Lending Competition and Funding Collaboration

Abstract

We study competition and collaboration between a bank and a fintech firm in a market plagued by adverse selection. The bank has cheaper funding, whereas the fintech firm has better screening technology. Our innovation is to allow the bank to lend to the fintech, i.e., to finance its competitors. This partnership funding arrangement lowers the fintech's funding costs and reduces the bank's incentive to compete. We show that two lenders collaborate when the average quality of the borrower pool is low but compete when the quality gets high. While the fintech always benefits from partnership funding, the bank receives more profits only when the average quality is high, at the expense of higher interest rates the borrowers face.

Keywords: fintech, lending competition, partnership funding, adverse selection, winner's curse, financial inclusion.

1 Introduction

The rise of fintech lenders has posed serious challenges to traditional banks. According to Gopal and Schnabl (2022), the increased lending from fintechs has crowded lending by traditional banks after the 2008 financial crisis. Recent evidence shows that fintech lenders finance themselves primarily with credit from banks (Jiang et al., 2020). In fact, many of these lenders obtain funding from the same banks they compete with.[1] Why do banks finance (and therefore collaborate with) their competitors?

One answer is that these fintech lenders have superior lending technologies, and banks, by financing competitors, get to share the surplus created by these technologies.[2] Indeed, most fintech lenders describe their business models as relying on cutting-edge artificial intelligence and machine learning developments, which enable them to assess better small businesses' creditworthiness.[3] Yet, fintech firms are constrained by the higher funding costs of their primary owners, mostly venture capital firms, hedge funds, and wealthy individuals. By contrast, traditional banks have arguably cheaper funding due to reasons such as deposit insurance, implicit government guarantee, broad branch networks, and better diversification. Given the respective comparative advantage, it is natural for the two types of lenders to collaborate. However, it remains less clear when the two types of lenders compete and when they collaborate. Moreover, how does such collaborative partnership funding affect the borrowers' payoff, lenders' profits, and overall efficiency?

This paper develops a model to study these questions. Our theory builds upon the comparative advantage of the two lenders: the bank has cheaper funding, whereas the fintech firm has better screening technology. They directly compete to lend to the same set of borrowers who suffer from adverse selection. Moreover, fintech firms could also obtain bank funding, reducing the effective funding costs. The model highlights two important channels that arise from partnership funding. On the one hand, the reduced funding cost increases the fintech firm's competitiveness, intensifying *direct* lending competition. On the other hand, partnership funding offers the bank an alternative avenue to earn profits: by lending to the fintech firm, the bank could also *indirectly* share the surplus generated from fintech lending. Therefore, the bank has reduced incentives to compete in direct lending but would like to collaborate by offering partnership funding to its competitors.

[1] In Appendix B, we describe the case of OnDeck – a top fintech lender – who joins forces with Utah-based Celtic Bank – a top ten SBA (Small Business Administration) lender – to provide loans to small businesses. More examples include Avant and WebBank, Greensky and Fifth Third Bank, Funding Circle and British Business Bank, and many others.

[2] There are also alternative explanations, such as regulatory arbitrage and/or convenience benefits, which we discuss formally later in the paper.

[3] Berg et al. (2020) show that digital footprints can be informative in predicting consumer default in addition to traditional credit scores. Frost et al. (2019) show that machine learning and data from e-commerce platforms are better at predicting losses. Also see Gambacorta et al. (2020), Agarwal et al. (2020), Di Maggio et al. (2022).

We show that the magnitudes of these two channels depend on the degree of adverse selection or, equivalently, the average quality of the borrower pool. As a result, one should expect to observe different levels of collaboration and competition in different markets: collaboration (competition) prevails when the average quality is low (high). Moreover, we show that while partnership funding always increases the fintech firm's profits, it might reduce the borrowers' payoff and the bank's profits.

Let us be more specific. We model a continuum of borrowers with either high or low-quality projects, and only a high-quality project has a positive net present value (NPV). Each borrower seeks credit from either a bank or a fintech firm. We assume the bank's funding cost falls below the fintech firm's. Meanwhile, the fintech firm has an information advantage. Specifically, the bank cannot differentiate the borrowers' types and only lend blindly, whereas the fintech firm has a screening technology that generates a private signal on each borrower. Given this, the bank suffers from the winner's curse when it directly competes with the fintech firm for borrowers: whenever it wins the competition, chances are that it will lend to a low-quality borrower and suffer losses. This setup is reminiscent of the problem of common-value auctions under asymmetric information (Milgrom and Weber, 1982) and the applications to bank lending (Broecker, 1990; Hauswald and Marquez, 2003). Our setup allows lenders (or bidders) to have different information technology and funding costs similar to Dell'Ariccia and Marquez (2004).

A main departure of our model from the existing literature is that we allow the bank to also lend to the fintech firm. Specifically, the fintech firm can borrow a fraction of its funding from the bank to reduce its effective funding cost. This fraction can be motivated in various ways, such as inter-bank relationship development, search friction, or agency frictions that require the fintech firm to have enough skin in the game. The presence of partnership funding allows the two lenders to collaborate in addition to directly competing for borrowers.

Our first set of results concerns the relative degree of collaboration and competition between the two lenders. We show that collaboration dominates when the average quality of the borrower pool is very low. Intuitively, the bank wouldn't lend blindly because, most likely, the borrower is low-quality. In this case, direct lending generates expected losses to the bank. For this set of borrowers, the fintech firm's screening technology is particularly useful because it helps identify high-quality ones, just like finding a needle in the haystack. The bank could also share some profits from the fintech's screening technology by offering partnership funding and charging a spread. As a result, one should only observe the fintech firm lending to high-quality borrowers with funding from the bank – collaboration. When the average quality of the borrower pool gets very high, screening becomes less useful compared to blind lending. In other words, the information advantage of the fintech firm is mitigated and could be dominated by the bank's funding advantage. As a result, one should only observe the bank lending to all borrowers. Even though the fintech firm does not lend in equilibrium, its presence poses threats to the bank, forcing the latter lender to charge a lower loan rate – competition. Finally, when the average quality of the borrower pool is neither too high nor too low, the fintech firm's information advantage and the bank's funding cost advantage are comparable. As a result, competition and collaboration coexist, and one could observe lending by both lenders.

The results on competition and collaboration imply that fintech firms are more likely to enter markets whose average quality is neither too high nor too low. Indeed, we show that the fintech firm's profits are non-monotonic in the average quality of the borrower pool. There are very few high-type borrowers in the pool with low average quality. Consequently, the fintech firm's lending volume and profits are low. By contrast, when the average quality becomes very high, the competition from the bank is intensified, and the bank's funding advantage dominates the fintech firm's information advantage. Therefore, the fintech firm's profit margin gets substantially squeezed.

If either screening or entry entails a cost to the fintech firm, our model predicts the following lending patterns. Neither lender is active when the average quality is low, and borrowers are credit rationed, as in Stiglitz and Weiss (1981). When the average quality gets a bit higher, the fintech firm charges high interest rates to high-quality borrowers, with partnership funding from the bank. Even though the perceived credit quality is low, the ex-post default rates of loans are also very low. When the average quality further improves, both lenders compete to lend, and high-quality borrowers can always receive financing. Because the bank lends blindly, low-quality borrowers might also receive financing. Therefore, compared to the previous region, loan defaults are more likely. Finally, only the bank lends to all borrowers when the average quality reaches the highest region. Overall, these lending patterns generate a unique prediction that ex-post loan default rates are a non-monotonic function of the ex-ante perceived credit quality.

In the first-best benchmark, all high-quality borrowers should obtain funding from the bank, whereas all low-type borrowers should not be financed. The equilibrium in our model, therefore, features two types of inefficiency. The funding inefficiency arises whenever the fintech firm lends using its own funding, which is more costly; the lending inefficiency arises whenever the bank lends blindly because it often ends up offering credit to low-quality, negative NPV projects. Interestingly, the degree to which the two sources of inefficiency prevail in equilibrium is also non-monotonic in the average quality of the borrower's pool. Funding inefficiency is closely related to the lending volume of the fintech firm, and consequently, it peaks when the average quality is neither too high nor too low. By contrast, lending inefficiency depends on the total lending volume of the bank and the fraction of low-type projects present in the market. These two variables move in opposite directions: as the average quality of the pool goes up, the volume of bank lending increases, but the share of the low-type projects decreases. Lending inefficiency reaches its maximum when the average quality is neither too high nor too low.

Our second set of results highlights the role of the partnership funding market. Introducing partnership funding always reduces the fintech firm's effective funding cost, increasing its profits. Somewhat surprisingly, the presence of the partnership funding could reduce the payoff of borrowers and the bank. In general, the partnership funding market introduces two forces. On the one hand, it reduces the fintech firm's funding cost and makes it more competitive against the bank. This channel intensifies competition between the two lenders, reducing the bank's profits and benefiting the borrowers through lower loan rates. On the other hand, it allows the bank to profit from direct lending to the borrower and from offering partnership funding to the fintech firm. Ceteris paribus, the bank competes less aggressively in the direct lending market. This channel mitigates competition between the two lenders, which could increase the bank's profits but harm the borrowers. The two channels interact differently in markets with different average quality. When the quality is low, competition is low. The introduction of the partnership funding market allows the bank to earn some profits from the set of borrowers it would not lend anyway. This increases the bank's profits but reduces the borrower's payoff. By contrast, information asymmetry is less severe, and competition is high when the average quality is high. The introduction of the partnership funding market reduces the fintech firm's effective funding cost, which gets passed through to borrowers as lower loan rates. Therefore, partnership funding erodes the bank's profits but increases borrowers' payoff.

Our modeling framework follows from Broecker (1990), Hauswald and Marquez (2003), Dell'Ariccia et al. (1999), and Dell'Ariccia and Marquez (2004) which comes from the literature on common-value auctions with asymmetric information (Milgrom and Weber, 1982). This literature has established no pure-strategy equilibrium exists in the bidding game, and the equilibrium must be one with mixed strategies. We depart in two aspects. First, similar to Dell'Ariccia and Marquez (2004) we allow for bidders to have both heterogeneous costs and information sets. Second, we allow the two bidders to collaborate and share the surplus. By doing so, we can weigh the relative magnitudes of competition and collaboration and show how both depend on the composition of the pool of borrowers.

Our paper contributes to a growing literature that studies the effect of fintech on lending. Buchak et al. (2018) documented the increased market share of fintech lenders and, more broadly, shadow banks in the residential mortgage between 2007 and 2015. Jiang (2019) shows that in the residential mortgage market, fintech lenders are funded by the same banks with which they compete in lending. Parlour et al. (2020) highlight the information spillovers from payment processing to lending while He et al. (forthcoming) and Goldstein et al. (2022) analyze the consequences of proposed open banking regulation that allows customers to share information across lenders. These papers highlight the potential downsides of consumer data portability. We do not allow for information sharing but instead focus on the effects of partnership funding and the welfare implications. Similarly, our analysis presents a cautionary tale of how the presence of partnership funding can hurt borrowers. Huang (2022) analyzes competition between a traditional bank and fintech, who rely on different lending technologies (collateral for bank and information for fintech). In contrast, in our model, both a fintech firm and a bank lend based on information but differ in the quality of information acquisition technology and funding costs. Moreover, we allow the lenders to collaborate via the partnership funding market - a channel absent in Huang (2022). Partnership funding is the central focus of Jiang (2019). That model has no adverse selection, and banks and shadow banks offer differentiated products. By casting the model in the context of information asymmetry, our paper offers new predictions on the degree of collaboration and competition in different markets and the entry patterns by fintech firms. Moreover, we highlight how partnership funding affects lending competition through the two channels highlighted earlier. The two models have some different predictions. For example, in Jiang (2019), a more competitive partnership funding market is always beneficial to borrowers due to the pass-through of lower funding costs. This result is no longer true in our model because when the fintech firm becomes more competitive, the winner's curse effect can be more severe, which might reduce lending competition and eventually harm the borrower.

This paper is also related to the literature on the new bank's entry into a market with adverse selection, which typically assumes the new bank has an information disadvantage but a cost advantage. Dell'Ariccia and Marquez (2004) analyze a similar problem, but they focus on how different degrees of information asymmetry affect the outcome of bank competition. Our paper differs in that we study both competition and collaboration between different lenders and how each may emerge as the quality of the borrower pool changes. Sengupta (2007) shows that the less-informed foreign bank opts to use costly collateral to screen borrowers, whereas the incumbent bank relies on its information advantage. In this paper, equilibrium is restricted to one with pure strategies. There is no role of collateral in our model. Moreover, we allow for both pure- and mixed-strategy equilibrium and show conditions under which either can emerge. Our paper is also related to Corbae and Gofman (2019), whereby the bank commits not to compete by lending funds to a competitor. In our paper, the bank still has the funding to compete after lending funds to a competitor, but it chooses not to in some circumstances.

2 The Model

We introduce a model with two dates $t = 0, 1$ and three sets of players. All players are risk-neutral, have limited liabilities, and do not discount the future. One bank and one fintech firm compete to lend to borrowers of two types. Meanwhile, the bank may lend to the fintech firm in the partnership funding market. Figure 1 lays out the building blocks of the model.

