Bank-Platform Competition in the Credit Market

(Preliminary version)

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Abstract

The paper analyzes the equilibrium on 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. The bank and the platform are differentiated on the borrower side and on the investor side. The bank offers a safe contract to the investor, whereas the platform offers a risky contract, such that the investor is only reimbursed if the borrower is successful. The bank offers a contract to the borrower that requires the borrower to supply a collateral, whereas the platform does not demand any guarantee.

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

JEL Codes: L1, L5, G2.

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1 Introduction

Over the last ten years, the entry of non-banks in the retail credit market has impacted the volume of credit offered to retail borrowers and the risks faced by financial intermediaries. Non-banks such as online P2P lenders, payday lenders or balance sheet lenders often rely on business models that differ from the traditional organization of banks. Among these new players, lending platforms such as Prosper, Lending Club or Zopa have managed to attract more than 10% of the market of retail lending in several countries (e.g., in the United-States, in the United-Kingdom).\footnote{Morgan Stanley estimated in 2017 that the market for online SME lending would amount to one fifth of total SME lending in 2020 (See Mills and Mc Carthy, Harvard Business Review, 2017).}

Several empirical papers have started to study how the entry of lending platforms impacts the availability of credit for retail consumers and the average risk on the retail lending market. However, very little is known from a theoretical perspective about the impact of entry of lending platforms on the equilibrium in the retail credit market. In particular, we are not aware of any paper analyzing how competition between a bank and an alternative finance provider organized as a platform impacts the repayments made by borrowers, the investors’ behavior and the profitability of platforms. This paper aims at answering these research questions.

Lending platforms are part of the wider FinTech movement that is reshaping competition in the banking industry.\footnote{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...).} Like banks, lending platforms create value by matching borrowers with investors and by pricing credit risk with credit scoring techniques. In other words, they perform the traditional brokerage function of financial intermediaries (see Havrylchyk and Verdier, 2018). However, platforms offer innovative services both on the borrower side and the investor side. On the borrower side, platforms allow consumers to make a credit application online, which reduces the cost of access to credit. Furthermore, they 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. On the investor side, platforms offer to investors risky contracts, as the latter are only paid back if...
the borrower is successful.

This innovative business model enables platforms to differentiate themselves from traditional banks. Banks make profits on the net interest margin between the interest rate received from borrowers and the interest rate paid to depositors. A bank typically offers to investors-depositors a demandable debt contract. Depositors do not have any knowledge of the underlying loans which are selected by the bank and do not participate in the screening process. Moreover, they may withdraw their funds at any time provided the bank is solvent. In case the bank fails, they benefit from deposit guarantee schemes up to a certain limit. Since loans and funding sources may differ in terms of risk and maturity, the business model of banks relies on the management of maturity transformation.\footnote{See Diamond and Dybvig, 1983, Gorton and Pennacchi, 1990.} 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).

Unlike banks, platforms neither perform risk nor maturity transformation. If an investor decides to fund a loan, the loan repayment is directly paid by the borrower to the investor. A platform makes profit on the servicing fees paid the investor and the origination fees paid by the borrower. Furthermore, investors face a liquidity risk when they fund a loan on the platform, because they cannot withdraw their investment before maturity. Therefore, platforms transfer a share of the credit risk and the liquidity risk to investors.\footnote{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.}

This explains why lending platforms often benefit from a specific regulatory regime in various countries. Their organization depends on the regulatory framework of the country in which they operate.\footnote{See OECD (2018) for examples of different regulatory frameworks for crowdfunding platforms.} In several countries, regulators do not allow platforms to manage deposit accounts, forcing them to rely on banks to serve their consumers. In that case, banks can extract rents on their incumbent position, both from the depositors and from the fees they charge to platforms to originate loans. Therefore, entry of P2P lenders does not necessarily imply a reduction of banks’ profits. However, more research is needed to understand the impact of entry of P2P platforms on competition in the retail credit market. What is
the impact of competition with asymmetric business models on borrowers’ repayments and investors’ behavior? Both researchers and regulators express concern that the entry of P2P platforms may change the equilibrium in the retail credit market, which is characterized by several frictions (i.e., information asymmetries, imperfect competition, regulatory constraints). On the one hand, platforms may help smaller borrowers who are underserved by banks to have access to credit, relieving the problem of credit rationing that may be more severe for this population. Platforms may fund those borrowers better than banks for various reasons. First, they are not subject to the same regulatory requirements. Hence, their cost of funding risky or less profitable loans may be lower. Second, they are also able to use alternative scoring techniques to improve the information available on a targeted group of consumers. Furthermore, they often offer an alternative solution to borrowers who are not able to supply a collateral to their banks, either because their project is not mature or because their business relies on intangible assets. On the other hand, several regulators (as the Financial Conduct Authority in the United-Kingdom) have expressed concerns that platforms could overcharge borrowers for their services. Moreover, the co-existence of various regulatory regimes may decrease the efficiency of financial regulations by allowing banks to benefit from regulatory arbitrage opportunities.

We build a model to study the equilibrium on the retail credit market when a bank competes with an alternative finance provider organized as a platform. The bank and the platform compete with different services on the borrower side and on the investor side. Borrowers are heterogeneous and have different probabilities of success. Borrowers and investors first open an account in a bank. Then, they may borrow or lend respectively at the bank or through a lending platform. In order to serve a client, the platform may have to pay an access charge to the bank. This implies that the bank can raise a profit directly from depositors (investors and borrowers), from its home borrowers or by outsourcing loans to the platform. Investors are also heterogeneous and differ across their liquidity needs.

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, in

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6See the OECD Report: Enhancing SME access to diversified financing instruments, February 2018.
which all firms are all asked to provide the same amount of collateral. The collateral enables
the bank to select the borrowers of better quality. On the contrary, the platform does not
ask for a collateral. On the investor side, the bank guarantees the return on deposits to the
investors, while on the platform the lenders bear 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. At the equilibrium, 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 bank contract (return on the
safe asset and size of the collateral) on the viability of the platform and on the repayments
asked by the bank and the platform. Because of the two-sided nature of the market, the
impact of the bank repayment rate and the collateral on the platform’s profit is non trivial,
because of the externality exerted by the borrower on the investor. This depends on borrower
heterogeneity: lower repayment rates attract more borrowers, but decrease their quality, as
given by the average probability of success. This in turn affects the incentives for investors
to participate to the platform or to deposit their money in the bank.

We are able to show that competition between the bank and the platform may have
a non standard impact on the borrower repayment. Depending on borrower heterogeneity,
the platform may choose to raise the borrower repayment when the bank prices loans more
agressively. Indeed, if the bank reduces the borrower repayment, it exerts a negative ex-
ternality on the quality of the platform’s loans. Hence, the platform needs to increase the
return offered to investors, which raises the borrower repayment. We identify the conditions
under which the platform adjusts the price structure in favor of investors, to the detriments
of borrowers.

The reminder 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 analyze a benchmark in
which the bank is a monopoly on the market. In Section 5, we solve for the equilibrium of
the game. In Section 6, we analyze the robustness of our model and discuss some policy
implications of our results. 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).\footnote{Several papers rely on the analysis of micro-data coming from the two main platforms in the United-States, Prosper and Lending Club.}

A strand of this 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 (Burtler 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., 2015). Other papers analyze the platform’s incentives to offer information to investors. Using data from Lending Robot, Vallée and Zeng (2018) 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. Two papers study the platform’s pricing mechanism by analyzing Prosper’s decision to switch from an auction process to a system with posted prices (Franks et al., 2016, Liskovich and Shaton, 2017).

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 the credit obtained through P2P platforms is a complement or a substitute to 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., 2016, Butler et al., 2016). In particular, Butler et al. show that borrowers who are located in more competitive markets demand lower reservation rates on the 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 in-roads 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, trying 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 (2017) 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 on 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 in one standard deviation of P2P lending activity. Furthermore, banks are more affected by entry in less competitive markets.

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 sources. A literature studies why SMEs resort to Venture Capital (See Gompers and Lerner, 2011 for a survey). Berger and Schaeck (2011) 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 (2018) 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.8

Our paper is also related to a wide strand of literature on competition with asymmetric business models, one firm being organized as a platform (See Casadesus-Masanell on the market for video games).

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.

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8On the one hand, ICO financing creates an agency conflict between the entrepreneur and investors, because the level of investment in the project is chosen after funds have been secured. On the other hand, ICO financing enables a risk-averse entrepreneur to transfer part of the venture risk to diversified investors, without diluting his control rights.
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 a quicker access to credit. On the investor side, the platform enables the investor to choose whether or not to fund a loan. The bank may extract rents from its monopoly on deposit activities. Furthermore, deposit contracts are more liquid than debt contracts offered by the platform. Our model enables us to study how competition impacts repayment rates on the credit market and investor participation to the platform.

**Borrower** A risk-neutral borrower needs $1 of funding to invest in a risky project that yields $y > 1$ with probability $\theta \in [\underline{\theta}, \bar{\theta}]$ and 0 otherwise. Initially, the borrower has no monetary wealth and owns a collateral of value $C$. His probability of success $\theta$ 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.

At the first stage of the game, the borrower may open an account in the bank, which costs him a fixed fee $F_B$. Opening an account in the bank is needed to borrow at the following period, either from the bank or the platform. 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 the distribution of $\theta$ is common knowledge (i.e., it is also known to the financial intermediaries and the investor). He believes that his probability of success $\theta$ is distributed on $[\underline{\theta}, \bar{\theta}]$ according to the probability density $h$ and the cumulative $H$.  

At the second stage, the borrower may choose to borrow from his home bank or from an alternative provider, a platform, that offers a different lending contract. In all cases, the borrower is protected by limited liability in case of failure. The bank’s contract involves a fixed repayment $R^B_1$ in case of success and the payment of a collateral $C < 1$ in case of

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9We do not model any information advantage of the bank over the platform and choose to leave this issue for future research.

