sign of the sum of the last three terms is generally negative. To see this, we set $c_b \in [\underline{c}_b, \overline{c}_b]$ to ensure the existence of an interior solution. For instance, setting $c_b = (\underline{c}_b + \overline{c}_b)/2$ we obtain:

$$\frac{d\theta_0^*}{dR_f} = \frac{d\theta_{0B}}{dR_f} - \frac{\sqrt{\mathrm{Rf}^2 + 8(C+s_b)} - \mathrm{Rf} + (C+s_b)}{2(8+2R_f-(C+s_b))\sqrt{\mathrm{Rf}^2+8(C+s_b)}} < \frac{d\theta_{0B}}{dR_f}.$$

Qualitatively similar results are obtained choosing other values of $c_b \in [\underline{c}_b, \overline{c}_b]$.