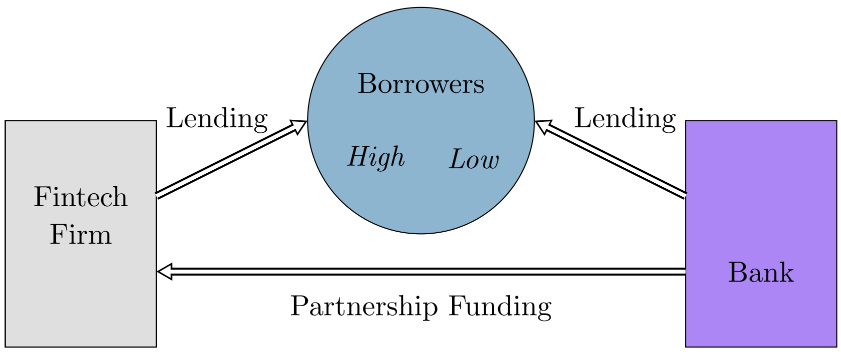

Figure 1: Model Overview

2.1 Borrowers and Projects

We model a continuum $i \in [0, 1]$ of penniless borrowers of two types: high and low. The borrower's type is private information only known by the borrower herself. Let μ be the fraction of high-type borrowers. Each borrower is infinitesimal and has access to a fixed-scale investment technology that requires \$1 at $t = 0$. Once the investment is made, the project generates R with probability p_{θ_i} and 0 with probability $1 - p_{\theta_i}$, where $\theta_i \in \{h, l\}$ stands for the borrower's type. For the rest of the paper, we assume without loss of generality that $p_h = 1$ and $p_l = p \in (0, 1)$. In our model, borrowers shall be interpreted as either small businesses or consumers who seek personal loans.

2.2 Lenders, Screening, and Partnership Funding

One bank and one fintech firm compete to lend to borrowers. To raise \$1, the bank needs to pay a gross interest payment r_B to its financiers, whereas the fintech firm needs to pay a total cost of r_F. One can interpret r_B as the return to a riskless storage technology available to the financiers. We assume $r_F > r_B \geq 1$ to reflect the idea that the bank has a funding advantage, which could come from government subsidy, deposit market power, liquidity insurance, or a better network in attracting deposits. The difference $r_F - r_B$ is an iceberg cost for the fintech firm to raise financing. Whereas the bank has a funding advantage, the fintech firm has a better screening technology. Specifically, we assume the bank can not screen any borrower, whereas the fintech firm has a costless screening technology. In particular, the technology generates a private signal on each borrower, either good g or bad b (we assume that the signals are *i.i.d.* across borrowers). Specifically,

$$\Pr(b|h) = e_1, \qquad \Pr(g|l) = e_2, \tag{1}$$

where e_1 and e_2 are the probability of a type-I and type-II error, respectively. Let q_g (q_b) be the total measure of borrowers who receive a good (bad) signal. Following the law of large numbers,

$$q_g = \mu(1 - e_1) + (1 - \mu)e_2, \qquad q_b = \mu e_1 + (1 - \mu)(1 - e_2). \tag{2}$$

Conditional on a good/bad signal, the fintech firm's posterior of a borrower being a high type is

$$\mu_g = \frac{\mu\,(1 - e_1)}{q_g}, \qquad \mu_b = \frac{\mu e_1}{q_b}. \tag{3}$$

We assume $e_1 + e_2 < 1$ so that $\mu_b < \mu < \mu_g$. For the baseline analysis, we assume $e_1 = e_2 = 0$, so that screening generates a perfect signal. In this case, $q_g = \mu$, $q_b = 1 - \mu$, $\mu_g = 1$ and $\mu_b = 0$. To simplify notation, we define

$$P(\tilde{\mu}) = \tilde{\mu} + (1 - \tilde{\mu})p, \ \forall \tilde{\mu} \tag{4}$$

as the conditional probability of producing R if the average quality is $\tilde{\mu}$. We introduce the following assumption throughout the paper.

Assumption 1. *The funding costs satisfy*

$$r_F < P(\mu_g) \cdot R, \ r_B > P(\mu_b) \cdot R. \tag{5}$$

Under Assumption 1, it is profitable for the fintech firm to lend using its own funding to a borrower conditional on a good signal. Yet, it is unprofitable for a bank to lend to a borrower conditional on a bad signal. Note under $r_F > r_B$, Assumption 1 implies that for both lenders, a borrower's project has a positive NPV under a good signal but has a negative NPV under a bad signal.

Even though the fintech firm has a funding disadvantage, it can borrow from the bank to (partially) offset the disadvantage. Specifically, the fintech firm can borrow a fraction $\lambda \leq 1$ of its funding from the bank, where $1-\lambda$ could be interpreted as the fintech firm's skin in the game. The interest rate of this partnership funding is determined via Nash Bargaining. Let α and $1-\alpha$ be the bargaining power of the fintech firm and the bank. The gross interest rate of the partnership funding satisfies $\alpha r_B + (1-\alpha) r_F$.

2.3 Equilibrium

The timing goes as follows.

- $t = 0$
  - The fintech firm screens and obtains a signal on each borrower.
  - The bank and the fintech firm simultaneously offer interest rates to each borrower. The borrower decides which offer to accept.
  - The partnership funding market opens, and the fintech firm can borrow a maximum fraction of λ of its funding from the bank.[4]
- $t = 1$
  - The project's outcome is realized. The borrower repays the loan, and the fintech firm repays the partnership funding.

There are no active decisions to be made at $t = 1$. At $t = 0$, the result in the funding market is straightforward. Let ℓ_F and ℓ_B be the equilibrium lending amount made by the fintech firm and the bank. Due to risk neutrality, the fintech firm always chooses to borrow $\lambda \ell_F$ from the bank and fund the remaining $(1-\lambda)\ell_F$ from its own financiers. Let us define

$$r_E = \lambda \alpha r_B + (1 - \lambda \alpha) r_F \tag{6}$$

as the effective funding cost of the fintech firm. For each loan made by the fintech firm, the bank makes expected profits

$$\Pi_B = \lambda(1-\alpha)(r_F - r_B) \tag{7}$$

[4]Results of the paper stay largely unchanged if the partnership funding market opens before the lending competition. The equilibrium identified later still survives in such an alternative timing arrangement, but there might be other self-fulfilling equilibria. For example, the fintech firm could choose not to establish a partnership funding arrangement because it anticipates losing in the direct lending competition, and due to its high effective funding cost, it will indeed lose in the competition.

through partnership funding. Sometimes, it is useful to write $r_E = \Pi_B + \lambda r_B + (1-\lambda) r_F$ so that it becomes clear that part of the fintech firm's effective funding costs arises from the bank's profits from partnership funding.

Let R_B and R_F be the gross interest rate offer made to the borrower by the bank and the fintech firm, respectively. Clearly, $R_B \in [0, R] \cup \{+\infty\}$, $R_F \in [0, R] \cup \{+\infty\}$, and both offers can be stochastic[5]. When $R_F \to +\infty$ ($R_B \to +\infty$), we say the fintech firm (bank) does not make an offer. As a result, it is convenient to define the cumulative distribution functions (CDFs) $F_B(\cdot)$ and $F_F(\cdot)$ to be the strategies of the bank and fintech firm. The borrower's decision is straightforward: she should accept the offer with the lower interest rate. For simplicity, we assume whenever there is a tie, the borrower opts to accept the offer from the bank. This assumption can be motivated by the other non-pecuniary services offered by the bank, and it is made without loss of generality. Results are unchanged under alternative tie-breaking rules (see Remark 2).

Let $\tilde{V}_B(i)$ and $\tilde{V}_F(i)$ be bank's and fintech firm's the expected payoff from lending to an individual borrower $i \in [0, 1]$. We have

$$\tilde{V}_F(i) = \mathbb{1}_{R_B(i) > R_F(i)} \cdot \Big[(p + (1-p)\mathbb{1}_{\theta_i = h}) R_F - r_E \Big] \tag{8}$$

$$\tilde{V}_B(i) = \mathbb{1}_{R_B(i) \leq R_F(i)} \cdot \Big[(p + (1-p)\mathbb{1}_{\theta_i = h}) R_B - r_B \Big]. \tag{9}$$

Let us define V_B and V_F as the bank's and fintech firm's profits from lending to borrowers. Aggregating across all borrowers, we have

$$V_J = \int_0^1 \tilde{V}_J(i) di, \text{ and } \qquad \ell_J = \int_0^1 \mathbb{1}_{R_J(i) > R_{J'}(i)} di \qquad \text{for } J \neq J' \in \{F, B\}.$$

We look for a Bayesian Nash Equilibrium, where the fintech firm's interest rate offer $R_F \sim F_F(\cdot)$ maximizes V_F and the bank's interest rate offer $R_B \sim F_B(\cdot)$ maximizes $V_B + \ell_F \Pi_B$. In particular, (8) shows that while making the interest offer, the fintech firm takes into account that it has an effective rate of r_E instead of r_F. Meanwhile, the bank also takes into account that even though it loses borrowers to the fintech firm, it still profits from lending to the fintech firm in the partnership funding market. Therefore, it aims to maximize $V_B + \ell_F \Pi_B$.

[5] When the bank (or fintech firm) offer is stochastic, each borrower i receives an *i.i.d.* realization $R_B(i)$ (or $R_F(i)$) from the offer distribution. This result allows us to use the exact law of large numbers in the cross-section of borrowers and obtain bank profits, borrower surplus, and welfare that are deterministic.

2.4 Modeling Discussion

Nash bargaining. Note that we have modeled the partnership funding market as a Nash-bargaining game between the fintech firm and the bank. This modeling choice allows us to study different degrees of interbank funding competition by varying the bargaining power of one party. Moreover, it offers a way to split the surplus between the two parties and determines the interest rates in the partnership funding. Alternatively, we can construct the model such that after lending competition, the fintech firm can always borrow from the bank with which it competes. With probability α, it can find a second bank to form partnership funding. If $\alpha = 0$, the first bank has monopoly power in partnership funding and can charge r_F. If $\alpha = 1$ instead, very naturally, the fintech should induce Bertrand competition and borrow at a rate r_B. Note that given our model has three parties (bank, fintech, and borrowers), Nash bargaining affects not only how the surplus is divided between bank and fintech but also the size of the surplus.

3 Solution

This section starts by solving the model under the assumption that screening generates a perfect signal to the fintech firm, i.e., $e_1 = e_2 = 0$. The results under general type-I and type-II errors are presented in Section 3.5.

3.1 Competition and Collaboration

This subsection solves the problem that the bank and the fintech firm compete for one representative borrower. The law of large numbers allows us to apply the results to the entire set of borrowers later.

In general, the bank suffers from a winner's curse effect. Whenever the bank wins the lending competition, chances are that the borrower is a low-type, and the fintech firm has figured out so. Extending a loan to a low-type borrower always leads to a loss. The previous literature has established that under this winner's curse effect, the equilibrium is necessary one with mixed strategies (Rajan, 1992; Hauswald and Marquez, 2003). Our problem differs in two aspects. First, the bank and the fintech firm have different funding costs. Second, even if the bank loses the borrower to the fintech, the bank can still profit from the partnership funding market.

Let us start by putting a lower bound on the bank's payoff and, therefore, its interest-rate bid in the lending competition. When the bank does not make an offer (equivalently $R_B \to +\infty$), the fintech firm lends to the borrower with probability μ, that is, when the realized signal from screening is good. Subsequently, the bank's expected profit from partnership funding is $\mu \Pi_B$, where

Π_B has been defined in (7). Meanwhile, by offering an interest rate R_B and winning the lending competition, the bank's expected profits are at most $P(\mu)R_B - r_B$, where $P(\mu)$ is the probability that the representative borrower will repay the loan. Note that these profits would be further reduced after considering the winner's curse effect. Whenever a bank makes a potentially winning bid in the lending competition, it must be that

$$P(\mu)R_B - r_B \geq \mu\Pi_B \Rightarrow R_B \geq \underline{R}_B := \frac{r_B + \mu\Pi_B}{P(\mu)} \tag{10}$$

Depending on the parameters, $\underline{R}_B$ may be greater or less than R. For the rest of this paper, we refer to $\underline{R}_B$ as the bank's *curse-free bid* because it is the lowest bid by the bank, even without the winner's curse effect.

Similarly, there is a lower bound on the fintech firm's bid in the lending competition. Following (1), we know that a fintech firm may only bid after it has received a good signal about the borrower. An offer R_F generates expected profits $R_F - r_E$. Meanwhile, the fintech firm receives zero by not making an offer (or equivalently, $R_F \to +\infty$). Therefore, R_F must satisfy

$$R_F - r_E \geq 0 \Rightarrow R_F \geq \underline{R}_F := \frac{r_E}{P(\mu_g)} = r_E. \tag{11}$$

Clearly, $\underline{R}_F < R$ follows from Assumption 1 and $r_E < r_F$. For the rest of this paper, we refer to $\underline{R}_F$ as the fintech firm's *break-even bid*.

A comparison between $\underline{R}_B$ and $\underline{R}_F$ highlights the relative advantages of the bank and the fintech firm. Comparing the denominators, $P(\mu) < P(\mu_g) = 1$ reflects the fintech firm's information advantage. In terms of the numerators, $r_B < r_E$ captures the bank's funding advantage, and a lower r_B further increases the advantage. Finally, the term $\mu\Pi_B$ captures the bank's potential partnership funding profits, which are the profits if the fintech firm manages to lend to all borrowers with a good signal (so $\ell_F = \mu$).

The equilibrium outcome depends on the comparison between $\underline{R}_B$ and $\underline{R}_F$. Let us elaborate.

Case 1 $\underline{R}_B \leq \underline{R}_F$: dominating funding cost advantage

Knowing that the fintech firm's bid always exceeds $\underline{R}_F$, the bank would never make any bid $R_B < \underline{R}_F$. Interestingly, the bank would never make an interest-rate offer strictly above $\underline{R}_F$, either. Intuitively, the bank is able to avoid the winner's curse effect when its funding advantage dominates the informational disadvantage. In this case, the presence of the fintech firm is just to prevent the bank from charging a monopoly interest rate.

Lemma 1. *If $\underline{R}_B \leq \underline{R}_F$, the bank never offers an interest rate $\hat{R}_B \in (\underline{R}_F, R]$ with a positive probability mass. Moreover, the bank never offers an interest rate $\hat{R}_B \in (R_1, R_2)$ with a positive probability density, for $\forall R_1, R_2$.*

Given Lemma 1, the bank adopts a pure strategy by offering an interest rate $\underline{R}_F$ and always wins over the borrower. The fintech firm, even though it never wins the lending competition, must also offer an interest rate on $[\underline{R}_F, R]$. This offer deters the bank from deviating and charging an interest rate higher than $\underline{R}_F$, and the distribution of this offer is not uniquely determined.