10For example, in the United-States, borrowers who seek credit from Lending Club or Prosper need to prove that they have a valid bank account. The ability to manage deposit accounts is a key difference between banks and lending platforms in various countries and jurisdictions (e.g., Austria, Belgium, Finland, France, European Union). Furthermore, banks are able to create money when they accept to fund a borrower.

11As 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 (1973), who assume that borrowers differ in terms of riks.
failure. The platform’s contract involves a fixed repayment $R_B^p$ in case of success, but no collateral in case of failure.\footnote{Several platforms offer credit without requiring any collateral from their borrowers. For instance, the French platform LendiX (renamed October) compares different credit contracts offered by banks and platforms to their borrowers. The platform may provide credit without any collateral at a higher interest rate than the bank and with a quicker reply. There are several other platforms in France offering credit contracts without collateral (e.g., Prexem). Note that the platform repayment includes the fees paid to the platform. The website lendingmemo.com explains to borrowers that they should take the sum of the origination fee and the interest rate into account when comparing credit offers on platforms.}

Each time the borrower seeks credit from the bank (resp., the platform), he incurs a fixed cost $s_b$ (resp. $s_p$). We assume that $s_p \leq s_b$, such that the platform and the bank are also differentiated in quality in the dimension of search costs. If $s_p < s_b$, the platform may have a quality advantage over the bank as it reduces the cost of access to credit.\footnote{Usually, platforms may deliver quicker answers to borrowers than banks. They also suppress the cost for the borrower of visiting a bank branch.}

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, either by the bank or by the platform. The borrower forms passive expectations on the probability $p_e$ of being funded on the platform, because he cannot observe the contract offered by the platform to its investor. If the borrower is not funded by the platform, he may pay the fixed cost to seek credit from the bank.\footnote{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, Adams 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. For example, Havrylchyk et al. (2018) show that an increase in one standard deviation in the density of bank branches at the county level in the United-States reduces the volume of P2P loans funded by Lending Club and Prosper by 29%.}

In that case, we assume that he obtains a credit with probability $1 - \gamma \in [0,1]$ from the bank. If $\gamma = 0$, the bank offers the same credit contract to the consumer if the latter is rejected by the platform. This may depend on the fact that the bank cannot monitor the platform’s activity and has no information on the fact that the borrower has asked a credit on the platform. When $\gamma > 0$, the borrower faces a loss in their utility when going back to the bank, aiming to capture the fact that borrowers not granted for credit on the platform may face reduced access to bank loans. This might happen if the bank monitors platform activities and can propose less favorable conditions to borrowers after they reveal not able to get financing on
the platform.\textsuperscript{15} When $\gamma = 1$, a borrower who does not obtain a credit from the platform is not able to get a loan from the bank.

Therefore, the borrower obtains a utility $u^b_B(\theta) = \theta(y - R^b_B) - (1 - \theta)C - s_b$ if he seeks credit from the bank and an expected utility

$$u^p_B(\theta) = p_e \theta(y - R^p_B) - s_p + (1 - p_e)(1 - \gamma)u^b_B(\theta)$$

if he seeks credit from the platform. The borrower’s reservation utility is equal to zero if he does not borrow.

\textbf{Investor} A risk-neutral investor wants to invest $\$1$ in a project. The investor is characterized by his private taste for liquidity $v \in [\underline{v}, \overline{v}]$, which is unobservable by the financial intermediaries and the borrower.\textsuperscript{16}

At the first stage, the investor may open an account in the bank, which costs him a fixed fee $F_I$. Opening an account in the bank is necessary to invest at the following period either in the bank or in the platform. The investor’s outside option is to invest in the risk-free asset, which yields a return of $R_f$. Deposits in the bank are perfectly insured.

When he opens an account, the investor is unaware of his private taste for liquidity that is revealed to him at the second stage. However, he knows the distribution of $v$, which is also known by the financial intermediaries. He believes that his taste for liquidity $v$ is distributed on $[\underline{v}, \overline{v}]$ according to the probability density $g$ and the cumulative $G$. For simplicity, we will assume that $v$ is uniformly distributed on $[0, 1]$ in our example. In the general case, we assume that $G/g$ is increasing and concave.

At the second stage, the investor observes whether the borrower seeks credit from the bank or the platform and decides whether or not to lend. The bank and the platform offer different types of contracts in terms of insurance and returns on investment. If the investor

\textsuperscript{15}One could argue that the bank may not be able to see whether the platform rejects a borrower because it does not have enough funds or because the probability of success of the project is very low. Balyuk (2018) provides evidence that banks increase credit to borrowers who are funded by P2P platforms.

\textsuperscript{16}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 the report conducted by the Cambridge Center for Alternative Finance).
lends through the bank, he obtains the return on deposits $R_d$ and does not take any risk as deposits are perfectly insured.\textsuperscript{17} If the investor lends through the platform, he receives the return offered by the platform $R_p^I$ if the borrower is successful and 0 otherwise.\textsuperscript{18} Therefore, the investor shares some risk with the platform. The investor is able to observe the contract offered by the financial intermediaries to the borrower and is therefore able to form responsive expectations on his probability of being reimbursed. He anticipates that he will be reimbursed with the average probability of success $p_M(\theta)$ of the borrowers that the platform is able to attract.\textsuperscript{19}

Furthermore, the investor incurs some disutility $v$ of investing in the platform rather than in the bank because investments in the platform are more illiquid.\textsuperscript{20} Therefore, the investor’s utility of lending through the bank is $u_b^I(v) = R_d$, whereas the investor’s utility of lending through the platform is $u_p^I(v) = p_M(\theta)R_p^I - v$. If he observes that the borrower seeks credit from the bank, the investor always agrees to lend if he obtains the return on deposits. If the borrower seeks credit from the platform, the investor agrees to fund the loan if he expects a higher utility of doing so than leaving its funds in a bank account.\textsuperscript{21}

**The bank** The bank offers deposit contracts to borrowers and investors, in exchange for fixed fees $F_B$ and $F_I$, respectively. Opening a deposit account is necessary to borrow from the platform or to invest in the platform.

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. Serving his own

\textsuperscript{17}We will discuss this assumption in our extension section by analyzing the case in which the investment in the bank is risky.

\textsuperscript{18}The return corresponds to the sum of the principal of the loan, the interest rate, net of the servicing fee.

\textsuperscript{19}We do not model screening efforts of investors and leave this aspect of the market for the extension section. 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).

\textsuperscript{20}Since platforms do not perform maturity transformation, in general, investors cannot withdraw their funds before maturity. Several platforms (e.g., Prosper, Lending Club) have started to organize secondary markets to enable investors to resell their loans. However, the volume of transactions on these markets is so low that investments in online loans are considered as particularly illiquid.

\textsuperscript{21}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).
borrower costs $c_b \geq 0$ to the bank. We assume that because of regulatory constraints, the bank is unable to price discriminate between borrowers by offering them a different type of contract that does not require a collateral.

If the platform is not allowed by regulation to issue loans, it has to rely on the bank to serve its borrowers. In that case, the platform and the bank are organized as the notary model (see Kirby and Worner, 2015). The platform pays an issuing fee $a$ to the bank when it serves the borrower, which can be seen as an access fee to the incumbent’s infrastructure. The bank incurs a marginal cost $k_b$ to issue the loan.\(^{22}\) If $k_b = a = 0$, the bank obtains no profit from the platform’s lending activity, nor does it incur any marginal cost.\(^{23}\)

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

**The platform** The platform is not allowed by regulation to manage deposit accounts.\(^{24}\) However, it may offer credit at the second stage to the borrower if it attracts funds from the investor.\(^{25}\) The platform offers a lending contract to the borrower that involves the fixed repayment $R^b_{BP}$ in case of success and no collateral in case of failure. The platform shares some risk with the investor who is offered $R^b_{PI}$ if the borrower is successful and zero otherwise.\(^{26}\)

\(^{22}\)For example, in the United-States, Prosper and Lending Club are not allowed by regulation to originate loans. Therefore, they rely on the origination services offered by WebBank, a FDIC-insured, Utah-chartered industrial bank that originates all borrower loans made through their marketplaces. After originating the loan, WebBank sells it back to the platform and charges a fee for this operation. In our framework, this parameter can also be seen as the opportunity cost for the bank of issuing the loan for the platform instead of investing in another asset.

\(^{23}\)In case the platform is able to issue loans, the fee $a$ could represent the cost for the platform of having access to external data sources to assess the borrower’s creditworthiness (e.g., Altares, Credit Safe...).

\(^{24}\)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 Sachs.

\(^{25}\)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 or two dominant platforms in the market that captures a large share of borrowers.

\(^{26}\)Platforms are usually compensated with origination fees and on-going 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). While the fees do not appear directly in our model, the sum of the servicing and the on-going fees can be deduced by computing the platform’s net interest margin. As argued by Wang (2019), several FinTech lenders tend to earn net interest margins as banks. In our framework, both are equivalent because the loan amount is fixed. We do not model the fixed fee that the platform receives for originating the loan but we will discuss this in an extension of our framework.
Serving the borrower costs \( c_p + a \) to the platform, where \( a \) is the access fee paid to the bank and \( c_p \) the marginal cost of serving the borrower. We do not make any assumption on the sign of \( a \), as it could be that the bank pays the platform to serve its borrowers. The platform’s marginal cost \( c_p \) is lower than the bank’s marginal cost \( c_b \).\(^{27}\) The platform’s profit is \( \pi^p \).

Assumptions:

(A1)

Assumption (A1) ensures that the credit market is covered when the bank competes with the platform at the equilibrium of the game.

(A2) The cost of access to a credit offer on the platform is sufficiently low.

Assumption (A2) ensures that it is always better for the marginal borrower at the equilibrium of the game to seek credit from the platform and the bank than only seek credit from the bank. In our uniform distribution example, it must be that \( s_p \le C + s_b \), otherwise, the bank captures the entire market.