Case 2 $\underline{R}_F < \underline{R}_B < R$: comparable funding and information advantage

Knowing that the bank's bid always exceeds $\underline{R}_B$, the fintech firm would never make any bid $R_F < \underline{R}_B$. In this case, it is unavoidable for the bank to suffer from the winner's curse. In contrast to the previous case, both lenders must adopt mixed strategies in equilibrium. Lemma 3 in the appendix rules out the case that the bank can offer an interest rate with a positive probability mass.

Therefore, in equilibrium, the bank must adopt a mixed strategy. The only way such mixing by the bank can be incentive compatible is that the fintech firm is also randomizing its bid on the same interval. Our next result shows that the mixed strategies must have a continuous CDF on the interval $[\underline{R}_B, R]$.

Lemma 2. *If $\underline{R}_F < \underline{R}_B < R$, both the bank and the fintech firm adopt mixed strategies with a probability density on $[\underline{R}_B, R]$. The fintech firm must offer R with a positive probability mass.*

Given the structure of the equilibrium, the CDFs of the interest rate offers can be uniquely determined by the opposite player's indifference condition. The fintech firm is indifferent between bidding $\underline{R}_B$ and winning almost for sure and bidding $\tilde{R} \in [\underline{R}_B, R]$ and winning with probability $1 - F_B(\tilde{R})$:

$$\underline{R}_B - r_E = \left(1 - F_B(\tilde{R})\right)(\tilde{R} - r_E). \tag{12}$$

Thus, the bank's distribution satisfies

$$F_B(\tilde{R}) = 1 - \frac{\underline{R}_B - r_E}{\tilde{R} - r_E} = \frac{\tilde{R} - \underline{R}_B}{\tilde{R} - r_E},\ \tilde{R} \in [\underline{R}_B, R]. \tag{13}$$

With a mass probability $1 - F_B(R) > 0$, the bank does not bid.

The bank is indifferent between not bidding at all and collecting profits $\mu\Pi_B$ from the partnership funding market and bidding any $\tilde{R} \in [\underline{R}_B, R]$. As a result

$$\mu\Pi_B = (1-\mu)\left(p\tilde{R} - r_B\right) + \mu\left[F_F(\tilde{R})\Pi_B + \left(1 - F_F(\tilde{R})\right)\left(\tilde{R} - r_B\right)\right], \tag{14}$$

which implies the offer by the fintech firm must satisfy the following distribution:

$$F_F(\tilde{R}) = \frac{\mu\Pi_B - \left(P(\mu)\tilde{R} - r_B\right)}{\mu\left[\Pi_B - \left(\tilde{R} - r_B\right)\right]},\ \tilde{R} \in [\underline{R}_B, R). \tag{15}$$

With a mass probability $1 - F_F(R) > 0$, the fintech firm bids R.[6]

Case 3 $\underline{R}_F < R < \underline{R}_B$: dominating information advantage

In this remaining case, the bank strictly prefers to lose the bidding game even with the highest feasible interest rate R. As a result, the bank does not participate in the lending competition, and the fintech firm always offers R to a good-signal borrower and nothing to a bad-signal one.

Note that the comparison among $\underline{R}_F$, $\underline{R}_B$, and R depends on μ. Given that $\underline{R}_B$ decreases with μ,[7] let us define

$$\bar{\mu} \equiv \frac{(1-\lambda\alpha p)r_B - p(1-\lambda\alpha)r_F}{\lambda(1-\alpha p)r_B + [(1-p) - \lambda(1-\alpha p)]r_F}$$
$$\underline{\mu} \equiv \frac{r_B - pR}{(1-p)R - \lambda(1-\alpha)(r_F - r_B)}.$$

Under Assumption 1, it is clear that $0 < \underline{\mu} < \bar{\mu} \leq 1$. Simple derivations show that $\underline{R}_B \leq \underline{R}_F$ for $\mu > \bar{\mu}$, $\underline{R}_F < \underline{R}_B < R$ for $\mu \in (\underline{\mu}, \bar{\mu})$, and $\underline{R}_B \geq R$ for $\mu \leq \underline{\mu}$. Given this result, we summarize the preceding discussion below.

Proposition 1 (Equilibrium Lending Competition and Funding Collaboration)**.** *The lending bidding game has an essentially unique equilibrium.*

1. *Collaboration: for $\mu \in [0, \underline{\mu}]$, the bank never bids, and the fintech firm lends to a good-signal borrower at a rate R and does not lend to a bad-signal borrower.*

[6] Both numerator and denominator in (15) are negative since $\mu\Pi_B - (P(\mu)\tilde{R} - r_B) < 0$, $\forall \tilde{R} > \underline{R}_B$ and is a stronger condition than $\Pi_B - (\tilde{R} - r_B) < 0$.

[7] We can show $\frac{d\underline{R}_B}{d\mu}$ is proportional to

$$p(1-\alpha)\lambda(r_F - r_B) - (1-p)r_B < p(R - r_B) - (1-p)r_B = pR - r_B < 0.$$

2. *Collaboration/Competition: for* $\mu \in (\underline{\mu}, \bar{\mu})$*, the bank randomizes between the bids in* $[\underline{R}_B, R]$ *with CDF* F_B *characterized by* (13)*. With probability* $1 - F_B(R)$*, the bank does not bid at all. The fintech firm's bid distribution on* $[\underline{R}_B, R)$ *follows* F_F *characterized by* (15)*. With a mass probability* $1 - F_F(R)$*, the fintech firm bids* R*.*

3. *Competition: for* $\mu \in [\bar{\mu}, 1]$*, the bank always bids* $\underline{R}_F$ *and lends to all borrowers with probability* 1.

Proposition 1 shows how the equilibrium competition and collaboration depend on the average quality of the borrower pool. When the average quality μ is sufficiently low ($\mu < \underline{\mu}$), the bank does not participate in the lending competition. Three factors affect this decision: (a) the low quality of the pool implies that lending blindly to an average borrower is not very profitable to begin with, (b) the winner's curse effect implies that the pool of borrowers attracted to the bank's offer is even worse than the average, further reducing potential profits from lending, and finally (c) the option to lend to the borrowers indirectly through the partnership funding market crowds out the incentives to participate in the lending competition. Absent competition from the bank, the fintech firm charges a monopolistic rate of R and provides funding after observing a good signal. Lending in this region is inefficient due to the fact that the fintech needs to finance a fraction of $1 - \lambda$ of the loan using its own costly funding.

When the average quality of the pool μ is sufficiently high ($\mu > \bar{\mu}$), the information advantage of the fintech firm diminishes and becomes dominated by the funding cost advantage of the bank. As a result, the bank always outbids the fintech firm in equilibrium and provides lending. Although the fintech firm does not lend in this region, its presence does shape the equilibrium outcome by capping the rate that the bank could charge the borrower, preventing the bank from acting like a monopolist. Lending in this region is inefficient due to the blind and uninformed of credit: the lack of screening by the bank results in financing negative NPV projects.

Finally, in the intermediate region, $\underline{\mu} < \mu < \bar{\mu}$, the information advantage of the fintech firm and the funding cost advantage of the bank are comparable. As a result, both institutions lend in equilibrium. Because both parties actively bid and can win with some positive probability, equilibrium lending has two sources of inefficiency. Lending is excessively costly whenever the fintech firm offers a winning bid; whenever the bank offers a winning bid, funds can be wasted on negative NPV projects.

Proposition 1 implies that the competition between the bank and the fintech firm should only be observed by an econometrician in borrower pools whose average quality is neither too high nor too low. The bank retreats from borrower pools with low average quality, whereas the fintech firm retreats from those with high average quality.

Next, we show how the equilibrium cutoffs $\underline{\mu}$ and $\bar{\mu}$ depend on the primitive model parameters.

Corollary 1 (Effect of the Funding Cost)**.** *Equilibrium cutoff $\bar{\mu}$ is decreasing in the funding cost of the fintech firm r_F and increasing in the funding cost of the bank r_B. Equilibrium cutoff $\underline{\mu}$ is increasing in both the funding cost of the fintech firm r_F and the funding cost of the bank r_B.*

An increase in r_F (or decrease in r_B) magnifies the funding cost advantage that the bank has over the fintech firm. This makes the fintech firm less competitive relative to the bank and increases the size of the region where the bank can outbid the fintech firm, i.e., decreases $\bar{\mu}$. Meanwhile, an increase in the bank's funding cost r_B makes low-quality pools further less attractive to the bank. As a result, the region $[0, \underline{\mu}]$ in which the fintech firm can charge the monopolistic rate expands. The fintech firm's funding cost r_F affects the cut-off $\underline{\mu}$ through the bank's choice between direct lending and partnership lending. Higher r_F increases partnership funding profits and reduces the bank's incentives to compete for direct lending. In response, the bank optimally cedes a larger region $[0, \underline{\mu}]$ to the fintech firm and only focuses on the partnership funding market.

3.2 Payoffs

When the average quality of the pool is very low $\mu < \underline{\mu}$, the fintech firm is effectively a monopolist and lends at an interest rate R after receiving a good signal. Therefore, a mass μ of all borrowers can receive funding, and all borrowers receive a zero payoff. The fintech firm makes expected profits

$$V_F = \mu \cdot (R - r_E),$$

and the bank earns partnership funding profits $\mu \Pi_B$. Therefore, the resulting welfare is

$$W = \mu \Pi_B + \mu \cdot (R - r_E) = \mu \cdot (R - (1-\lambda) r_F - \lambda r_B). \tag{16}$$

Equation (16) shows that in this region, the welfare loss is driven by the funding inefficiency, i.e., the fact that the fintech firm must finance a fraction $1 - \lambda$ of its loans using its own funding, which is more costly.

When the average quality of the pool is very high $\mu > \bar{\mu}$, the bank always wins by bidding $\underline{R}_F$. In this case, the fintech firm makes zero profit, whereas a borrower of type $\theta_i \in \{h, l\}$ receives a payoff $p_{\theta_i}(R - \underline{R}_F)$. The bank receives no profits from partnership funding but earns $P(\mu)\underline{R}_F - r_B$ from directly lending to the borrowers. The resulting welfare is

$$W = P(\mu) R - r_B. \tag{17}$$

Equation (17) shows that in this region, the welfare loss is driven by lending inefficiency, i.e., by the fact that low-type borrowers also receive funding.

In the intermediate region $\underline{\mu} < \mu < \bar{\mu}$, both the bank and the fintech firm actively bid and win with positive probabilities. A borrower with a good signal can always receive financing and therefore receives a payoff $-\int_{\underline{R}_B}^{R}(R-\tilde{R})d\left((1-F_B(\tilde{R}))\cdot(1-F_F(\tilde{R}))\right)$.[8] By contrast, a borrower with a bad signal can only be financed by the bank, so that the expected payoff is $\int_{\underline{R}_B}^{R}(R-\tilde{R})dF_B(\tilde{R})$. Given that the fintech firm places a random bid following a good signal, any bid $\tilde{R}_F \in [\underline{R}_B, R]$ must generate the same profits. When the fintech firm bids $\tilde{R}_F = \underline{R}_B$, it always wins over the borrower and receives expected profits

$$V_F = \mu\Big(\underline{R}_B - r_E\Big) \tag{18}$$

The bank places a random bid in $[\underline{R}_B, R] \cup \{\infty\}$. As a result, its total profits from direct lending and the partnership funding market are the same regardless of whether the bank is bidding or not. Not bidding would generate total profits equal to

$$V_B + V_i = \mu \cdot \Pi_B. \tag{19}$$

Summing up, we get the total welfare

$$W = \mu\left[R - (\lambda r_B + (1-\lambda) r_F)\int_{\underline{R}_B}^{R}\Big(1 - F_B(\tilde{R}_F)\Big)\,dF_F(\tilde{R}_F) - r_B\int_{\underline{R}_B}^{R}F_B(\tilde{R_F})dF_F(\tilde{R}_F)\right] + (1-\mu)F_B(R)(pR - r_B). \tag{20}$$

The next proposition describes how equilibrium objects, bank profits, partnership funding profits, borrower and total welfare vary with the average quality of the borrower pool μ.

Proposition 2. *The bank's total profit strictly increases in μ. By contrast, the fintech firm's profit is non-monotonic in μ: it increases for $\mu < \underline{\mu}$ and could be non-monotonic on $\mu \in \left[\underline{\mu}, \bar{\mu}\right]$. The payoff of both high- and low-type borrowers increases in μ.*

Figure 2 plots the profits and welfare when the average quality of the borrower pool varies. The top-left panel describes the profits of the bank and the fintech firm, as well as the total welfare. There are a few interesting observations. First, the fintech firm's profits are non-monotonic in μ: it increases for $\mu < \underline{\mu}$; for $\mu \in [\underline{\mu}, \bar{\mu}]$, it could also be non-monotonic. Intuitively, this result holds because for $\mu < \underline{\mu}$, there is no competition, and, as a result, the fintech firm earns a monopoly

[8] Since CDF for $\Pr(\min\{R_F, R_B\} \le \tilde{R}) = 1 - (1 - F_F(\tilde{R}))(1 - F_B(\tilde{R}))$.

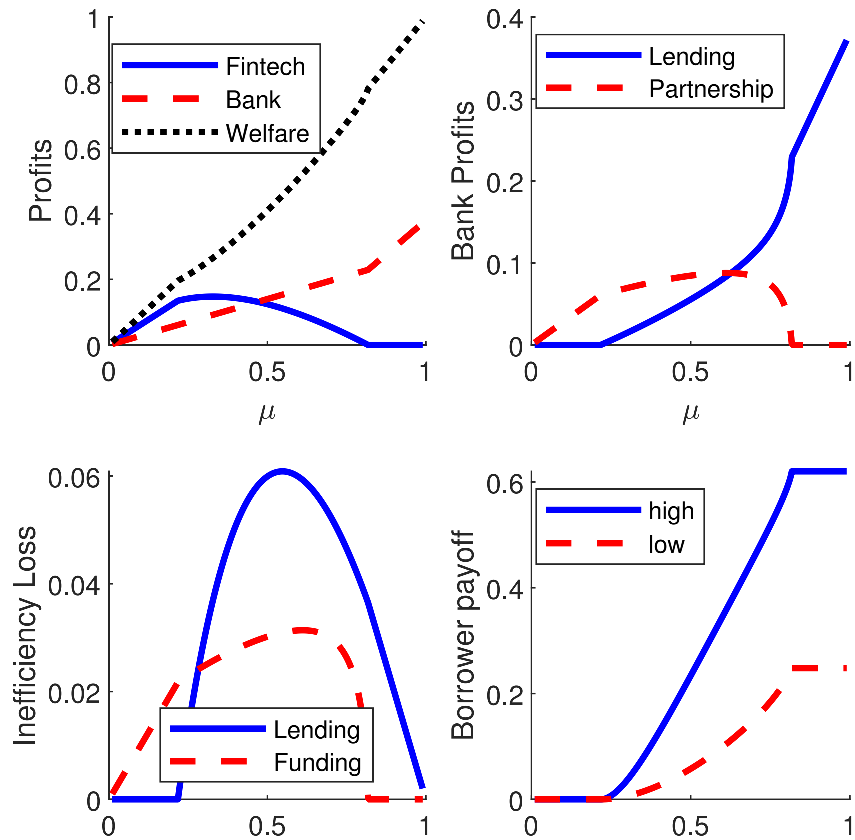

Figure 2: Profits, Welfare, and Lending under Different μ

This figure describes the equilibrium profits and welfare when the average quality of the borrower pool μ varies. The left panel plots the profits and welfare, and the right panel decomposes the bank profits into direct lending and partnership funding. The parameters in this figure are as follows: $R = 2.0$, $p = 0.1$, $r_F = 1.5$, $r_B = 1.0$, $\lambda = 0.8$, $\alpha = 0.2$, $e_1 = 0$, $e_2 = 0$.

rent. An increase in μ results in the fintech firm lending to and profiting from a larger pool of high-type borrowers. By contrast, for $\mu \in [\underline{\mu}, \bar{\mu}]$, there are both competition and collaboration. A higher μ in general leads to more high-type borrowers, which increases the fintech firm's potential profits. Meanwhile, a higher μ intensifies the bank's competition, which reduces the fintech firm's per-borrower profits $\underline{R}_B - r_E$. We have shown that $\underline{R}_B$ decreases with μ. Intuitively, when μ goes up, the bank is more likely to be repaid when it lends blindly. Therefore, the curse-free bid $\underline{R}_B$ at which it is indifferent between lending blindly and partnership funding goes down. Combining these effects, the overall profits $(\mu(\underline{R}_B - r_E))$ can be non-monotonic in μ. Finally, when μ rises above $\bar{\mu}$, the fintech firm completely retreats from lending and therefore makes zero profits.

By contrast, the bank's total profits always increase in μ, and the slope becomes even higher for $\mu > \bar{\mu}$. The top-right panel of Figure 2 decomposes the bank's total profits into direct lending and partnership funding. Whereas the profits from direct lending increase in μ, the profits from partnership funding are, again, non-monotonic in μ, because when μ goes up, there are both more high types and more competition.

Finally, the yellow line of the top-left panel plots the total welfare against μ. Interestingly, it is also non-monotonic $\mu \in [\underline{\mu}, \bar{\mu}]$. The bottom-left panel decomposes welfare losses into lending and funding inefficiency. The red line measures funding inefficiency, defined as the equilibrium amount of fintech firm lending times $(1-\lambda) \cdot (r_F - r_B)$. The blue line measures lending inefficiency, defined as the probability of low types being financed times $r_B - pR$. Clearly, both inefficiencies are non-monotonic in μ. On one hand, a higher μ means that the fraction of low-type borrowers gets lower. On the other hand, a higher μ increases lending competition by banks, which results in a higher probability that low types get financed. Finally, as illustrated in the bottom-right panel, the borrower's payoff increases in μ, and the high-type borrower receives a higher payoff than a low-type borrower.

Remark 1. *Note that the welfare function has only included the payoff to borrowers, the bank, and the fintech firm, but not the financiers of the bank/fintech firm. One interpretation is that $r_B - 1$ and $r_F - 1$ are the iceberg costs of the bank and the fintech firm in raising cash, and their creditors only receive* 1*. If, instead, we interpret r_B and r_F as the rates the creditors require, then the funding costs are merely transfers from the institutions to their creditors. In this case, the welfare loss only comes from the bank funding bad projects. When μ gets higher, the bank is more likely to submit a bid that is weakly less than R to finance the bad project, which increases the welfare loss. Meanwhile, when μ gets higher, there are fewer bad projects to begin with. The overall effects can be non-monotonic, as shown by the blue line of the right panel of Figure 2.*

3.3 Collusion

Given the model's setup, it is natural to anticipate the two lenders colluding and always collaborating. The collusion outcome, which corresponds in our model to the first-best, is as follows: the fintech firm charges an interest rate of R to a high-type borrower and does not lend to a low-type borrower. Moreover, all the funding comes from the bank, and the bank and fintech firm split the collusion profits. This arrangement features collaboration, which is our equilibrium for $\mu < \underline{\mu}$. This subsection shows that the collusion outcome cannot be implemented for $\mu \geq \underline{\mu}$. Throughout, we assume $\lambda = 1$ and $\alpha = 0$, so the fintech firm can, in principle, finance the entire loan by borrowing from the bank at an interest rate r_B. Note that $\bar{\mu} = 1$ under $\lambda = 1$, so that the equilibrium is characterized by one threshold $\underline{\mu}$: there is collaboration for $\mu < \underline{\mu}$, whereas both collaboration and competition exist for $\mu > \underline{\mu}$.

Under $\lambda = 1$ and $\alpha = 0$, (7) shows that the profits from partnership funding are $\mu(r_F - r_B)$. Meanwhile, the bank could undercut the fintech firm by offering slightly below R and receive $P(\mu)R - r_B$ which is above the partnership funding profits as long as $\mu > \underline{\mu}$. Given this, the bank always has incentives to deviate by offering R to all borrowers and earning positive profits.

Why wouldn't the two lenders collude for $\mu > \underline{\mu}$? Intuitively, under the collusion outcome, the bank may always deviate and privately offer an interest R to all borrowers and undercut the fintech. Such a deviation becomes very profitable when μ gets very high. In this case, the fintech must share much of the profits with the bank to deter the deviation. However, for each \$1 borrowed from the bank, the fintech firm cannot commit to sharing profits more than $r_F - r_B$ with the bank; otherwise, it prefers to finance the loan using its own funding.

To summarize, two factors prevent the collusion outcome under $\mu > \underline{\mu}$. First, the bank may have incentives to deviate and offer an interest rate that is slightly below R and lend to all borrowers. Second, the fintech always has the option to use its own funding, which essentially sets a cap on the bank's shared profits from collusion.

3.4 The Effect of Partnership Funding Market

In this subsection, we explore the effect of the partnership funding between the bank and the fintech firm. Surprisingly, introducing a partnership funding market can often make either the borrowers or the bank worse off.

We begin with the effect on the thresholds $\{\underline{\mu}, \bar{\mu}\}$.

Corollary 2 (Effect of the Partnership Funding Market)**.** *Equilibrium cutoffs $\underline{\mu}$ and $\bar{\mu}$ are increasing in the fraction of funds λ provided via the partnership funding market. When $\lambda = 1$, $\bar{\mu} = 1$ and the competition region disappears.*

An increase in the fraction of funds λ provided via the partnership funding market has two effects. First, it makes partnership funding more attractive to the bank. Higher potential profits from partnership funding incentivize the bank to bid less aggressively. As a result, the collaboration region $[0, \underline{\mu}]$ becomes larger. Second, a reduction in the fintech firm's skin in the game $1-\lambda$ (increase in λ) reduces its effective cost of funding r_E, making it more competitive against the bank. This force shrinks the region where the bank can outbid the fintech firm $[\bar{\mu}, 1]$.

Next, we examine how the partnership funding market affects the equilibrium payoff and welfare efficiency. We first specialize to the two corner cases $\lambda \in \{0, 1\}$, corresponding to the situation without and with the partnership funding market.

Proposition 3 (The Effect of Partnership Funding Market)**.**

1. *There exists a μ_θ^* such that a type-θ borrower is better off with the partnership funding market if and only if $\mu \geq \mu_\theta^*$.*

2. *The fintech firm always receives more profits with the partnership funding market.*

3. *There exists a μ_B^* such that the bank receives more profits with the partnership funding market if and only if $\mu < \mu_B^*$.*

In general, the presence of the partnership funding market introduces two channels. On one hand, it reduces the fintech firm's funding cost to better compete with the bank. Competition allows the lower funding cost to be passed on to borrowers. We refer to this channel as the *competition channel* for the rest of the paper. On the other hand, the partnership funding market allows the bank to make profits not only from directly lending to the borrower. In other words, when the bank receives profits from partnership funding, it has lower incentives to compete with the fintech firm in the direct lending market. We refer to this channel as the *collusion channel* for the rest of the paper. Proposition 3 shows how these two channels interact differently in markets characterized by different average quality levels. When μ is low, there is not much competition, and the collusion channel dominates, increasing the bank's profits at the cost of reducing the borrower's payoff. By contrast, when μ is very high, the competition channel dominates. The partnership funding passes through the fintech's lower funding cost, which benefits the borrower but reduces the bank's profits.

The results in Proposition are illustrated by Figure 3. The top-left panel compares a high-type borrower's payoff with and without the partnership funding market. Results are similar for a low-type borrower. Clearly, the partnership funding market benefits borrowers in a low μ pool more than borrowers in a high μ pool. The top-right panel compares the fintech firm's profits. It is unsurprising that the fintech firm is always better off with the partnership due to its lower funding cost. Intuitively, both channels favor the fintech firm: the lower funding cost allows it to compete more aggressively, and the partnership funding reduces the competition from the bank. Therefore, the fintech firm shall be better off for any μ. Turning to the bottom-left panel. Interestingly, the bank receives higher (lower) profits with the partnership funding market when μ is low (high), due to the relative magnitude of the competition and the collusion channel. Finally, the bottom-right panel compares the total welfare, and the result is intuitive: the partnership funding market eliminates the funding inefficiency and therefore can only increase welfare.

We conclude this subsection by showing the comparative statics with respect to λ. This exercise corresponds to an improvement in the partnership funding, such as reducing search friction or a better inter-bank monitoring technology. Figure 4 starts with $\lambda = 0$ in the competition region, i.e.

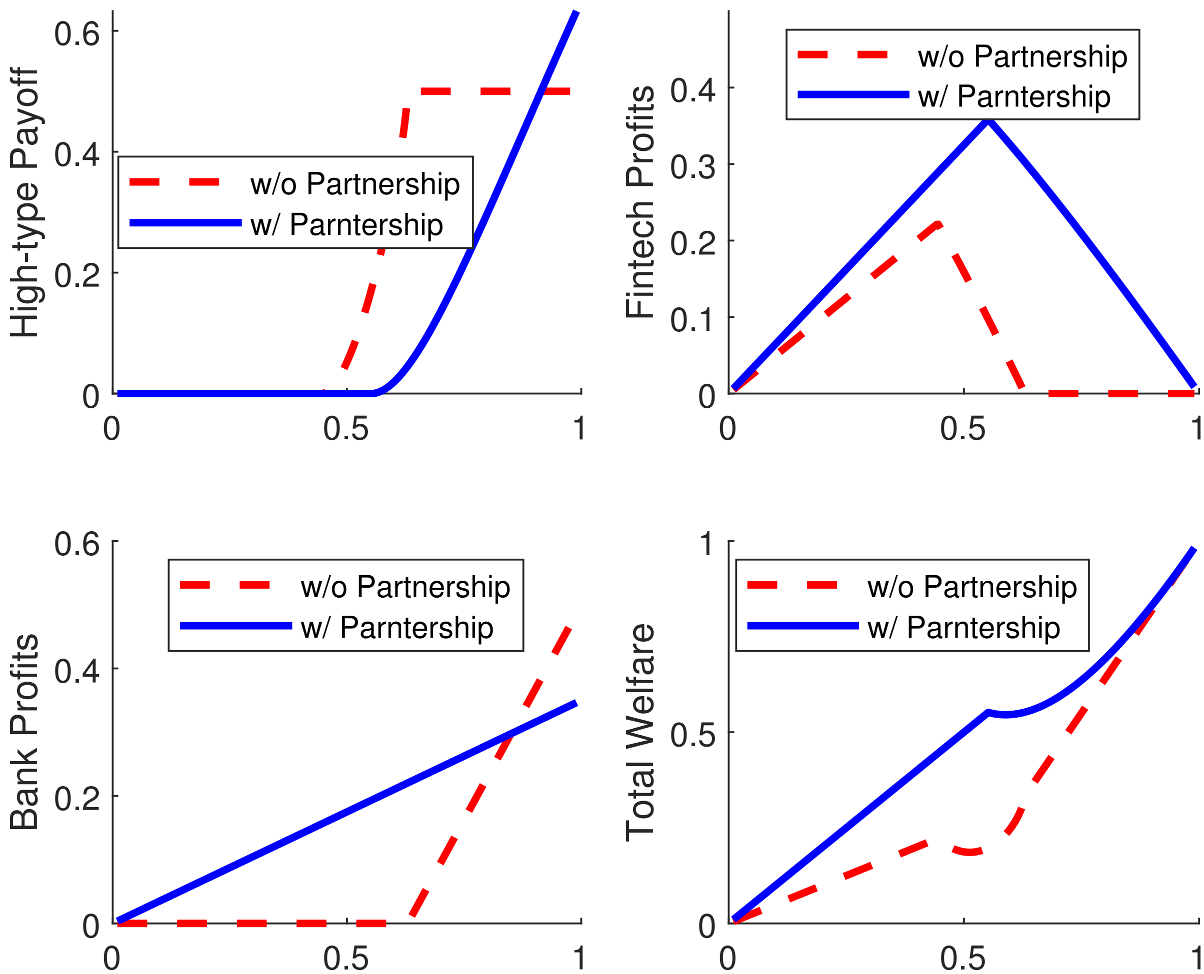

Figure 3: Profits and Welfare with and without the partnership funding market

This figure describes the equilibrium profits and welfare with and without the partnership funding market when the average quality of the borrower pool μ varies. The left panel plots the profits and welfare, and the right panel decomposes the bank profits into direct lending and partnership funding. The parameters in this figure are as follows: $R = 2.0$, $p = 0.1$, $r_F = 1.5$, $r_B = 1.0$, $\alpha = 0.2$, $e_1 = 0$, $e_2 = 0$. $\lambda = 1$ and $\lambda = 0$ respectively stand for with and without the partnership funding market.