In the paper, we will use the notations:

- \( \mathbb{E}(\hat{\theta}) = \frac{1}{\theta} \int \theta h(\theta) d\theta \) and \( \mathbb{E}(\tilde{\theta}) = \frac{\tilde{\theta}}{\tilde{\theta}} \int \theta h(\theta) d\theta \),
- \( \mathbb{E}(v_0) = \int_{v_0}^{\pi} v g(v) dv \) and \( \mathbb{E}(v_0) = \int_{v_0}^{\pi} v g(v) dv \).

Example: In the paper, we use a simple example, in which \( \theta \) and \( v \) are respectively uniformly distributed on \([0, 1]\). Furthermore, we assume that \( s_p = 0 \) to ensure that every borrower derives a positive utility of demanding a credit on the platform.

\(^{27}\)Since online lenders face lighter regulation as banks, it is often argued that their funding cost is lower than the banks’ funding cost, because they face a lower cost of capital. However, one could argue that banks have a large stock of intangible capital that entrants do not possess, namely data on their customer base. Begenau and Landvoigt (2017) show that shadow banks capture a larger share of banking activity due to regulatory arbitrage. Buchak et al. (2017) find that non-banks enter more in US counties with more exposure to fair-lending lawsuits.
Timing of the game: The timing of the game is as follows:

- At the first stage, 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 $R_B^b$. The platform chooses the repayment of the lending contract $R_B^p$ and the interest rate paid to investors $R_I^p$.

- At the second stage, the borrower learns his private probability of success $\theta$ and decides whether or not to borrow from the bank or the platform. The investor learns his private taste for liquidity $v$. He observes whether the borrower seeks credit from the bank or the platform and decides whether or not to lend to the borrower.

- At the third stage, the project pay-offs materialize. If the project is successful, the bank and the platform are reimbursed. The platform pays the interest rate to the investor if the project is successful. 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.

In section 4, we solve the game through backward induction and determine the Nash equilibrium of the game.

4 A benchmark: a monopolistic bank

In this section, 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 credit contract without price discrimination The bank chooses the interest rate that maximizes its profit subject to the participation constraint of the borrower and the investor. We denote by

$$\tilde{\theta}_B \equiv (C + s_b)/(y - R_B^b + C)$$

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 constraint of the borrower and the investor are given by

\[ F_B \leq \int_{\theta_B} u_B^b(\theta) h(\theta) d\theta, \]

and

\[ F_I \leq R_d - R_f. \]

The borrower opens an account if and only if his expected utility of borrowing exceeds the cost of the deposit fee. The investor opens an account if and only if he expects to earn at least the return on the risk-free asset.

The bank’s profit under monopoly is given by

\[ \pi^b = F_B + F_I + \int_{\theta_B} (\theta R_B^b + (1 - \theta)C - R_d - c_b) h(\theta) d\theta + \int_{\theta} (R_f - R_d) h(\theta) d\theta. \]

(1)

The bank’s profit in Eq. (1) 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 is always able to invest in the risk-free asset and obtain the return \( R_f \). In all cases, the bank pays the return \( R_d \) to depositors.

In Lemma 1, we give the profit-maximizing marginal borrower \( \theta_B^m \) chosen by a monopolistic bank and the corresponding profit-maximizing repayment \( (R_B^b)^m \).

**Lemma 1** A monopolistic bank chooses a borrower repayment given by

\[ (R_B^b)^m = y + C - \frac{y(C + s_b)}{s_b + c_b + R_f}. \]

The bank is indifferent on the choice of the deposit rate as it extracts completely the surplus of depositors. A monopolistic bank extracts completely the surplus of the marginal borrower, the latter being given by \( \theta_B^m = (s_b + c_b + R_f)/y \).

The bank makes a profit given by \( (\pi^b)^m = y E(\theta_B^m) - (s_b + c_b + R_f)(1 - H(\theta_B^m)) \).

There is an infinity of credit contracts defined by a collateral and an interest rate that
yields the same level of risk and the same profit for the bank. Moreover, there is an infinity of combinations of deposit fees and deposit rates that leave the investor indifferent between leaving his money in a bank account and investing in the risk-free asset.

5 Competition between the bank and the platform

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

5.1 The investor’s decision to fund a credit on the platform

At the third stage, the investor decides whether or not to lend to the borrower. If he observes that the borrower seeks credit from the bank, the investor always agrees to lend if he obtains the return on the safe asset. If he observes that the borrower seeks credit from the platform, the investor agrees to lend if and only if

\[ u^p_I(v) \geq u^b_I(v) \equiv R_d. \]  

We denote by \( v_0(R^p_I, \tilde{\theta}, R_d) \) the taste for liquidity that leaves the investor indifferent between leaving its funds in the bank or funding a loan on the platform. The taste for liquidity of the indifferent investor is implicitly defined by \( u^p_I(v_0(R^p_I, \tilde{\theta}, R_d)) = R_d \). Therefore, the marginal investor is given by

\[ v_0(R^p_I, \tilde{\theta}, R_d) \equiv p_M(\tilde{\theta}) R^p_I - R_d. \]  

The probability that the investor wishes to lend on the platform is \( G(v_0(R^p_I, \tilde{\theta}, R_d)) \). The investor’s participation to the platform depends on the return offered by the platform \( R^p_I \). Moreover, it also depends on the marginal borrower \( \tilde{\theta} \) and on 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.\(^{28}\)

\(^{28}\)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
5.2 The borrower’s decision to seek credit from the bank or the platform

At the second stage, the borrower decides whether or not to seek credit from the bank or the platform. The borrower compares his expected utility of seeking credit from the bank and from the platform. For this purpose, he takes into account the probabilities of being funded by each financial intermediary. If the borrower only seeks credit from the bank, he is funded with certainty if he is able to offer the collateral required by the bank. If he seeks credit from the platform, he is funded with probability $p_e$ on the platform and with probability $(1 - \gamma)$ by the bank if he is not funded by the platform. Therefore, 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

$$u_B^b(\theta) \geq u_B^p(\theta).$$  \hspace{1cm} (4)

Suppose that neither the bank nor the platform captures the entire market. Replacing for $u_B^b(\theta)$ and $u_B^p(\theta)$ into Eq. (4), we find that the indifferent consumer $\tilde{\theta}$ between the bank and the platform is given by

$$\tilde{\theta} = \frac{(C + s_b)(p_e + (1 - p_e)\gamma) - s_p}{y(1 - p_e)\gamma + (C - R_B^p)(p_e + (1 - p_e)\gamma) + p_e R_B^p}.$$  \hspace{1cm} (5)

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.\textsuperscript{29}

Since $(C + s_b)(p_e + (1 - p_e)\gamma) \geq s_p$ from Assumption (A2), the numerator of $\tilde{\theta}$ is positive. For $\tilde{\theta}$ to be positive, it must be that the difference between the repayment rate asked by the platform and the repayment asked by the bank is sufficiently large. Finally, note that either platforms. In our model, we consider that investors are able to make rational expectations on their expected probability to receive the return on their investment.

\textsuperscript{29}Note that this analysis encompasses the monopoly case of Section 4. If the probability to be funded on the platform is null ($p_e = 0$), if a loan is never funded by the bank when the borrower seeks credit from the platform ($\gamma = 1$) and if the cost of seeking credit on the platform is null ($s_p = 0$), then the marginal borrower is identical to $\bar{\theta}_B$.\textsuperscript{17}
the bank or the platform can capture the entire lending market depending on the amount of collateral for the bank loan.

5.3 The demand for credit from financial intermediaries

A borrower seeks credit from the bank if and only if $\theta \geq \tilde{\theta}$ and on the platform if and only if $\theta \leq \tilde{\theta}$. If the market is covered, the demand for credit on the platform is given by $H(\tilde{\theta})$ and the demand for credit at the bank’s is given by $1 - H(\tilde{\theta})$. 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.

Note that in our model, the entry of the platform may both be a complement and a substitute to bank credit. If $\tilde{\theta} \geq \theta^m_B$, for given repayment rates charged by the bank and the platform, some borrowers who seek credit from the bank under monopoly prefer to seek credit from the platform under duopoly. Hence, those borrowers (characterized by a medium probability of success) substitute platform credit for bank credit. However, the platform serves the borrowers who have a low probability of success and who are not served under monopoly. Hence, for borrowers of lower quality, the platform complements bank credit.30

5.4 The platform’s best response at the first stage

The platform chooses the return $R^p_I$ given to investors and the borrower repayment $R^p_B$ that maximize its expected profit given by

$$\pi^p = G(v_0(R^p_I, \tilde{\theta}, R_d)) \int_0^{\tilde{\theta}} \left( \theta (R^p_B - R^p_I) - (a + c_p) \right) h(\theta) d\theta. \quad (6)$$

30Finally, remark that since borrowers borrow a constant amount in our framework from one financial intermediary (but not both), we do not capture 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.
Replacing for \( p_M(\tilde{\theta}) \) into (6), the platform’s profit is given by

\[
\pi^p = G(v_0(R^p_I, \tilde{\theta}, R_d))H(\tilde{\theta})((R^p_B - R^p_I)p_M(\tilde{\theta}) - (a + c_p)).
\]

In Proposition 1, we give the platform’s best-responses \( R^p_B \) and \( R^p_I \) to the marginal borrower \( \tilde{\theta} \) chosen by the bank. For this purpose, we use the following notations:

- \( \varepsilon_I \) the elasticity of investor demand to the return \( R^p_I \),
- \( \varepsilon_B \) the elasticity of borrower demand to the repayment \( R^p_B \),
- \( \mu_P \) the elasticity of the platform’s expected revenue \( p_M(\tilde{\theta})R^p_B \) to the repayment \( R^p_B \).