$\mu > \bar{\mu}$. In this case, a marginal increase in λ further intensifies the competition channel, whereas the collusion channel is absent because the partnership funding profits are 0. Lower r_E implies increased competition for the borrowers, which leads to a reduction in the bank's profits and an increase in borrowers' payoffs. Only the equilibrium bank bid is affected by λ in this region, and, as a result, welfare, fintech firm profits, and inefficiencies remain constant.

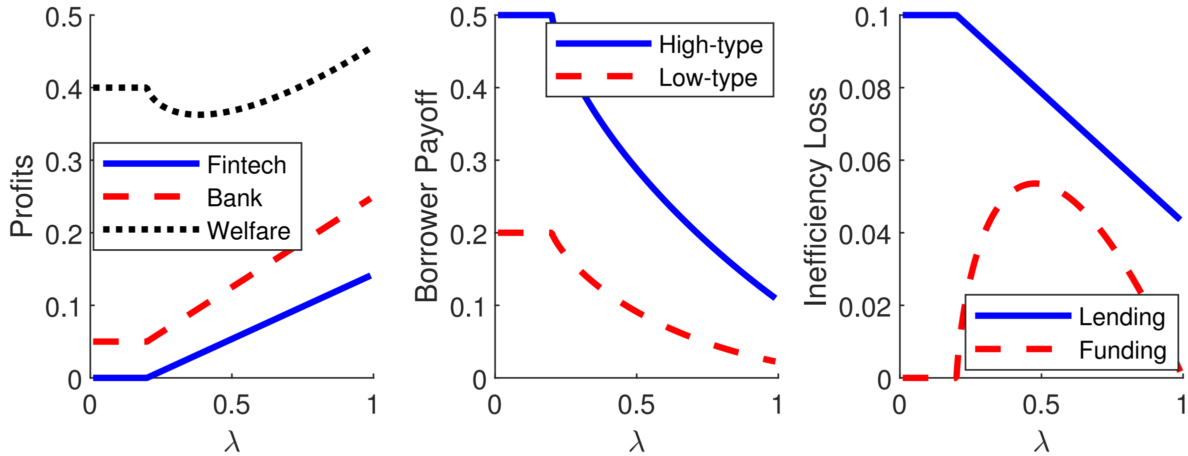

Figure 4: Comparative Statics w.r.t. λ

For $\lambda > 0.25$, the equilibrium outcome in Figure 4 is competition with collaboration. Higher λ now reduces competition through the partnership funding market channel. Lower competition translates into a lower borrower's payoff, as shown in the center panel of Figure 4. Both the bank and the fintech benefit from less competitive bidding, as shown in the left panel of Figure 4. The total welfare is affected by the behavior of funding inefficiencies plotted in the right panel of Figure 4. Lending inefficiency declines since the bank increasingly retreats from direct lending in favor of partnership funding. Funding inefficiency, however, exhibits non-monotone behavior. Higher λ reduces per-dollar funding inefficiency since the fintech firm can increasingly rely on partnership funding. However, higher λ also increases the total volume of fintech firm lending and amplifies funding inefficiency as a result.

3.5 The Effect of Signal Error

In this subsection, we examine how the two types of errors, e_1 and e_2 affect the equilibrium outcome and welfare. Assumption 1 imposes an upper and lower bound on μ. Specifically,

$$\mu \in \left[\frac{(r_F/R - p)e_2}{(1 - e_1 - e_2 p) - (1 - e_1 - e_2)r_F/R}, \frac{(1 - e_2)(r_B/R - p)}{(e_1 - (1 - e_2)p) + (1 - e_1 - e_2)r_B/R}\right].$$

The lower bound comes from $r_F < P(\mu_g) \cdot R$ and the upper bound comes from $r_B > P(\mu_b) \cdot R$.

We first show that the equilibrium characterized in Proposition 2 is robust to introducing type I and type II errors. While the equilibrium retains its general structure, type I and type II errors affect the profits of the bank and fintech firm differently, as we describe below.

Type I error

Let us start with type-I error $e_1 > 0$ and $e_2 = 0$ so that a fintech firm might receive a bad signal when facing a high-type borrower. In this case, $q_g = \mu(1 - e_1)$, $q_b = \mu e_1 + (1 - \mu)$, $\mu_g = 1$, and $\mu_b = \frac{\mu e_1}{q_b}$. The equilibrium is still characterized by two thresholds $\{\bar{\mu}_1, \underline{\mu}_1\}$, and we have the following results.

Corollary 3. *With type-I error, the equilibrium consists of three regions: collaboration for $\mu < \underline{\mu}_1$, collaboration/competition for $\mu \in (\underline{\mu}_1, \bar{\mu}_1)$, and competition $\mu > \bar{\mu}_1$ similar to Proposition 1. Both thresholds $\bar{\mu}_1$ and $\underline{\mu}_1$ decrease with e_1.*

Moreover, equilibrium fintech firm profits and bank profits are (weakly) decreasing in e_1 in every region.

Intuitively, a higher e_1 reduces the likelihood of good signals, and as a result, it also reduces the equilibrium amount of lending by the fintech firm. Lower fintech firm lending volume implies lower demand for partnership funding and lower partnership funding profits for the bank. Consequently, the bank has more incentives to compete with the fintech firm than offering partnership funding. Therefore, the region that the bank dominates in lending shall increase, leading to a decrease in $\bar{\mu}_1$. A similar reason leads to a decrease in $\underline{\mu}_1$. To see this, note that the decrease in $\underline{\mu}_1$ is driven by the fact that as e_1 goes up, partnership funding profits Π_B are lower so that the bank's curse-free bid $\underline{R}_B$ is lower as well.

The negative effect of e_1 on the bank profits stems only from the partnership funding market. It is absent whenever the partnership funding markets are closed, i.e., $\lambda = 0$. The negative effect of e_1 on the fintech firm profits stems from both the reduced lending due to a lower likelihood of observing a good signal and stronger bank competition.

Type II error

Now, we turn to the case of type-II error $e_1 = 0$ and $e_2 > 0$, so that a fintech firm might receive a good signal when facing a low-type borrower. In this case, $q_g = \mu + (1 - \mu)e_2$, $q_b = (1 - \mu)(1 - e_2)$, $\mu_g = \frac{\mu}{q_g}$, and $\mu_b = 0$. The equilibrium is again characterized by two thresholds $\{\bar{\mu}_2, \underline{\mu}_2\}$, and we have the following results.

Corollary 4. *With type-II error, the equilibrium consists of three regions: collaboration for $\mu < \underline{\mu}_2$, collaboration/competition for $\mu \in (\underline{\mu}_2, \bar{\mu}_2)$, and competition $\mu > \bar{\mu}_2$ similar to Proposition 1. The upper threshold $\bar{\mu}_2$ is decreasing in e_2 and the lower threshold $\underline{\mu}_2$ is increasing with e_2.*

Moreover, equilibrium fintech firm profits are decreasing, and bank profits are increasing in e_2 in every region.

Intuitively, an increase in type-II error has two effects. First, it reduces the average quality of the pool conditional on good signal μ_g. As a result, the fintech firm's informational advantage is mitigated, and it bids less aggressively (direct effect). Second, higher e_2 increases the likelihood of observing the good signal q_g. Keeping the bidding strategies fixed would translate into an increase in the volume of fintech firm lending and, consequently, partnership funding profits, reducing the bank's incentives to compete (indirect effect).

The threshold $\underline{\mu}_2$ is driven by the bank's incentives. Higher e_2 translates into an increase in the volume of partnership funding through q_g and strengthens the bank's incentives to withdraw from direct lending in favor of partnership funding. As a result, $\underline{\mu}_2$ increases in e_2. The other threshold $\bar{\mu}_2$ is pinned down by the competitive incentives of the bank and fintech firm, respectively. For μ close to $\bar{\mu}_2$, the volume of partnership funding is close to zero. Hence, an increase in q_g does little to deter the bank from competing. Lower information advantage of the fintech firm due to lower μ_g, however, decreases the competitiveness of the fintech firm. Hence, the region where the bank dominates expands with e_2, and the upper threshold $\bar{\mu}_2$ decreases with e_2.

Total bank profits are affected in the same direction by both forces. The bank benefits from a less competitive fintech firm and from a higher potential partnership funding market. Hence, its profits are increasing in e_2. For the fintech firm, the two forces are working in opposite directions. However, the direct channel dominates, and the fintech firm profits are decreasing in e_2. To see the intuition, consider the two corner cases $\mu = \bar{\mu}_2$ and $\mu = \underline{\mu}_2$. As discussed earlier, partnership funding profits are zero at $\mu = \bar{\mu}_2$, and the indirect channel is absent. Hence the fintech firm profits are decreasing in e_2 due to the direct effect. At $\mu = \underline{\mu}_2$, the partnership funding profits are high, and the indirect effect should increase the probability of the fintech firm winning the bidding game. However, the fintech firm wins it with a probability 1, to begin with. Hence the indirect effect is muted and the profits are decreasing due to the direct effect again.

Figure 5 describes the results under type-I and II errors. As mentioned before, the bank's profits are higher under type-II error, followed by no-error and type-I. By contrast, profits of the fintech firm are always lower with either type of error.

Discussion: Partnership Funding and Imperfect Signal

Without the partnership funding market, the Type I and Type II errors affect the equilibrium only through a direct channel. Namely, a Type I error leads the fintech firm to miss out on some of the high-quality borrowers, and a Type II error effectively reduces the quality of the pool that the fintech firm competes for. Importantly, the direct effect of Type I does not change the fintech firm incentives to compete, conditional on receiving a good signal. Because of that, it also does not

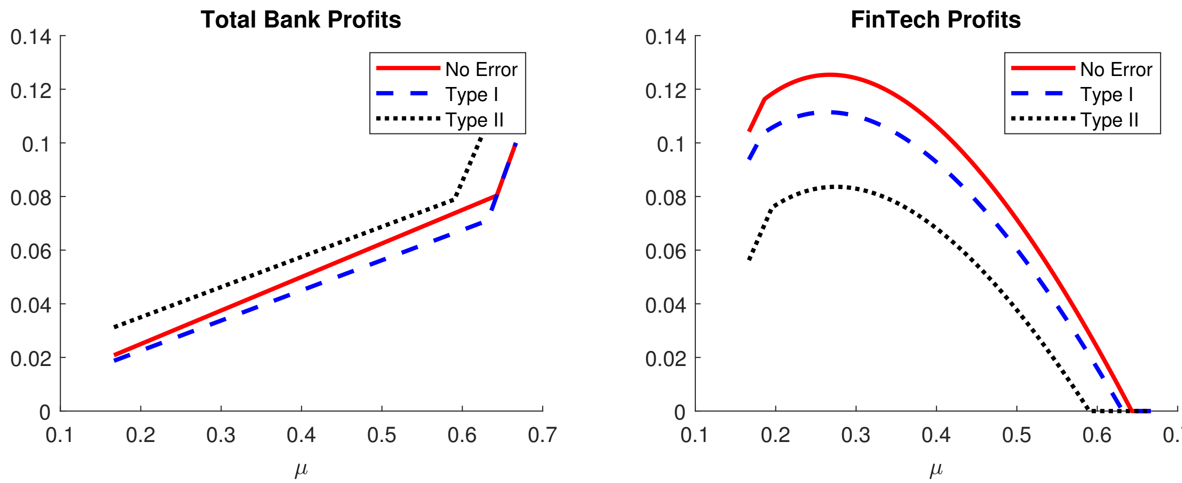

Figure 5: Lender profits under imperfect signals

impact the incentives of the bank to compete.[9]

The presence of a partnership funding market introduces an indirect effect. Type I (Type II) error decreases (increases) the potential size of the partnership funding market and increases (decreases) the bank's incentive to compete against the fintech firm. The indirect effect further increases the total bank's profits in Type II error and decreases profits in Type I error. The indirect effect acts in the opposite direction on the fintech firm's profits. As shown by the left panel of Figure 5, the presence of type-II error actually increases the total bank profits.

4 Robustness and Extensions

4.1 Costly Screening and Entry

Our baseline model has taken as given the lending market structure, which is populated by a bank and a fintech firm. Moreover, we have assumed that screening entails no cost to the fintech firm, i.e., the fintech firm is endowed with a costless screening technology. We relax both assumptions in this subsection.

Screening and Entry Cost for Fintech

In this benchmark model, the fintech firm's profits are non-monotonic: it peaks when the average quality of the borrower pool is neither too high nor too low. The reason is, when the

[9] Formally, the bidding CDFs F_B and F_F do not depend on e_1, and the equilibrium outcome is not affected by the Type I error.

average quality gets too low, there are not many high-type borrowers to begin with, so the fintech firm's profits are low. By contrast, when the average quality gets too high, the competition from the bank intensifies, and the fintech firm's profits are low again. Therefore, if either screening or entry entails a physical cost to the fintech firm, our model predicts that the fintech firm will be active in markets where the average quality is neither too high nor too low.

The equilibrium when the fintech firm has either entry or screening cost is as follows. When the average quality is very low, neither lender is active. When the average quality gets higher, the fintech firm actively lends, with financing from the bank. When the average quality gets further improved, both lenders are actively competing and collaborating. Finally, when the average quality gets to the highest region, only the bank lends.

Screening and Entry Cost for Bank

Now, suppose by paying a fixed cost, the bank could also acquire the same screening technology such that its information disadvantage is completely removed. After paying the cost, the bank can always outbid the fintech firm and earn expected profits $\mu(r_E - r_B)$. The difference in the bank's expected profits with and without the screening technology is

$$\begin{cases} \mu(r_E - r_B) - \mu\Pi_B = \mu(1-\lambda)(r_F - r_B) & \mu < \bar{\mu} \\ \mu(r_E - r_B) - (P(\mu)r_E - r_B) = \mu\underbrace{(pr_E - r_B)}_{<0} + (r_B - pr_E) & \mu > \bar{\mu}. \end{cases}$$

Simple calculations show that this difference peaks at $\bar{\mu}$. Therefore, our model predicts that if there is a fixed cost to adopt the screening technology, the bank will choose to do so if the average quality of the borrower pool is neither too high nor too low. Intuitively, when μ is low, there are too few high types to begin with, so the equilibrium amount of lending is low. Meanwhile, when μ is high, the bank's informational disadvantage is less important, so the incentives to acquire the informational technology are also lower.

4.2 Non-Pecuniary Benefits

We interpret borrowers as either consumers or small-business owners. In practice, these borrowers could value non-pecuniary benefits associated with different lenders. For example, it has been well-documented that the rise of fintech lending has been partially attributed to the convenience and speed offered by these lenders. Moreover, lending relationships with banks are sticky, partly due to the extensive branch network and payment clearing services. We study non-pecuniary benefits in this subsection. Specifically, we differentiate between whether the fintech firm or the bank

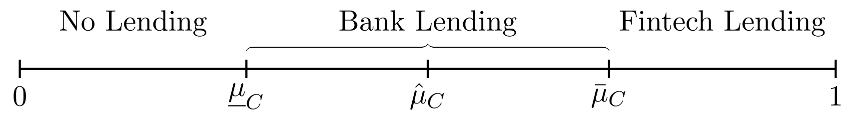

Figure 6: Equilibrium Illustration under convenience benefits

has the benefits. We will show that the equilibrium results are different if the fintech firm only has convenience advantages, whereas the results are qualitatively unchanged if it has both convenience and informational advantages.

Fintech Convenience Benefits without Screening Advantage

Let us first explore a model in which the fintech firm does not have any informational advantage in screening technology. In other words, the fintech firm is as uninformed as the bank. However, the fintech firm offers convenience benefits to borrowers in that the bank can only outbid the fintech firm if its bid satisfies $R_B < R_F - \Delta_F$, where $\Delta_F > 0$ captures the speed and simplified procedures when borrowers apply for credit from the fintech firm.

Figure 6 illustrates the equilibrium market outcome as a function of the average borrower quality μ. Appendix A.2 contains the detailed analysis. The equilibrium is characterized by three thresholds: $\{\underline{\mu}_C, \hat{\mu}_C, \bar{\mu}_C\}$. For $\mu < \underline{\mu}_C$, neither lender offers any credit. For $\mu \in \left[\underline{\mu}_C, \bar{\mu}_C\right]$, the bank conducts all the lending. For $\mu \in [\bar{\mu}_C, 1]$, the fintech firm conducts all the lending. Finally, For $\mu < \hat{\mu}_C$, the fintech firm finds it unprofitable to lend and therefore does not offer any loan. This result implies that the bank enjoys monopoly profits and charges interest rate R for $\mu \in \left[\underline{\mu}_C, \hat{\mu}_C\right]$ but faces competition and charges interest rate $\frac{r_E}{P(\mu)} - \Delta_F$ for $\mu \in [\hat{\mu}_C, \bar{\mu}_C]$.

Note that the results are in sharp contrast to the model where the fintech firm has an informational advantage, where the equilibrium is characterized in Proposition 1. The fintech firm's advantage derived from convenience benefits generates $P(\mu) \cdot \Delta_F$ expected profits for the fintech firm, which increases in μ. Intuitively, the result holds because the fintech firm's informational advantage is smaller when higher average borrower quality μ is high, whereas its effective convenience advantage is larger in markets with higher μ. In the model with only convenience benefits, higher average borrower quality μ translates into higher expected profits that allow the fintech firm to be more competitive. Consequently, the fintech firm dominates the markets with the highest average quality of the borrowers μ and the bank lends in the markets with intermediate quality.

Fintech Convenience Benefits with Screening Advantage

Next, we turn to the case that the fintech firm has both convenience benefits and informational advantages. Again, the convenience benefits are modeled such that the bank can only outbid the fintech firm if its bid satisfies $R_B < R_F - \Delta_F$. The equilibrium turns out very similar to the one described by Proposition 1, with the only exception that $\bar{\mu}$ is defined as the threshold such that $R_B = \underline{R}_F - \Delta_F$ holds. Intuitively, the convenience benefit reduces the fintech firm's effective funding cost by Δ_F, which further increases its competitiveness.

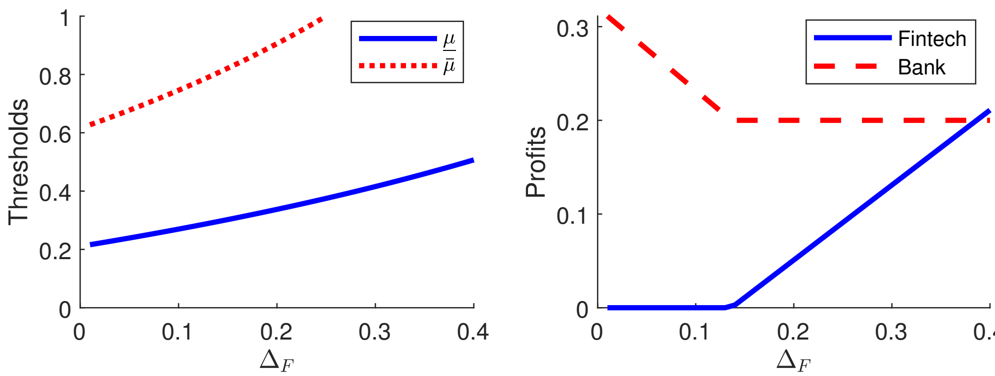

Figure 7: Comparative Statics in fintech benefit Δ_F ($\mu = 0.8$).

Figure 7 shows the results. The left panel shows that the equilibrium is characterized by thresholds $\{\underline{\mu}, \bar{\mu}\}$ as long as Δ_F is not too high. Otherwise, $\bar{\mu}$ goes to one, and the region where the bank's cost advantage dominates vanishes. Note that both thresholds increase with Δ_F. The right panel shows that the fintech's expected profits increase with Δ_F, whereas the bank's ones decrease.

Remark 2. *In the case that the fintech firm offers more convenience benefits if we take the limit of $\Delta_F \downarrow 0$, the result corresponds to the one in the benchmark model in which the tie favors the fintech firm. Therefore, our earlier results in section 3 are robust to the way that ties are settled.*

Sticky Banking Relationships

Finally, we consider the case that the bank offers non-pecuniary benefits in that the fintech firm can only outbid the bank if its bid satisfies $R_F < R_B - \Delta_B$, where $\Delta_B > 0$. Once again, we define $\underline{R}_B$ and $\underline{R}_F$ as in (10) and (11). If Δ_B gets very high such that $\underline{R}_F + \Delta_B > R$, the fintech firm could never win the borrower over, and its presence does not pose a threat to the bank. If, on the other hand, $\underline{R}_F + \Delta_B \leq R$, The equilibrium is qualitatively similar to the one in Section 3, which is characterized by three regions. In the first region $\underline{R}_B > R$ (low average quality), the bank never lends, and the fintech firm acts as a monopolist lender who offers R to high-type borrowers.

In the second region $\underline{R}_F + \Delta_B < \underline{R}_B < R$ (intermediate average quality), both lenders could win the borrowers. In equilibrium, the bank both offers R and retreats from lending with positive probability masses. As a result, whereas the fintech firm introduces competition and the resulting winner's curse effect prevents the bank from always bidding, the convenience benefit Δ_B enhances the bank's monopoly power in that it still sometimes offers R on the equilibrium path. Finally, in the last region $\underline{R}_B < \underline{R}_F + \Delta_B$, the bank always outbids the fintech firm and offers an interest rate $\underline{R}_F + \Delta_B$. We supplement the details in Appendix A.2. The broader takeaway from this exercise is that the convenience benefit essentially offers monopoly power to the bank, which stifles lending competition.

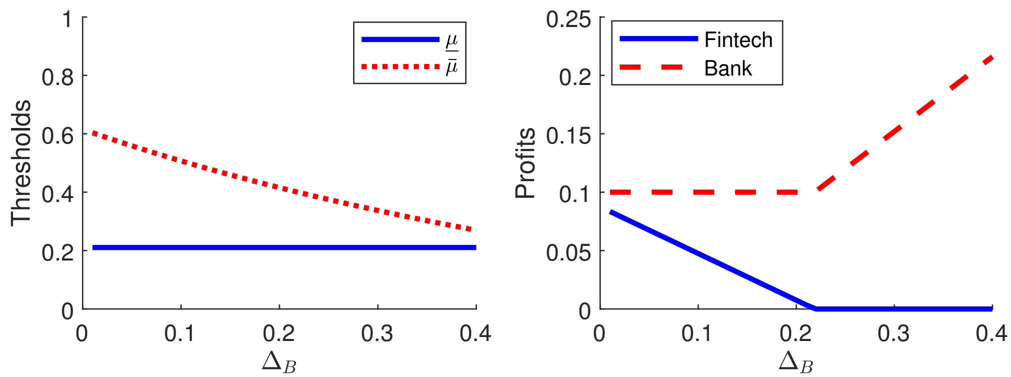

Figure 8: Comparative Statics in bank benefit Δ_B ($\mu = 0.4$).

Figure 8 shows the results. Clearly, $\underline{\mu}$ (the threshold where the bank breaks even by offering R) does not change with Δ_B, whereas $\bar{\mu}$ decreases in Δ_B. The right panel shows that the fintech's expected profits decrease with Δ_B, whereas the bank's profits increase.

4.3 Bank Competition

In the benchmark model, we have taken as given the intermediation sector being populated by one bank and one fintech firm. In other words, the environment that we study is one with a pre-existing bank with some local monopoly power in lending, faced with a new fintech firm entering the market, consistent with Philippon (2016).

This subsection studies the role of bank competition. We will first consider a model where competition only exists in the partnership funding market. Results show that the fintech company and the bank it directly competes with in lending both favor collaborating through partnership funding. In other words, the equilibrium described in section 3 satisfies the requirements of a core equilibrium. Next, we study the model where competition exists in both direct lending and partnership funding. The equilibrium structure in funding collaboration and lending competition is largely unchanged.

Competition in the Partnership Funding

Let us first consider the model in which the fintech firm obtains a fraction λ of the partnership financing from a third, non-competing bank. One can think of this bank as a lender with special lending expertise in a different geographical location. Borrowing from the third-party bank allows the fintech firm to reduce its funding cost from r_F to r_E without affecting the competing bank's incentives via partnership funding profits. Note that in such a model, the per-loan partnership funding profits are $\Pi_B = 0$. The bank's curse-free bid becomes $\underline{R}_B = \frac{r_B}{P(\mu)}$, whereas the fintech firm's break-even bid $\underline{R}_F$ stays unchanged. The two critical thresholds in the average quality are

$$\underline{\mu}_{NC} = \frac{r_B/R - p}{1-p} < \underline{\mu} \qquad \bar{\mu}_{NC} = \frac{r_B/r_E - p}{1-p} < \bar{\mu},$$

where the subscripts NC stand for non-competing. Our next result compares the payoffs of the different market participants in the benchmark model to the one with third-party financing.

Proposition 4 (Partnership Financing from a Non-Competing Bank)**.**
If the fintech firm obtains financing from a non-competing bank as opposed to a partner bank, then

1. *the fintech firm and the bank receive (weakly) fewer profits,*

2. *but the borrowers are (weakly) better off.*

Proposition 4 implies that the fintech firm always prefers to borrow from the same bank with whom it competes to some other banks who do not directly participate in the lending competition. Non-competing bank financing isolates the effect of bank funding cost from the lending competition. Relative to the case without the partnership funding market, non-competing bank financing only reduces the effective funding cost of the fintech firm but does not mitigate the bank's incentives for competition. This change increases fintech firm profits and forces the bank to bid more aggressively; hence, the bank profits decrease. However, this will come at a cost: borrowers are worse off compared to the situation where the fintech firm obtains financing from the non-competing bank. Therefore, the borrowers benefit from the increased competition between the bank and the fintech firm.

Competition in direct lending and partnership funding

Next, we consider the model that the lending market was originally populated with two banks competing with each other and one fintech firm entering. Given so, the fintech firm naturally has the bargaining power in the partnership funding market, so that $r_E = \lambda r_B + (1-\lambda) r_F$ and $\Pi_B = 0$. In other words, the two banks compete in offering to fund the fintech firm and end up earning zero profits from partnership funding.