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** For a given marginal borrower \( \tilde{\theta} \) and a deposit rate \( R_d \) chosen by the bank, the platform chooses a return for investors such that

\[
\frac{(R^p_B - R^p_I)p_M(\tilde{\theta}) - (a + c_p)}{p_M(\tilde{\theta})R^p_I} = \frac{1}{\varepsilon_I},
\]

and the price structure such that

\[
\frac{R^p_I}{R^p_B} = \frac{\mu_P\varepsilon_I}{\varepsilon_B}.
\]

**Proof.** See Appendix B-1.

On the investor side, the platform trades off between increasing the return offered to investors, 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 \( R^p_I \), the lower the platform’s mark-up on its marginal cost.

On the borrower side, the platform trades off between increasing the loan repayment \( R^p_B \), 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 rate exactly compensates the marginal loss from the surplus that is extracted from the marginal borrower and the marginal investor.

In Lemma 1, the ratio $R^p_I/R^p_B$ 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 $R^p_I$, divided by the elasticity of the marginal borrower to the repayment $R^p_B$, 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 of demand elasticities between both sides. However, our model differs from the literature because the platform’s revenue is uncertain. This explains why the price structure is weighted by the elasticity of the platform’s expected revenue to the borrower repayment.

Our model explains why platforms may retain some margin from the return that is paid to investors. In some markets, this asymmetry between the investor and the borrower side is a source of distortion. For example, in July 2018, the FCA has expressed the concern that platforms may overcharge borrowers on the mortgage residential market, showing that in some cases investors could only receive 3% of return while borrowers could pay an interest rate exceeding 30%.

Finally, note that the platform’s margin $R^p_B - R^p_I$ corresponds to the sum of the fees paid by the borrower and the investor each time a borrower repays a loan (servicing+on-going fees).

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

$$\tilde{R}^p_B(\tilde{\theta}) = 2((1 - (1 - p_e)\gamma)(C + s_b) + p_e(R_d + c_p + a))/(3\tilde{\theta}p_e),$$

and

$$\tilde{R}^p_I(\tilde{\theta}) = ((1 - (1 - p_e)\gamma)(C + s_b) - 2p_e(-2R_d + c_p + a))/(3\tilde{\theta}p_e).$$
For a given level of \( p_e \), the price structure is given by

\[
\frac{\tilde{R}_I^p}{R_B^p} = \frac{((1 - (1 - p_e)\gamma)(C + s_b) - 2p_e(-2R_d + c_p + a))}{2((1 - (1 - p_e)\gamma)(C + s_b) + p_e(R_d + c_p + a))}.
\]

In the special case of a uniform distribution, the price structure is independent of \( \tilde{\theta} \).

The marginal investor at the profit-maximizing prices: Competition between the bank and the platform impacts the marginal borrower, which in turn determines the platform’s optimal choice of the marginal investor. The marginal investor depends both on the average probability of success of borrowers who demand a credit on the platform and the return offered by the platform in case of success. Therefore, the marginal investor internalizes a share of the risk borne by the platform in its decision to fund a loan on the platform.

In Corollary 1, we give the implicit definition of the marginal investor as a function of the marginal borrower when the platform chooses the prices that maximize its profit. For this purpose, let \( k(\tilde{\theta}) \equiv p_M(\tilde{\theta})R_B^p/\varepsilon(\tilde{\theta}, R_B^p) \), where \( \varepsilon(\tilde{\theta}, R_B^p) = -(R_B^p/E(\tilde{\theta}))(dE(\tilde{\theta})/dR_B^p) \) denotes the elasticity of the expected probability of success \( E(\tilde{\theta}) \) to the repayment \( R_B^p \). In Appendix B-3, we prove that \( \varepsilon(\tilde{\theta}, R_B^p) = \tilde{\theta}^3 h(\tilde{\theta})R_B^p/(\beta E(\tilde{\theta})) \), where

\[
\beta \equiv ((C + s_b)(p_e + (1 - p_e)\gamma) - s_p)/p_e.
\]

Therefore, we have \( k(\tilde{\theta}) = \beta p_M(\tilde{\theta})E(\tilde{\theta})/\tilde{\theta}^3 h(\tilde{\theta}) \).

**Corollary 1** For a given marginal borrower \( \tilde{\theta} \) and a deposit rate \( R_d \) chosen by the bank, at the profit-maximizing prices chosen by the platform, the marginal investor on the platform \( v^*_0(\tilde{\theta}, R_d) \) is implicitly defined by

\[
v^*_0(\tilde{\theta}, R_d) = \frac{\tilde{\theta}}{(\tilde{\theta} - p_M(\tilde{\theta}))} \left( k(\tilde{\theta}) - \frac{G(v^*_0(\tilde{\theta}, R_d))}{g(v^*_0(\tilde{\theta}, R_d))} \right) - (a + c_p) - R_d.
\]

**Proof.** See Appendix B-3. \( \blacksquare \)

Corollary 1 enables us to analyze how competition between the bank and the platform impacts the marginal investor at the profit-maximizing prices chosen by the platform. The
bank chooses the marginal borrower when it competes with the platform. An increase in the marginal borrower has a non-trivial impact on the marginal investor. On the one hand, it increases the average probability of success, which raises the marginal investor. On the other hand, it changes the return that the platform offers to the investor. Depending on the relative elasticities of borrower demand, investor demand and the elasticity of the platform’s revenue to the expected repayment, the platform may either increase or decrease the return offered to the investor. As we explain below, this second effect depends on the distribution of the probability of success and the investor’s taste for liquidity.

In Appendix B-4, we show that \( \frac{dv_0^*}{d\hat{\theta}} \) has the sign of \( e p_M(\hat{\theta}) \left( k(\hat{\theta}) - \frac{G(v_0^*)}{g(v_0^*)} \right) \).

We have that \( \frac{dp_M(\hat{\theta})}{d\hat{\theta}} \geq 0 \) and \( \frac{k(\hat{\theta}) - G(v_0^*)}{g(v_0^*)} \geq 0 \). The sign of \( \frac{dp_M(\hat{\theta})}{d\hat{\theta}} - p_M(\hat{\theta}) \) and the sign of \( k' \) are ambiguous and depend on the distribution of the probability of success. In our uniform distribution case, since \( p_M(\hat{\theta}) = \hat{\theta}/2 \) and \( k(\hat{\theta}) = \beta/4 \), \( v_0^* \) is independent of \( \hat{\theta} \).

In the general case, \( v_0^* \) depends on \( \hat{\theta} \) and its variation with \( \hat{\theta} \) 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 to the platform. For example, if the probability of success follows an exponential distribution, the marginal investor decreases with the marginal borrower.

In Corollary 2, we express the platform’s profit at the profit-maximizing prices as a function of the marginal borrower chosen by the bank.

**Corollary 2** For a given marginal borrower \( \hat{\theta} \) and a deposit rate \( R_d \) chosen by the bank, the platform makes a profit

\[
\pi^p(\hat{\theta}, R_d) = H(\hat{\theta}) \frac{G^2(v_0^*(\hat{\theta}, R_d))}{g(v_0^*(\hat{\theta}, R_d))}.
\]

**An example - uniform distributions:** If \( v \) and \( \theta \) are uniformly distributed on \([0, 1]\), the marginal investor is given by \( v_0^*(\hat{\theta}, R_d) = (\hat{\theta}/2)\hat{R}^p(\hat{\theta}) - R_d \), that is, we have

\[
v_0^*(\hat{\theta}, R_d) = \frac{C - 2p_c(R_d + c_p + a) + s_b - (1 - p_c)\gamma(C + s_b)}{6p_c}.
\]
In the uniform distribution case, the marginal investor does not depend on $\tilde{\theta}$.

Rational expectations imply that the borrower anticipates correctly the probability of being funded, that is, we have $p^*_e = v^*_0(\tilde{\theta}, R_d)$. Therefore, the borrower anticipates that he is funded with probability

$$p^*_e = \max(0, \frac{1}{12}(\sqrt{P^2 + 24(C(1 - \gamma) + s_b(1 - \gamma)}) - P),$$

where $P = 2(R_d + a + c_p) - (C + s_b)\gamma$.

From Corollary 2, the platform’s profit is given by $\pi^p(\tilde{\theta}, R_d) = \tilde{\theta}(v^*_0(\tilde{\theta}, R_d))^2$. Replacing for $v^*_0(\tilde{\theta}, R_d)$ given in Eq. (7), we find that

$$\pi^p(\tilde{\theta}, R_d) = \frac{\tilde{\theta}(C + s_b - 2p^*_e(R_d + a + c_p) - (1 - p^*_e)(C + s_b)\gamma)^2}{36(p^*_e)^2}. \quad (8)$$

**Comparative Statics:** In Lemma 1, we analyze how changes in the marginal borrower impact the price structure.

**Lemma 2** An increase in the deposit rate increases the price structure. If the marginal investor $v^*_0$ decreases (resp., increases) with the marginal borrower $\tilde{\theta}$, the price structure $R^p_i/R^p_B$ increases (resp., decreases) with the marginal borrower.

**Proof.** See Appendix A-5. ■

When the bank increases the deposit rate, all else being equal, the platform increases relatively more the return offered to investors than the repayment asked to borrowers. The platform adjusts the price structure in favor of investors, to the detriments of borrowers.

The variations of the bank’s borrower repayment may have an ambiguous impact on the price structure. This depends on the relationship between the marginal investor and the marginal borrower. Suppose that the marginal investor increases with the marginal borrower. As the marginal borrower decreases with the bank’s repayment rate, any reduction in the bank’s borrower repayment decreases the price structure. Therefore, if the bank decides to price loans more aggressively, the platform reacts by reducing the price structure, that is, all else being equal, it reduces relatively more the price on the borrower side than on the investor side. Interestingly, if the marginal investor decreases with the marginal borrower, the
platform reacts by increasing the price structure when the bank reduces its repayment rate. Hence, competition between the bank and the platform may generate increasing repayment rates for borrowers on the platform.

In Lemma 2, we provide some comparative statics on the variation of the platform’s profit with the return on deposits, the marginal borrower and the level of collateral for a given $p_e$.