The rest of the model can be solved as the benchmark under the assumption $\alpha = 1$. Note that in equilibrium, the bank never makes any profit even if $\mu > \bar{\mu}$, whereas the fintech firm earns some positive amount of profits as long as $\mu < \bar{\mu}$. Compared to the benchmark model with a single bank, competition between the two banks eliminates the bank's rents associated with funding advantage. However, competition between banks increases the profits associated with the fintech firm's informational advantage by reducing the partnership funding rate.

4.4 Fintech Competition

Let us introduce fintech competition into the model. Specifically, we extend the benchmark model to one with one bank and two fintech firms. Results are straightforward when both fintech firms observe the same signals from one borrower. The two fintech firms engage in Bertrand competition, driving their expected profits to zero. That is, the fintech firms will offer interest rates $\underline{R}_F = \frac{r_E}{P(\mu_g)}$ upon observing a good signal but retreat from lending upon observing a bad signal. The bank, as before, would like to offer an interest rate that is at least $\underline{R}_B$. The equilibrium turns out straightforward. If $\underline{R}_B \leq \underline{R}_F$, the bank lends at an interest rate $\underline{R}_F$ and earns positive rents due to its lower funding cost. If $\underline{R}_B > \underline{R}_F$, the two fintech firms lend and offer an interest rate $\underline{R}_F$ while the bank retreats from direct lending to the partnership funding market.

Results are more interesting when the two fintech firms' signals are not perfectly correlated. In fact, the results will be isomorphic to those in the benchmark model. To see this, let us assume the two fintech firms receive signals that are conditionally independent and are subject to type-I error: a high-type borrower could receive a bad signal with probability e_1, and the distribution of this type-I error is independent across the two fintech firms. Results under type-II error are described at the end of this subsection.

Our next result summarizes the equilibrium. The specific expressions for thresholds $\underline{R}_B^{2F}$, $\bar{R}_B^{2F}$, $\underline{R}_F^{2F}$, $\underline{\mu}^{2F}$, and $\bar{\mu}^{2F}$ are available in the appendix.

Proposition 5 (Equilibrium with Fintech Competition)**.**

1. *Collaboration: for $\mu \in [0, \underline{\mu}^{2F}]$, the bank never bids. For each FinTech firm, it offers a random*

random interest rate on $[e_1 R + (1-e_1)\underline{R}_F^{2F}, R]$ *after observing a good signal and does not lend after observing a bad signal.*

2. *Collaboration/Competition: for* $\mu \in [\underline{\mu}^{2F}, \bar{\mu}^{2F}]$*, the bank offers a random interest rate in* $[\underline{R}_B^{2F}, \bar{R}_B^{2F}]$ *for some* $\bar{R}_B^{2F} < R$ *and does not bid at all with a positive prob. The finTech firm's bid distribution on* $[\underline{R}_B^{2F}, R]$*.*

3. *Competition: for* $\mu \in [\bar{\mu}^{2F}, 1]$*, the bank always bids* $\underline{R}_F^{2F}$ *and lends to all borrowers with probability* 1*.*

According to Proposition 5, our benchmark result on collaboration and competition between the bank and the fintech firm are robust if we introduce competition within fintech firms. When μ is very high (low), the informational advantage from the fintech is small (large) compared to the bank's funding advantage. The equilibrium features collaboration (competition) when the fintech's informational advantage is higher (lower) compared to the bank's cost advantage.

Before concluding, let us briefly mention the results of the two fintech firms receiving conditionally independent signals that are subject to type-II errors. Results are largely identical to those in Proposition 5, and we can define the thresholds $\bar{\mu}^{2F}$ and $\underline{\mu}^{2F}$ similarly. Besides, there exists another threshold $\frac{e_2(r_E/R-p)}{1-p-(1-e_2)(r_E/R-p)}$ below $\underline{\mu}^{2F}$, such that if $\mu < \frac{e_2(r_E/R-p)}{1-p-(1-e_2)(r_E/R-p)}$, where fintechs would not lend even after receiving a good signal, because it is very likely that the good signal comes from a low-type borrower who populates the majority of the borrower pool.[10] We supplement the details in the Appendix.

5 Conclusion

Motivated by the rise of fintech firms in the financial industry, we develop a theory that features competition and collaboration between fintech firms and traditional banks. Our theory highlights the role of partnership funding, which allows fintech firms to borrow from banks. We show the two lenders collaborate when the average quality of the borrower pool is low but compete when the quality is high. The partnership funding increases the fintech firms' competitiveness in the direct lending market and reduces the banks' incentives to compete. As a result, borrowers can only benefit if the average quality of the borrower pool is already sufficiently high. Otherwise, they can be worse off. By contrast, the bank earns more profits if and only if the average quality of the borrower pool is sufficiently low. The presence of partnership funding shifts the fintech firm's preferences towards technologies that make more type-II errors relative to type-I errors. Screening technology

[10]When $\mu = \frac{e_2(r_E/R-p)}{1-p-(1-e_2)(r_E/R-p)}$, conditional on a good signal, we have $\left(\frac{\mu}{\mu+(1-\mu)e_2} + \frac{(1-\mu)e_2}{\mu+(1-\mu)e_2}p\right) \cdot R = r_E$.

with type-II errors increases the total volume of fintech firms and consequently partnership funding. Higher partnership funding profits discourage banks from competing to the benefit of the fintech firm.

We have assumed the low types of projects have negative NPV. Results can be different if even those projects can have positive NPV. In that case, when the average quality gets sufficiently low, the winner's curse effect is also mitigated, in which case the bank should be the dominating lender. That said, the assumption that a low-type project is of negative NPV is arguably more plausible in the context of bank lending.

Regulatory requirements have been considered as a major reason behind the bank's retreat from lending to certain borrowers. In principle, the equilibrium structure identified in Proposition 1 can also be generated in a model where a bank needs to incur additional regulatory costs when it lends to borrowers that are risky based on observable variables. Such a model has different empirical predictions from ours regarding credit quality. In the model that highlights regulation, fintech firms offer credit to borrowers with low average quality, and ex-post the default rates of these loans should be higher than the credit offered by banks. In our model, even though fintech firms also offer credit to borrowers with low average quality measured by observable characteristics, the ex-post default rates of these loans should be lower compared to the bank credit, due to the fintech firm's information advantage. The result that better screening reduces default is a robust prediction in models with information asymmetry. Empirical tests can be designed to differentiate the importance of regulatory costs from information asymmetry.

We have assumed that the two lenders make interest offers simultaneously. One alternative is to allow the fintech firm to make an offer first. The bank, observing the fintech firm's offer, decides whether to match. This can be motivated by the mounting evidence that the fintech firm underwrites loans much faster and offers better convenience. In such a model, the bank will have a second-mover advantage and get all the profits. To see this, note that the fintech firm will never make any offer after knowing the borrower is a low type: such an offer can only generate losses in the subgame. Knowing so, the bank will match any offer made by the fintech firm and earn positive profits. In this model, the information advantage of the fintech firm is fully dissipated due to the fact that it must make an offer and the interest-rate offer is publicly observable. There is only the bank's funding advantage. Therefore, the fintech firm will either try to hide its interest-rate offer (in which case the game is back to the static one) or make an exploding offer before the bank can react (in which case a cream-skimming effect can show up).

There is no aggregate uncertainty in our model. Given so, the law of large numbers implies that the profits of both lenders are deterministic. Therefore, there is no associated risk of default on partnership funding. Extending the model with aggregate shocks and more dynamics can be an interesting future direction.

For tractability concerns, our paper has assumed that borrowers follow binary-type distributions and that the final cash flows generated by the projects are also binary. Results will be qualitatively unchanged if the borrower's type remains binary, the final cash flows follow a continuous distribution, and the screening technology generates a signal on the borrower's type. This is because both lenders are risk-neutral so only care about the expected profits. Results also stay largely unchanged if instead, borrowers' type distribution is continuous, and the fintech firm's screening technology generates a signal on the eventual outcome of the project (which is still binary). The model is more complicated if the borrowers' type distribution is continuous, and the fintech firm's screening technology generates a signal on the borrower's type.

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A Appendix

A.1 Proofs

Proof of Lemma 1

Proof. We prove by contradiction. There are two cases: $\hat{R}_B \in (\underline{R}_F, R)$ and $\hat{R}_B = R$.

Suppose the bank bids some $\hat{R}_B \in (\underline{R}_F, R)$ with a probability mass Δ_B, then for any $\varepsilon > 0$, the fintech firm must bid with a strictly positive probability on $(\hat{R}_B, \hat{R}_B + \varepsilon]$. If instead there exists an ε^* such that $F_B(\hat{R}_B + \varepsilon^*) - F_B(\hat{R}_B) = 0$, then the bank earns strictly higher profits by bidding $\hat{R}_B + \frac{\varepsilon^*}{2}$ compared to bidding $\hat{R}_B$, a contradiction. By bidding $\hat{R}_B + \varepsilon$, a fintech firm with a good signal receives profits $\Big(1 - F_B(\hat{R}_B + \varepsilon)\Big)(\hat{R}_B + \varepsilon) - r_E$. By bidding $\hat{R}_B - \varepsilon$, a fintech firm with a good signal receives profits $\Big(1 - F_B(\hat{R}_B - \varepsilon)\Big)(\hat{R}_B - \varepsilon) - r_E$. The difference between the two $\Big(1 - F_B(\hat{R}_B - \varepsilon)\Big)(\hat{R}_B - \varepsilon) - \Big(1 - F_B(\hat{R}_B + \varepsilon)\Big)(\hat{R}_B + \varepsilon) \to \Delta_B \hat{R}_B > 0$ as $\varepsilon \downarrow 0$, a deviation.

Suppose the bank bids $\hat{R}_B = R$ with a probability mass Δ_B. Then bidding $R - \varepsilon$ strictly dominates R for the fintech firm. Therefore, the fintech firm never bids R in equilibrium. By bidding R, the bank only lends to a borrower with a bad signal and makes a loss, a contradiction.

To rule out intervals, we prove by contradiction. Let (R_1, R_2) be the interval where the right boundary R_2 is closest to R.[11] This implies the bank is indifferent between any bid $\hat{R}_B \in (R_1, R_2)$. Then the fintech firm must also bid on the same interval (R_1, R_2) without any gaps $(\hat{R}_1, \hat{R}_2)$. Otherwise, bidding $\hat{R}_2$ strictly dominates $\hat{R}_1$ for the bank.

Next, it must be that $R_2 = R$. If not, bidding R is dominated by bidding R_2 from the perspective of the fintech firm.

Finally, we show that $R_2 = R$ leads to a contradiction. Depending on whether the fintech firm bids R with a probability mass or not, there are two cases. If the fintech firm does not bid R with a probability mass, then by bidding R the bank almost surely lends to a borrower with a bad signal, which results in a loss - a contradiction. If the fintech firm bids R with a probability mass, by bidding R, it can only win if the bank does not bid at all with a positive probability (since the ties are broken in favor of the bank, and bank bid $R_B \leq R$ would win against fintech firm's $R_F = R$). The fact that not bidding is part of the bank's equilibrium strategy is a contradiction because not bidding and getting zero expected profits is strictly dominated by bidding $\underline{R}_F$ and receiving positive expected profits. Hence, by bidding R the fintech firm never wins and receives zero profits. Since the fintech firm is indifferent between any bids it makes it must be that fintech firm makes zero profits for any bid $R_F \in (R_1, R)$. This is possible only if the fintech firm never wins for any of those bids which is impossible when the bank is also bidding in (R_1, R) without mass points. □

Lemma 3. *If $\underline{R}_F < \underline{R}_B < R$, the bank can not offer an interest rate with a positive probability mass.*

[11] Since we have ruled out mass probabilities, the same result holds if the interval is half-open or open.

Proof of Lemma 3

Proof. The proof is the same as Lemma 1. □

Proof of Lemma 2

Proof. We begin by arguing that the fintech firm must also adopt a mixed strategy when receiving a good signal. Suppose on the contrary that the fintech firm chooses a pure strategy $R_F(g) \in [\underline{R}_B, R]$ when receiving a good signal, and do not bid ($R_F(b) = \infty$) when receiving a bad signal. Then, any bid of the bank $R_B \in (R_F(g), R]$ wins if and only if the borrower is of the low type, which incurs a loss. This is the winner's curse problem, implying that the bank cannot attach positive probability on bidding $(R_F(g), R]$. On the other hand, if the bank only attaches positive probability on bidding $[\underline{R}_B, R_F(g)]$, the fintech firm has an incentive to deviate to $R_F(g) - \varepsilon$. We have established contradiction in both cases. Hence, the fintech firm has to play a mixed strategy over some interval.

We follow similar steps as the proof in Lemma 1 to show that there are no holes, and the right boundary of the interval must be R. Therefore, when both institutions randomize their bids, the interval is $[R_1, R]$ for $R_1 \geq \underline{R}_B$ since the bank must make non-negative profits. When both the bank and the fintech firm randomize their bids in $[R_1, R_2]$, it must be that $R_2 = R$. Otherwise, offering R_2 is strictly dominated by bidding R and the fintech firm would prefer to bid R instead of mixing in $[R_1, R_2]$. Randomizing by both parties in $[R_1, R]$ also implies that the fintech firm must have a positive mass of bids at R. This is to assure the bank's incentive by alleviating the winner's curse problem. Absent such a mass, when the bank's bid gets close to R, almost surely it can only win when the fintech firm receives a bad signal, which results in a loss.