**Lemma 3** The platform’s profit decreases with the return on deposits $R_d$. If $dv_0/d\tilde{\theta} \geq 0$, the platform’s profit increases with the marginal borrower $\tilde{\theta}$ and the level of collateral $C$. If $dv_0^*/d\tilde{\theta} \leq 0$, the platform’s profit may either increase or decrease with the marginal borrower $\tilde{\theta}$ and the level of collateral $C$.

**Proof.** See Appendix A-6. ■

The return on deposits represents the investor’s outside option if he does not invest in the platform. The higher the return on deposits, the lower the platform’s profit. The profitability of lending platforms is therefore correlated to the returns offered by other investment opportunities such as deposits.\(^{31}\) Note that regulatory caps on deposit rates may favor platform entry.

An increase in the marginal borrower has two effects on the platform’s profit. On the one hand, it increases the probability that the borrower wishes to borrow from the platform, which increases the platform’s profit (see the first term of Eq. (12)). On the other hand, it impacts the probability that the investor wishes to fund a loan on the platform (see the second term of Eq. (12)). If the marginal investor decreases (resp., increases) when the marginal borrower increases, the second effect on the platform’s profit is negative (resp., positive).

A higher level of collateral has also two impacts on the platform’s profit. On the one hand, a higher level of collateral increases the average quality of the borrower when the latter borrows from the platform. If $dv_0^*/d\tilde{\theta} \geq 0$ (resp., $\leq 0$), this increases (resp., decreases) the probability that the investor wishes to lend on the platform. On the other hand, it increases the negative marginal impact of a higher repayment rate on borrower demand.

\(^{31}\)There is also empirical evidence that banks’ mark-ups are strongly correlated to the business cycle (see Olivero, 2010).
5.5 The bank’s best-response at the first stage

At the first stage, the bank chooses the deposit fees, the loan repayment and the deposit rate that maximize its profit. As the bank has the monopoly on deposits, it chooses the deposit fees such that the borrower’s and the investor’s participation constraints are satiated.

We denote by $E_B(R^b_B, R_d, R^p_I, R^o_B)$ (resp., $E_I(R^b_B, R_d, R^p_I, R^o_B)$) the borrower’s (resp., the investor’s) expected revenue of leaving his money in a bank account. The borrower’s expected revenue depends on his expected utility of taking a loan from the bank or from the platform. The investor’s expected revenue depends on his expected utility of leaving his money in a bank account or lending it through the platform. The borrower’s and the investor’s participation constraints are given respectively by

$$F_B \leq E_B(R^b_B, R_d, R^p_I, R^o_B),$$

and

$$F_I \leq E_I(R^b_B, R_d, R^p_I, R^o_B),$$

where $E_B$ and $E_I$ are given in Appendix B-i).

The bank’s profit is given by $\pi^b = F_B + F_I + \pi^I_h + \pi^I_o$, where $\pi^I_h$ corresponds to the profit on in-house lending activities and $\pi^I_o$ 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 neither funded by the bank nor by the platform.

The bank lends in-house to borrowers who have a high probability of success and to the borrowers who are not funded by the platform. It makes a profit $\pi^I_h$ from in-house lending transactions given in Appendix B-ii)). The bank also extracts some revenues from depositors thanks to in-house lending transactions which generate a profit $\pi^d_h$ given in Appendix B-ii). The total profit $\pi_h = \pi^d_h + \pi^I_h$ that the bank obtains from in-house lending activities is given
by
\[
\pi_h = \frac{\bar{\theta}}{\partial} \int (\theta y - s_b - c_b - R_f) h(\theta) d\theta + (1 - \gamma)(1 - p_c) \int \frac{\bar{\theta}}{\partial} u_{B}^{h}(\theta) h(\theta) d\theta \\
+ (1 - \gamma)(1 - G(v_0)) \int (\theta y - u_{B}^{h}(\theta) - s_b - c_b - R_d) h(\theta) d\theta.
\]

In addition, the bank obtains a profit from lending transactions that are outsourced to the platform. This profit \(\pi^{l}_o\) is equal to the net revenues obtained when it receives the access fee for issuing the loan and it is given in Appendix B-ii). The bank also obtains a profit \(\pi^{d}_o\) from the revenues that it extracts from depositors thanks to the lending transactions that are concluded on the platform. The total profit \(\pi_o = \pi^{d}_o + \pi^{l}_o\) that the bank obtains from outsourcing loans to the platform is given by
\[
\pi_o = \frac{\bar{\theta}}{\partial} \int w_{B}^{d}(\theta) h(\theta) d\theta + H(\bar{\theta})(G(v_0(R^p_{I}, \bar{\theta}, R_d))(a - k_b) + \int (u_{I}^{d}(v) - R_f) g(v) dv.
\]

Given that the participation constraints of depositors are binding, the bank’s profit is given by \(\pi^b = \pi_h + \pi_o\). The bank’s profit depends on the interest rate \(R^b_B\) only through the choice of the indifferent borrower \(\bar{\theta}\). Therefore, it is equivalent for the bank to maximize its profit with respect to \(R^b_B\) or \(\bar{\theta}\).

We assume that the second-order conditions hold when the bank maximizes its profit with respect to \(\bar{\theta}\) and \(R_d\). We denote the profit-maximizing best-responses of the bank to \(R^p_B\) and \(R^p_I\) by \(\theta\) and \(R_d\). We also denote by:

- \(F^p_{I}(\bar{\theta}) \equiv p_M(\bar{\theta}) R^p_{I} G(v_0(R^p_{I}, \bar{\theta}, R_d)) - E(v_0(R^p_{I}, \bar{\theta}, R_d))\) the revenues that the bank extracts from the marginal depositor who funds a loan on the platform,

- \(\bar{w}_{B}^{p}(\bar{\theta}) = p_c \bar{\theta} (y - R^p_B - s_p\) the borrower’s utility of taking a loan on the platform.

In Proposition 2, we explain how the bank chooses its best-responses \(\bar{\theta}\) and \(\bar{\theta}\) to \(R^p_B\) and \(R^p_I\).

**Proposition 2** If there is an interior solution, 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, we have

\[ y\hat{\theta} - c_b - s_b - R_f = \frac{G(\hat{v}_0)(a - k_b - R_f + H(\hat{\theta})p'_M(\theta)R_f^p/h(\hat{\theta})) + \pi^p_B(\hat{\theta}) + F^p_I(\hat{\theta})}{(1 - (1 - \gamma)(1 - G(\hat{v}_0))}, \tag{9} \]

where \( \hat{v}_0 = v_0(R_f, \hat{\theta}, \hat{R}_d) \). The deposit rate equalizes the marginal cost and the marginal benefits of increasing the probability that an investor funds a loan on the platform, that is, we have

\[ \hat{R}_d = R_f - (a - k_b) + \frac{1 - \gamma}{H(\theta)} \int (\theta y - u^b_B(\theta) - s_b - c_b - R_f)h(\theta)d\theta. \tag{10} \]

**Proof.** See Appendix C. ■

We start by understanding the choice of the deposit rate in Eq. (10). If the bank raises the deposit rate, the investor is less likely to fund a loan on the platform because the return offered by the platform becomes less attractive. The bank chooses the deposit rate so as to equalize the marginal cost and the marginal benefit of increasing the probability that the investor funds a loan on the platform. The marginal cost is the loss of revenue from outsourcing lending activities (i.e., \( R_f - (a - k_b) \)). The marginal benefit is the increase in the probability that the bank funds a loan that is rejected by the platform, which generates a surplus that the bank is able to extract from the borrower-depositor. If the bank never funds loans that are rejected by the platform, the deposit rate is simply equal to the marginal net cost of outsourcing lending activities.

We now analyze the choice of the marginal borrower in Eq. (9). An increase in the marginal borrower has two effects on the bank’s profit. First, it reduces the probability that a borrower seeks credit from the bank. The bank loses marginally the rents that it extracts from the marginal lender (see the left-hand side of Eq. (9)). Second, the probability that a borrower seeks credit from the platform increases. The bank gains the marginal revenues that it extracts from the marginal borrower and the investors who fund a loan on the platform through the deposit fees and the access fee (see the right-hand side of Eq. (9)). The expected utility of the marginal borrower who seeks credit on the platform increases and investor participation to the platform becomes higher. Therefore, the bank extracts higher rents from lending transactions on the platform (i.e., \( \pi^p_B(\hat{\theta}) \)), higher rents from the deposits of investors who fund a loan on the platform (i.e., \( F^p_I(\hat{\theta}) \)) and if \( a - k_b - R_f \geq 0 \), higher revenues
from lending transactions that are funded by investors (i.e., \( G(v_0(\tilde{\theta}, R_{t,B}^0, \tilde{R}_d))(a - k_b - R_f) \)).

**An example:** If \( \gamma = 1 \), with our uniform distributions, we find that the bank chooses either \( \tilde{R}_d = R_f - (a - k_b) \) and \( \tilde{\theta} > 0 \) or \( \tilde{\theta} = 0 \) and there are two levels of \( \tilde{R}_d \) that yield the same level of profit for the bank.

**The impact of competition on the quality of the bank’s lending portfolio:**
In Corollary 3, we compare the bank’s best-response to the repayment rate that the bank chooses under monopoly.

**Corollary 3** If \( G(v_0)(a - k_b - R_f + H(\tilde{\theta})p_M'(\tilde{\theta})R_{t,I}^0/h(\tilde{\theta})) + \pi_B(\tilde{\theta}) + F_I^p(\tilde{\theta}) \geq 0 \) (resp., \( \leq 0 \)), the bank serves fewer (resp., more) borrowers when it competes with the platform than in the monopoly case. The average quality of the bank’s lending portfolio increases (resp., decreases).

**Proof.** See Appendix D. ■

This analysis enables us to understand whether the entry of a P2P lending platform may generate an expansion of bank credit. If the marginal benefit of outsourcing lending activities to the platform is positive, the bank serves fewer borrowers when it competes with the platform than in the monopoly case. This marginal benefit is the sum of the revenues from access and the surplus that is extracted from depositors thanks to the platform’s activity. In that case, the average quality of the bank’s lending portfolio is improved by platform entry. If the marginal benefit of outsourcing lending activities to the platform is negative, the bank serves more borrowers when it competes with the platform than in the monopoly case. Therefore, the average quality of the bank’s lending portfolio is reduced when it competes with the platform.

**The equilibrium on the credit market** We derive the conditions under which there is an equilibrium in our uniform example. If there is an equilibrium that we denote by \( \{\theta^*, F_B^*, F_I^*, (R_{t,B}^0)^*, (R_{t,I}^0)^*\} \), it must be that the bank and the platform play their best-responses to each other’s strategy, that is, that \( (R_{t,B}^0)^* = \tilde{R}_B^0(\tilde{\theta}((R_{t,B}^0)^*, (R_{t,I}^0)^*)), (R_{t,I}^0)^* = \tilde{R}_I^0(\tilde{\theta}((R_{t,B}^0)^*, (R_{t,I}^0)^*)) \) and \( \theta^* = \tilde{\theta}((R_{t,B}^0)^*, (R_{t,I}^0)^*) \).
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 is highly dependent of the regulatory framework in which platforms are allowed to operate. If platforms need to rely on banks for their activities, banks have more incentives to open the retail credit market to competition, as long as they can extract rents from depositors. The entry of platforms impacts the quality of banks’ lending portfolio and the fees charged by banks to depositors. A bank faces a trade-off between outsourcing loans to the platform and serving its borrowers itself.

References


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


Appendix

Appendix A: Proof of Lemma 1  Since the participation constraints are satiated, the bank’s profit is given by

$$
\pi^b = \bar{\bar{\sigma}} \int_{\bar{\bar{\theta}}_B} (y\theta - s_b - c_b - R_f) h(\theta) d\theta.
$$

The bank is able to extract the expected surplus that the borrower and the investor obtain from the lending transaction through the deposit fees. Therefore, we have

$$
\pi^b = y\overline{E}(\bar{\bar{\theta}}_B) - (s_b + c_b + R_f)(1 - H(\bar{\bar{\theta}}_B)).
$$

It is equivalent for the bank to choose its interest rate on loans \( R^b_B \) and the indifferent borrower \( \bar{\bar{\theta}}_B \). Solving for the first-order condition of profit-maximization, we find that

$$
\frac{d\pi^b}{d\theta_B} = (R_f + s_b + c_b - y\bar{\bar{\theta}}_B)h(\bar{\bar{\theta}}_B).
$$

Therefore, the bank extracts completely the rents of the lending transaction made by the marginal borrower, which is given by \( \theta^m_B = (s_b + c_b + R_f)/y \).

Appendix B -1: Proof of Proposition 1  We denote the platform’s margin by \( m_p = (R^p_B - R^p_I)p_M(\bar{\bar{\theta}}) - (a + c_p) \). Solving for the first-order conditions of profit-maximization, we find that

$$
\frac{d\pi^p}{dR^p_I} = p_M(\bar{\bar{\theta}})g(v_0(R^p_I, \bar{\bar{\theta}}, R_d))H(\bar{\bar{\theta}})m_p - G(v_0(R^p_I, \bar{\bar{\theta}}, R_d))p_M(\bar{\bar{\theta}})H(\bar{\bar{\theta}}), \quad (FOC-PF1)
$$

and

$$
\frac{d\pi^p}{dR^p_B} = \frac{d\bar{\bar{\theta}}}{dR^p_B} (G(v_0)p_M'(\bar{\bar{\theta}})H(\bar{\bar{\theta}})R^p_B + m_p h(\bar{\bar{\theta}})G(v_0)) + p_M(\bar{\bar{\theta}})H(\bar{\bar{\theta}})G(v_0). \quad (FOC-PF2)
$$
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

\[ m_P = G(v_0(R^p_I, \tilde{\theta}, R_d))/g(v_0(R^p_I, \tilde{\theta}, R_d)). \]

Replacing for the elasticity of investor demand to the interest rate \( R^p_I \) given by

\[ \varepsilon_I = (dG(v_0(R^p_I, \tilde{\theta}, R_d))/dR^p_I)(R^p_I/G(v_0(R^p_I, \tilde{\theta}, R_d))), \]

we find that

\[ \frac{m_P}{p_M(\tilde{\theta})R^p_I} = \frac{1}{\varepsilon_I}. \]

Therefore, we have

\[ \frac{(R^p_B - R^p_I)p_M(\tilde{\theta}) - (a + c_p)}{p_M(\tilde{\theta})R^p_I} = \frac{1}{\varepsilon_I}. \]

This equation corresponds to the Lerner formula.

Dividing Eq. (FOC-PF2) by \( H(\tilde{\theta})G(v_0) \), we find that

\[ \frac{d\tilde{\theta}}{dR^p_B} (p_M(\tilde{\theta})R^p_B + \frac{h(\tilde{\theta})}{H(\tilde{\theta})} m_P) + p_M(\tilde{\theta}) = 0. \]

Therefore, multiplying this equation by \( (R^p_B/p_M(\tilde{\theta})) \), we find that

\[ \frac{R^p_B}{p_M(\tilde{\theta})} \frac{d(p_M(\tilde{\theta})R^p_B)}{dR^p_B} + \frac{R^p_B}{p_M(\tilde{\theta})} \frac{d\tilde{\theta}}{dR^p_B} \frac{h(\tilde{\theta})}{H(\tilde{\theta})} m_P = 0. \]

Replacing for \( \varepsilon_B = -(h(\tilde{\theta})R^p_B/H(\tilde{\theta}))(d\tilde{\theta}/dR^p_B) \) and \( \mu_P = (d(R^p_Bp_M(\tilde{\theta}))/dR^p_B)(R^p_B/p_M(\tilde{\theta})R^p_B) \),

we find that

\[ R^p_B \mu_P - \frac{\varepsilon_B}{p_M(\tilde{\theta})} m_P = 0. \]

This implies that we have

\[ \frac{m_P}{p_M(\tilde{\theta})R^p_B} = \frac{\mu_P}{\varepsilon_B}, \]

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that is,
\[
\frac{(R_B^p - R_I^p)p_M(\tilde{\theta}) - (a + c_P)}{p_M(\tilde{\theta})R_B^p} = \frac{\mu_P}{\varepsilon_B},
\]
Dividing this equation by the first equation of the FOC, we find that
\[
\frac{R_I^p}{R_B^p} = \frac{\mu_P\varepsilon_I}{\varepsilon_B}.
\]
This completes the proof of Proposition 1.

**Appendix B-2: Second-Order conditions in the uniform case** Using the notations of Monge, we find that at the profit-maximizing prices chosen by the platform
\[
r = \frac{\partial^2 \pi^p}{\partial^2 R_I^p} = -\frac{\tilde{\theta}^3}{2} < 0,
\]
and
\[
s^2 - rt = \frac{-\tilde{\theta}^6(C - 2p_e(a + c_P + R_I) + s_b + (-1 + p_e)(C + s_b)\gamma)^2}{48(C + s_b + (-1 + p_e)(C + s_b)\gamma)^2} < 0.
\]
Therefore, 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 \(\tilde{\theta}, R_d\) and \(R_I^p\), the repayment of the borrower is given by
\[
R_B^p = R_I^p + (1/p_M(\tilde{\theta}))(a + c_P + G(v_0(R_I^p, \tilde{\theta}, R_d))/g(v_0(R_I^p, \tilde{\theta}, R_d))) \quad \text{(Eq-RBp)}
\]
Replacing for \(P'_M(\tilde{\theta})H(\tilde{\theta}) = h(\tilde{\theta})(\tilde{\theta} - P_M(\tilde{\theta}))\) into (Eq. FOC-PF2), we find that in an interior solution
\[
E(\tilde{\theta}) + \frac{d\tilde{\theta}}{dR_B^p}h(\tilde{\theta})(R_B^p - R_I^p) - (a + c_P) + (\tilde{\theta} - P_M(\tilde{\theta}))R_I^p = 0.
\]
Since \(d\tilde{\theta}/dR_B^p = -(\tilde{\theta})^2/\beta\), where \(\beta = ((C + s_b)(p_e + (1 - p_e)\gamma) - s_p)/p_e\), replacing for \(R_B^p\)
given by the (Eq-RBp), we have that

\[(\theta - p_M(\theta))R^p_I = (a + c_P) + \frac{\beta E(\theta)}{h(\theta)\theta^2} - (\theta/p_M(\theta))(a + c_P + (G/g)(v_0(R^p_I, \tilde{\theta}, R_d))).\]

Therefore, the return chosen for investors \(\hat{R}^p_I\) is implicitly defined by

\[
\hat{R}^p_I = \frac{\theta}{p_M(\theta)(\theta - p_M(\theta))} \left[ \frac{p_M(\theta)\beta E(\theta)}{h(\theta)\theta^2} - (G/g)(v_0(\hat{R}^p_I, \tilde{\theta}, R_d)) \right] - a + c_P - R_d. \tag{11}
\]

The marginal investor is implicitly defined by

\[
v_0(\tilde{\theta}, R_d) = \frac{p_M(\tilde{\theta})}{\theta - p_M(\tilde{\theta})} \left[ \frac{\beta E(\tilde{\theta})}{h(\tilde{\theta})\tilde{\theta}^2} - \frac{\tilde{\theta}}{p_M(\tilde{\theta})}(G/g)(v_0(\tilde{\theta}, R_d)) \right] - a - c_P - R_d. \tag{Eq-v0}
\]

**Appendix B-4: variation of the marginal investor with the probability of success**

of the marginal borrower

From (Eq. v0), we have

\[
v^*_0(\tilde{\theta}, R_d) = \frac{\tilde{\theta}}{(\theta - p_M(\tilde{\theta}))} \left( \frac{p_M(\tilde{\theta})\beta E(\tilde{\theta})}{h(\tilde{\theta})\tilde{\theta}^2} - \frac{G(v^*_0(\tilde{\theta}, R_d))}{g(v^*_0(\tilde{\theta}, R_d))} \right) - (a + c_P) - R_d.
\]

We denote by \(K(\tilde{\theta}, R^p_B) = -(R^p_B/E(\tilde{\theta}))(dE(\tilde{\theta})/dR^p_B)\) the elasticity of the expected probability of success to the borrower repayment. We have

\[
\frac{dE(\tilde{\theta})}{dR^p_B} = \tilde{\theta}h(\tilde{\theta}) \frac{d\tilde{\theta}}{dR^p_B}.
\]

Since \(d\tilde{\theta}/dR^p_B = -\tilde{\theta}^2/\beta\), we have

\[
\frac{-R^p_BdE(\tilde{\theta})}{E(\tilde{\theta})dR^p_B} = \frac{\tilde{\theta}^3 h(\tilde{\theta})R^p_B}{\beta E(\tilde{\theta})}.
\]

We have

\[
v^*_0(\tilde{\theta}, R_d) = \frac{\tilde{\theta}}{(\theta - p_M(\tilde{\theta}))} \left( \frac{p_M(\tilde{\theta})R^p_B}{K(\tilde{\theta}, R^p_B)} - \frac{G(v^*_0(\tilde{\theta}, R_d))}{g(v^*_0(\tilde{\theta}, R_d))} \right) - (a + c_P) - R_d.
\]
Since $p_M(\tilde{\theta}) R_B^p / K(\tilde{\theta}, R_B^p) = k(\tilde{\theta})$, we have
\[
\frac{dv_0^*}{d\tilde{\theta}} (1 + (G/g)' \frac{\tilde{\theta}}{(\tilde{\theta} - p_M(\tilde{\theta}))}) = \frac{\tilde{\theta} k' (\tilde{\theta})}{(\tilde{\theta} - p_M(\tilde{\theta}))} + \frac{\tilde{\theta} p_M' (\tilde{\theta}) - p_M(\tilde{\theta})}{(\tilde{\theta} - p_M(\tilde{\theta}))^2} \left( k(\tilde{\theta}) - \frac{G(v_0^*)}{g(v_0^*)} \right).
\]
Since $(G/g)' \geq 0$ and $\tilde{\theta} - p_M(\tilde{\theta}) \geq 0$, $dv_0^*/d\tilde{\theta}$ has the sign of
\[
\tilde{\theta}(\tilde{\theta} - p_M(\tilde{\theta})) k'(\tilde{\theta}) + (\tilde{\theta} p_M'(\tilde{\theta}) - p_M(\tilde{\theta})) \left( k(\tilde{\theta}) - \frac{G(v_0^*)}{g(v_0^*)} \right).
\]
As $v_0 \geq 0$, it must be that $k(\tilde{\theta}) - \frac{G(v_0^*)}{g(v_0^*)} \geq 0$. Moreover, we have that
\[
-p_M(\tilde{\theta}) + \tilde{\theta} p_M'(\tilde{\theta}) = -\frac{E(\tilde{\theta}) + \tilde{\theta} h(\tilde{\theta}) (\tilde{\theta} - p_M(\tilde{\theta}))}{H(\tilde{\theta})}.
\]
We also have that $\tilde{\theta} - p_M(\tilde{\theta}) \geq 0$. If $-p_M(\tilde{\theta}) + \tilde{\theta} p_M'(\tilde{\theta}) \geq 0$ and $k'(\tilde{\theta}) \geq 0$, a higher probability of success of the marginal borrower increases the marginal investor. However, in the general case, it is impossible to conclude that $dv_0^*/d\tilde{\theta} \geq 0$.

How does the marginal borrower impacts the platform’s profit? We have
\[
\frac{d\pi_P}{d\tilde{\theta}} = h(\tilde{\theta}) \frac{G^2(v_0^*(\tilde{\theta}, R_d))}{g(v_0^*(\tilde{\theta}, R_d))} + H(\tilde{\theta}) G(v_0^*(\tilde{\theta}, R_d)) \left( \frac{\partial v_0}{\partial \tilde{\theta}} + \frac{\partial v_0}{\partial R_I^p} \frac{dR_I^p}{d\tilde{\theta}} \right) \left( \frac{2g^2 - Gg'}{g^2} \right).
\]
Since $(G/g)$ is increasing, we have $2g^2 - Gg' \geq 0$. Therefore, if $dv_0^*/d\tilde{\theta} \geq 0$, the platform’s profit increases with the marginal borrower.

**Appendix B-5: Variations of the price structure with the marginal borrower**

From (Eq-RBp), we have
\[
\frac{R_B^p}{R_I^p} = 1 + \frac{1}{p_M(\tilde{\theta}) R_I^p} \left( a + c_p + \frac{G(v_0^*)}{g(v_0^*)} \right).
\]
Since $v_0 = p_M(\tilde{\theta}) R_I^p - R_d$, we have
\[
\frac{R_B^p}{R_I^p} = 1 + \frac{1}{v_0^* + R_d} \left( a + c_p + \frac{G(v_0^*)}{g(v_0^*)} \right).
\]
Taking the derivative of this equation with respect to \( \tilde{\theta} \), we find that
\[
\left( \frac{R^p_B}{R^p_I} \right)'(\tilde{\theta}) = \frac{-1}{(v_0^* + R_d)^2} \left( a + c_p + \frac{G(v_0^*)}{g(v_0^*)} \right) - (v_0^* + R_d) \left( \frac{G'}{g} \right)'(v_0^*) \frac{dv_0^*}{d\tilde{\theta}}.
\]
Since \( G/g \) is concave, \((G/g)'\) is negative. Hence, \((R^p_B/R^p_I)'(\tilde{\theta})\) has the same sign as \(-dv_0^*/d\tilde{\theta}\).

Finally, as \( v_0^* + R_d \) is independent of \( R_d \), the variation of the price structure with the deposit rate as \( (R^p_B/R^p_I)(\tilde{\theta}) = (v_0^*) \) has the same sign as \( dv_0^*/d\tilde{\theta} \).

**Appendix B-6: comparative statics**

i) Since \( dv_0^*/dR_d = -1 \), we have
\[
\frac{d\pi^p}{dR_d} = -H(\tilde{\theta})G(v_0^*) \left( \frac{2g - Gg'}{g} \right) (v_0^*) \leq 0.
\]

ii) We have
\[
\frac{d\pi^p}{d\theta} = h(\tilde{\theta}) \frac{G^2(v_0^*(\tilde{\theta}, R_d))}{g(v_0^*(\tilde{\theta}, R_d))} + \frac{dv_0^*}{d\theta} H(\tilde{\theta})G(v_0^*(\tilde{\theta}, R_d)) \frac{2g(v_0^*(\tilde{\theta}, R_d)) - G(v_0^*(\tilde{\theta}, R_d))g'(v_0^*(\tilde{\theta}, R_d))}{g(v_0^*(\tilde{\theta}, R_d))}.
\]

iii) We have
\[
\frac{d\pi^p}{dC} = \frac{d\pi^p}{d\theta} \frac{d\theta}{dC} + \frac{dv_0^*}{dC} H(\tilde{\theta})G(v_0^*) \left( \frac{2g - Gg'}{g} \right) (v_0^*).
\]

We are also able to analyze how an increase in the level of collateral impacts the marginal investor. We have
\[
\frac{dv_0^*(\tilde{\theta}, R_d)}{dC} = \frac{\partial v_0^*(\tilde{\theta}, R_d)}{\partial \tilde{\theta}} \frac{d\tilde{\theta}}{dC} + \frac{\tilde{\theta}}{(\tilde{\theta} - p_M(\tilde{\theta}))} \frac{p_e + (1 - p_e)\gamma k(\tilde{\theta})}{p_e} \frac{1}{\beta}.
\]
An increase in the level of collateral has two effects on the marginal investor. On the one hand, a higher level of collateral increases the marginal borrower, which changes the investor’s decision to fund a loan on the platform. This effect can be either positive or negative, depending on the sign of \( dv_0^*/d\tilde{\theta} \). On the other hand, a higher level of collateral reduces the elasticity of borrower demand, which becomes less sensitive to the repayment rate chosen by the platform. This effect has a positive impact on the marginal investor because the average
quality of borrowers who demand a credit on the platform increases.

**Appendix C:** i) Participation constraints:

The participation constraints of the investor and the borrower are given by

\[ F_B \leq \int_{\tilde{\theta}}^\theta u_B^p(\theta)h(\theta)d\theta + \int_{-\infty}^{\tilde{\theta}} u_B^b(\theta)h(\theta)d\theta, \]

and

\[ F_I \leq H(\tilde{\theta}) \left( \int_{v_0} v_0 (R_f^p, \tilde{\theta}, R_d) g(v)dv + (1 - G(v_0(R_f^p, \tilde{\theta}, R_d)))(R_d - R_f) \right) \]

\[ + (1 - H(\tilde{\theta}))(R_d - R_f). \]

Indeed, the investor anticipates that he funds all the loans that are demanded at the bank and funds the loans that are demanded on the platform only if \( v \leq v_0 \).

ii) The bank lends to consumers who have a higher probability of success (i.e., such that \( \theta \geq \tilde{\theta} \)). The bank lends also with probability \( (1 - \gamma) \) to borrowers who seek credit on the platform (i.e., such that \( \theta \leq \tilde{\theta} \)) and who are not funded (which happens with probability \( 1 - G(v_0) \)). With probability \( \gamma (1 - G(v_0)) \), the borrower is neither funded by the bank nor by the platform and the bank invests its deposits in the risk-free asset. Therefore, the bank’s profit on in-house lending activities is given by

\[ \pi_h^I = \int_{\tilde{\theta}}^{\theta} (\theta y - u_B^b(\theta) - s_b - c_b - R_d)h(\theta)d\theta + \gamma (1 - G(v_0))\int_{\tilde{\theta}}^{\theta} (R_f - R_d)h(\theta)d\theta \]

\[ + (1 - \gamma)(1 - G(v_0))\int_{\tilde{\theta}}^{\theta} (\theta y - u_B^b(\theta) - s_b - c_b - R_d)h(\theta)d\theta. \]

The total profit \( \pi_h \) that the bank obtains from in-house lending activities corresponds to the sum of the profit generated from in-house loans \( \pi_h^I \) and the revenues extracted from
depositors (i.e., borrowers and investors) thanks to its in-house lending activity $\pi^d_h$, where

$$\pi^d_h = \frac{\bar{\sigma}}{\bar{\theta}} \int u^b_{B}(\theta) h(\theta) d\theta + (1 - \gamma)(1 - p_e) \frac{\bar{\sigma}}{\bar{\theta}} \int u^b_{B}(\theta) h(\theta) d\theta + (1 - H(\bar{\theta}))(R_d - R_f) + (1 - G(v_0)) H(\bar{\theta})(R_d - R_f).$$

Therefore, since $\pi_h = \pi^d_h + \pi^l_h$, we have

$$\pi_h = \frac{\bar{\sigma}}{\bar{\theta}} \int(\theta y - s_b - c_b - R_f) h(\theta) d\theta + (1 - \gamma)(1 - p_e) \frac{\bar{\sigma}}{\bar{\theta}} \int u^b_{B}(\theta) h(\theta) d\theta + (1 - \gamma)(1 - G(v_0)) \frac{\bar{\sigma}}{\bar{\theta}} \int(\theta y - u^b_{B}(\theta) - s_b - c_b - R_f) h(\theta) d\theta.$$

The bank obtains also a profit from lending activities that are outsourced to the platform. This profit is equal to the net revenues obtained when it receives the access fee for issuing the loan, that is we have

$$\pi^l_o = G(v_0(R^p_{IF}, \tilde{\theta}, R_d))(a - k_b).$$

The total profit $\pi_o$ that the bank obtains by outsourcing loans to the platform corresponds to the sum of the profit from issuing loans $\pi^l_o$ and the revenues $\pi^d_o$ extracted from depositors (i.e., investors and borrowers) thanks to those activities, where

$$\pi^d_o = H(\tilde{\theta}) \int_{\mathcal{U}} (u^p_{IF}(v) - R_f) g(v) dv + \int_{\mathcal{U}} \bar{\sigma} \frac{\bar{\theta}}{\bar{\theta}}(\theta y - u^p_{B}(\theta) - s_b - c_b - R_f) h(\theta) d\theta,$$

where $\bar{\sigma} = p_e(\theta y - R^p_{IF}) - s_p$. Since $\pi_o = \pi^d_o + \pi^l_o$, we have

$$\pi_o = \frac{\bar{\sigma}}{\bar{\theta}} \int_{\mathcal{U}} \bar{\sigma} \frac{\bar{\theta}}{\bar{\theta}}(\theta y - u^p_{B}(\theta) - s_b - c_b - R_f) h(\theta) d\theta + H(\tilde{\theta})(G(v_0(R^p_{IF}, \tilde{\theta}, R_d))(a - k_b) + \int_{\mathcal{U}} (u^p_{IF}(v) - R_f) g(v) dv).$$

Given that the participation constraints of depositors are binding, the bank’s profit is given by $\pi^h = \pi_h + \pi_o$. The bank’s profit depends on the interest rate $R^p_{IB}$ only through the choice of the indifferent borrower $\tilde{\theta}$. Therefore, it is equivalent for the bank to maximize its
profit with respect to $R^b_{b_3}$ or through $\tilde{\theta}$.

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

$$
\frac{d\pi^b}{d\theta} = \frac{d\pi_h}{d\theta} + \frac{d\pi_o}{d\theta},
$$

(FOC-B-ThetaTild)

and

$$
\frac{d\pi^b}{dR_d} = \frac{d(\pi_h + \pi_o)}{dR_d}.
$$

(FOC-B-DepositRate)

We start by solving (FOC-B-DepositRate). We denote by

$$
I_b = \int_{\theta} (\theta y - u^b_{B_3}(\theta) - s_b - c_b - R_f) h(\theta) d\theta.
$$

The bank’s profit depends on $R_d$ only through the marginal investor on the platform $v_0$. Therefore, we have

$$
\frac{d\pi^b}{dR_d} = g(v^*_0) \left( (1 - \gamma)I_b - H(\tilde{\theta})(a - k_b - R_d - R_f) \right).
$$

Therefore, if there is an interior solution, the profit-maximizing deposit rate is implicitly defined by

$$
(1 - \gamma)I_b = H(\tilde{\theta})(a - k_b + R_d - R_f),
$$

that is,

$$
R_d = R_f - a + k_b + \frac{(1 - \gamma)I_b}{H(\tilde{\theta})}.
$$

The profit-maximizing deposit rate is chosen such that $\partial\pi^b/\partial v_0|_{\tilde{R}_d} = 0$.

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

$$
\frac{d\pi^b}{d\tilde{\theta}} = \frac{d(\pi_h + \pi_o)}{d\tilde{\theta}}.
$$
Since
\[
\frac{d\pi_h}{d\theta} = \frac{d\pi_h}{d\theta} = -h(\tilde{\theta})(\tilde{\theta}y - s_b - c_b - R_f) + (1 - \gamma)(1 - G(v_0))(\tilde{\theta}y - u_B^h(\tilde{\theta}) - s_b - c_b - R_f) + \frac{\partial\pi_h}{\partial v_0} \frac{dv_0}{d\theta},
\]
and since borrowers anticipate correctly the probability of being funded (i.e., \(G(v_0) = p_v\)), we have
\[
\frac{d\pi_h}{d\theta} = -h(\tilde{\theta})(\tilde{\theta}y - s_b - c_b - R_f) - (1 - \gamma)(1 - G(v_0))(\tilde{\theta}y - s_b - c_b - R_f) + \frac{\partial\pi_h}{\partial v_0} \frac{dv_0}{d\theta}.
\]
Moreover, since
\[
\frac{v_0(R^p_{I, \tilde{\theta}, R_d})}{\int u^p_0(v)g(v)dv} = F^p_{I, \tilde{\theta}}(\tilde{\theta}) \text{ and } \partial u^p_0(v)/\partial \tilde{\theta} = p^p_{M}(\tilde{\theta})R^p_{I},
\]
we have
\[
\frac{d\pi_o}{d\theta} = h(\tilde{\theta})(\tilde{\theta}y - s_b - c_b - R_f - (1 - \gamma)(1 - G(v_0))(\tilde{\theta}y - s_b - c_b - R_f)) + \frac{\partial\pi_h}{\partial v_0} \frac{dv_0}{d\theta}.
\]
From (FOC-B-DepositRate), we can ignore the impact of the marginal borrower on the bank’s profit that goes through \(v_0\), as the bank already internalizes it in the choice of the deposit rate (i.e., at \(\tilde{R}_d\), we have \(\partial\pi^b_v / \partial v_0 = 0\)). Therefore, we have
\[
\frac{d\pi^b}{d\theta} = h(\tilde{\theta})(\tilde{\theta}y - s_b - c_b - R_f) + (1 - \gamma)(1 - G(v_0))(\tilde{\theta}y - s_b - c_b - R_f) + (1 - \gamma)(1 - G(v_0))(y\tilde{\theta} - c_b - s_b - R_f) + H(\tilde{\theta})p^p_{M}(\tilde{\theta})R^p_{I}G(v_0)
\]
Therefore, if there is an interior solution \(\tilde{\theta}\) to the bank’s profit-maximization, it is chosen such that
\[
G(\tilde{v}_0)(a - k_b - R_f) + \pi^p_{B}(\tilde{\theta}) + F^p_{I}(\tilde{\theta}) - (y\tilde{\theta} - c_b - s_b - R_f)
+(1 - \gamma)(1 - G(\tilde{v}_0))(y\tilde{\theta} - c_b - s_b - R_f) + H(\tilde{\theta})p^p_{M}(\tilde{\theta})R^p_{I}G(\tilde{v}_0)/h(\tilde{\theta}) = 0.
\]
where \( \hat{v}_0 = v_0(R_f, \hat{\theta}, \hat{R}_d) \). Therefore, we have

\[
(1-(1-\gamma)((1-G(\hat{v}_0))(y\hat{\theta}-c_b-s_b-R_f) = G(\hat{v}_0)(a-k_b-R_f + \frac{H(\hat{\theta})p'_M(\hat{\theta})R_f}{h(\hat{\theta})})+\pi^p_B(\hat{\theta})+F^p_I(\hat{\theta}).
\]

This completes the proof of Proposition 2.

**Appendix D: Proof of Corollary 3**  From Proposition 2, we have

\[
y\hat{\theta} - c_b - s_b - R_f = \frac{G(\hat{v}_0)(a-k_b-R_f + H(\hat{\theta})p'_M(\hat{\theta})R_f/h(\hat{\theta})) + \pi^p_B(\hat{\theta})+F^p_I(\hat{\theta})}{(1-(1-\gamma)(1-G(\hat{v}_0))}
\]

If the right-hand side of this equality is positive, we have \( y\hat{\theta} - c_b - s_b - R_f \geq 0 \). From our benchmark example, we have that \( y\theta^m_B = (R_f + s_b + c_b) = 0 \). Hence, if the right-hand side of this equality is positive, we have \( \hat{\theta} \geq \theta^m_B \) and the bank serves fewer borrowers than in the monopoly case. If the right-hand side is negative, we have \( \hat{\theta} \leq \theta^m_B \) and the bank expands credit compared to the monopoly case. Finally, for the bank to serve as many borrowers as in the monopoly case, it must be that the access charge is at least equal to

\[
\hat{a} = k_b + R_f + H(\hat{\theta})p'_M(\hat{\theta})R_f/h(\hat{\theta}) - \frac{\pi^p_B(\hat{\theta})+F^p_I(\hat{\theta})}{G(\hat{v}_0)}.
\]