To pin down R_1 we exploit the indifference condition of the fintech firm. On the one hand, the fintech firm can bid R_1 and win the bidding game almost for sure, generating expected profits $P(\mu_g)R_1 - r_E > 0$. On the other hand, the fintech firm can bid R and win whenever the bank bids above R (or, equivalently, does not bid), generating expected profits $(1 - F_B(R)) \cdot (P(\mu_g)R - r_E)$. Indifference between the two options implies that $F_B(R) < 1$, i.e., that the bank does not bid at all with a positive probability. This can only happen when the bank is indifferent between winning and losing for every bid it submits. As a result, $R_1 = \underline{R}_B$. □

Proof of Corollary 1

Proof. It is easily derived that

$$\frac{d\bar{\mu}}{dr_F} = \frac{-(1-p)(1-\lambda)r_B}{\{\lambda(1-\alpha p)r_B + [(1-p) - \lambda(1-\alpha p)]r_F\}^2} < 0$$
$$\frac{d\bar{\mu}}{dr_B} = \frac{(1-p)(1-\lambda)r_F}{\{\lambda(1-\alpha p)r_B + [(1-p) - \lambda(1-\alpha p)]r_F\}^2} > 0$$
$$\frac{d\underline{\mu}}{dr_B} = \frac{(1-p)R - \lambda(1-\alpha)(r_F - pR)}{[(1-p)R - \lambda(1-\alpha)(r_F - r_B)]^2}.$$

To show the last term is positive, it suffices to show that

$$(1-p)R > (r_F - pR) \Longleftrightarrow R > r_F.$$

Finally, $\frac{d\underline{\mu}}{dr_F} > 0$ is obvious. □

Proof of Proposition 2

Proof. Start with total bank profits:

$$V_B + V_i = \begin{cases} \mu\Pi_B & \text{for } \mu \le \bar{\mu} \\ P(\mu)r_E - r_B & \text{for } \mu \ge \bar{\mu} \end{cases} \tag{21}$$

where we used that for $\mu < \underline{\mu}$ we have $V_B = 0$ and $V_i = \mu\Pi_B$. For $\mu \in (\underline{\mu}, \bar{\mu})$ the bank is indifferent between losing and winning the bidding competition, hence the total profits are equal to profits when the bank always loses, i.e. $\mu\Pi_B$. Finally, for $\mu > \bar{\mu}$ the bank always bids $\underline{R}_F = r_E$ and wins. Clearly, $V_B(\mu) + V_i(\mu)$ is continuous and increasing.

Next, turn to fintech firm profits:

$$V_F = \begin{cases} \mu(R - r_E) & \text{for } \mu \le \underline{\mu} \\ \mu(\underline{R}_B - r_E) & \text{for } \mu \in (\underline{\mu}, \bar{\mu}) \\ 0 & \text{for } \mu \ge \bar{\mu} \end{cases} \tag{22}$$

Clearly, V_F is positive and increasing for $0 < \mu < \underline{\mu}$. And it equal to 0 for $\mu > \bar{\mu}$. So, overall it is non-monotone.

In $\mu \in (\underline{\mu}, \bar{\mu})$ the fintech firm's profits are

$$\begin{aligned} V_F &= \mu(\underline{R}_B - r_E) \\ &= \mu\left(\frac{r_B + \mu\Pi_B}{p + \mu(1-p)} - r_E\right) \\ &= \mu\frac{r_B + \mu\Pi_B - (p + \mu(1-p)r_E}{p + \mu(1-p)} \\ &= \mu\frac{r_B - pr_E - \mu((1-p)r_E - \Pi_B)}{p + \mu(1-p)} \\ &\sim a \cdot \mu \cdot \frac{b - \mu}{\mu + c} \end{aligned}$$

At $\mu = \bar{\mu}$ the fintech firm profit should be decreasing in μ, since $V_F(\bar{\mu}) = 0$ and $V_F(\mu) > 0$ for $\mu < \bar{\mu}$. Given the shape of V_F as a function of μ (linear minus a $1/\mu$ term) the fintech firm profits can either be (a) decreasing everywhere in $(\underline{\mu}, \bar{\mu})$ or (b) be hump-shaped, i.e., increasing in $(\underline{\mu}, \mu^*)$ and decreasing in $(\mu^*, \bar{\mu})$.

Next we consider the borrower surplus. To prove that it is increasing in μ we will rely on first order dominance of the cdfs F_B and F_F.

$$F_B(x) = \frac{x - \underline{R}_B}{x - \underline{R}_F} = \frac{x - \underline{R}_B(\mu)}{x - r_E}$$

Since $\underline{R}_B(\mu)$ is decreasing in μ, we have $F_B(x)$ is increasing in μ. Hence F_B at μ' dominates F_B at $\mu < \mu'$ in the FOSD sense.

Similarly,

$$F_F(x) = \frac{P(\mu)x - r_B - \mu\Pi_B}{\mu(x - r_B - \Pi_B)}$$
$$1 - F_F(x) = \frac{1-\mu}{\mu} \cdot \frac{r_B - px}{x - r_B - \Pi_B}.$$

Since $(1-\mu)/\mu = 1/\mu - 1$ is decreasing in μ, $F_F(x)$ is increasing in μ. Hence F_F at μ' dominates F_F at $\mu < \mu'$ in the FOSD sense.

Since both cdfs increase in the FOSD with μ, both types of borrowers prefer lower rates to higher, their surplus is increasing in μ.

□

Proof of Proposition 3.

Proof. First, establish the cutoffs of different lending regions. Define $\underline{\mu}_\lambda$ as a solution to

$$\underline{R}_B(\mu, \lambda) = R \tag{23}$$

and $\bar{\mu}_\lambda$ as a solution to

$$\underline{R}_B(\mu, \lambda) = \underline{R}_F(\mu, \lambda). \tag{24}$$

Then

$$\underline{\mu}_0 = \frac{r_B/R - p}{1-p} \qquad \bar{\mu}_0 = \frac{r_B/r_F - p}{1-p} \qquad \underline{\mu}_1 = \frac{r_B/R - p}{1 - p - (1-\alpha)(r_F - r_B)/R} \qquad \bar{\mu}_1 = 1 \tag{25}$$

1. Start with borrowers.

   Two cases are possible. If at $\bar{\mu}_0 < \underline{\mu}_1$ then only the fintech firm participates and bids R in which case the both types of borrowers get a zero payoff. Clearly, they are better at $\mu = \bar{\mu}_0$ without the partnership funding market.

   If $\bar{\mu}_0 > \underline{\mu}_1$ then both parties bid with CDFs F_B and F_F at $\mu = \bar{\mu}_0$ with $\lambda = 1$ and the high type's payoff is

$$V_H = R - \mathbf{E}[\min(\tilde{R}_B, \tilde{R}_F)]. \tag{26}$$

First, let's simplify the expected minimal bid:

$$
\begin{aligned}
&\mathbf{E}[\min(\tilde{R}_F, \tilde{R}_F)] = \int_{\underline{R}_B}^{R} xd[1-(1-F_F(x))(1-F_B(x))] \\
&= -\int_{\underline{R}_B}^{R} xd[(1-F_F(x))(1-F_B(x))] \\
&= R(F_F(R)-F_F(R-))(1-F_B(R-)) - \int_{\underline{R}_B}^{R-} xd[(1-F_F(x))(1-F_B(x))] \\
&= R(F_F(R)-F_F(R-))(1-F_B(R-)) - x[(1-F_F(x))(1-F_B(x))]\Big|_{\underline{R}_B}^{R-} \\
&+ \int_{\underline{R}_B}^{R-} [(1-F_F(x))(1-F_B(x))]dx \\
&= \underbrace{R(F_F(R)-F_F(R-))(1-F_B(R-)) - R[(1-F_F(R-))(1-F_B(R-))]}_{=0} + \underline{R}_B \\
&+ \int_{\underline{R}_B}^{R-} [(1-F_F(x))(1-F_B(x))]dx \\
&= \underline{R}_B + \int_{\underline{R}_B}^{R-} [(1-F_F(x))(1-F_B(x))]dx.
\end{aligned}
$$

The high-type borrower in a pool characterized by $\bar{\mu}_0$ is better off without the partnership funding market if

$$
\begin{aligned}
r_F &< \underline{R}_B + \int_{\underline{R}_B}^{R-} [(1-F_F(x))(1-F_B(x))]dx \\
r_F - \underline{R}_B &< \int_{\underline{R}_B}^{R-} [(1-F_F(x))(1-F_B(x))]dx.
\end{aligned}
$$

We evaluate the LHS at $\bar{\mu}_0$:

$$
r_F - \underline{R}_B = r_F - \frac{r_B + \bar{\mu}_0 \Pi_B}{r_B/r_F} = -\frac{\bar{\mu}_0 \Pi_B}{r_B/r_F} < 0.
$$

For the RHS, we know it is positive, so the inequality always holds at $\bar{\mu}_0$.

For the low-type borrower, the payoff with partnership funding market is

$$
\begin{aligned}
V_L(\lambda = 1) &= (1 - F_B(R)) \cdot p(R - \mathbf{E}[\tilde{R}_B \,|\tilde{R}_B < \infty]) \\
&< p(R - \mathbf{E}[\tilde{R}_B \,|\tilde{R}_B < \infty]) \\
&< p(R - \mathbf{E}[\min(\tilde{R}_F, \tilde{R}_B)]) \\
&< p(R - r_F) \\
&= V_L(\lambda = 0).
\end{aligned}
$$

We have established that when $V_\theta(\lambda = 1) < V_\theta(\lambda = 0)$ at $\mu = \bar{\mu}_0$. For $\mu > \bar{\mu}_0$ borrower's surplus $V_\theta(\lambda = 0)$ is constant, while $V_\theta(\lambda = 1)$ is strictly increasing.

When $\mu = 1$ the bank always bids r_E and always wins. With $\lambda = 1$ we have $r_E = r_B$ and with $\lambda = 0$ we have $r_E = r_F$, hence $V_\theta(\lambda = 1) > V_\theta(\lambda = 0)$. Hence, there exists $\mu^*_\theta > \bar{\mu}_0$ such that $V_\theta(\lambda = 1, \mu^*_\theta) = V_\theta(\lambda = 0, \mu^*_\theta)$. Borrowers are better off with partnership funding market for $\mu > \mu^*_\theta$ and better off without partnership funding market for $\mu < \mu^*_\theta$

For $\underline{\mu}_1 < \mu < \bar{\mu}_0$ we have non-trivial bidding by both bank and fintech firm regardless of λ. Hence the payoff of the low type player is determined via the expected minimal bid

$$\mathbf{E}[\min(\tilde{R}_F, \tilde{R}_F)] = \underline{R}_B + \int_{\underline{R}_B}^{R-} [(1 - F_F(x))(1 - F_B(x))]dx. \tag{27}$$

To see how the expected minimal bid varies with λ notice that we need to take only the derivative inside of the integral since the derivative w.r.t. $\underline{R}_B$ in the above expression cancels out.

Recall that

$$F_B(x) = \frac{x - \underline{R}_B}{x - r_E}.$$

Since $\underline{R}_B$ is increasing in λ and r_E is decreasing in λ, the cdf $F_B(x)$ is decreasing in λ. As a result, $1 - F_B(x)$ term is increasing in λ.

Similarly

$$\frac{\partial}{\partial \mu} F_F(x) \sim \frac{\partial}{\partial \Pi_B} F_F(x) \sim \frac{px - r_B}{()^2} < 0.$$

As a result, the term $1 - F_F(x)$ is increasing in μ.

Hence, the whole integral above is increasing in μ (it is a product of two non-negative increasing terms). Since the expected minimum bid is increasing in μ the payoff of the high type is decreasing in μ.

For the low type the welfare comparison comes from the fact that $F_B(x)$ id decreasing in λ. Hence $F_B(x)$ for $\lambda = 0$ dominates in the FOSD sense $F_B(x)$ for $\lambda = 1$. Since the low type prefers lower bids, it prefers the cdf F_B at $\lambda = 0$.

2. Next, consider the fintech firm. For $\lambda = 1$ the fintech firm profits are given by

$$V_F = \begin{cases} \mu(R - r_E) & \text{for } \mu \le \underline{\mu}_1 \\ \mu(\underline{R}_B - r_E) & \text{for } \mu \ge \underline{\mu}_1 \end{cases} \tag{28}$$

with $r_E = \alpha r_B + (1 - \alpha) r_F$ and $\underline{R}_B = \frac{r_B + \mu(1-\alpha)(r_F - r_B)}{P(\mu)}$. Note that $V_F = 0$ at $\mu = 0$ and at $\mu = 1$ and reaches it's maximum at $\mu = \underline{\mu}_1$.

For $\lambda = 0$ the fintech firm profits are given by

$$V_F = \begin{cases} \mu(R - r_F) & \text{for } \mu \leq \underline{\mu}_0 \\ \mu\left(\frac{r_B}{P(\mu)} - r_F\right) & \text{for } \mu \in (\underline{\mu}_0, \bar{\mu}_0) \\ 0 & \text{for } \mu \geq \bar{\mu}_0 \end{cases} \tag{29}$$

Note that $V_F = 0$ at $\mu = \bar{\mu}_0$ and reaches it's maximum at $\mu = \underline{\mu}_0$.

Comparison of V_F with and without the partnership funding market is obvious: for $\lambda = 1$ V_F starts with a higher slope, at $\mu = 0$, reaches its peak later (at $\underline{\mu}_1 > \underline{\mu}_0$) and stays positive for longer. Moreover, for $\mu \in [\underline{\mu}_1, \bar{\mu}_0]$, we have

$$V_F(\lambda = 1) - V_F(\lambda = 0) = \mu(\underline{R}_B - r_E) - \mu\left(\frac{r_B}{P(\mu)} - r_F\right).$$

To show this is positive, we need

$$\begin{aligned} \underline{R}_B - r_E &> \frac{r_B}{P(\mu)} - r_F \\ \frac{r_B + \mu(1-\alpha)(r_F - r_B)}{P(\mu)} - r_E &> \frac{r_B}{P(\mu)} - r_F \\ r_B + \mu(1-\alpha)(r_F - r_B) - P(\mu)r_E &> r_B - P(\mu)r_F \\ \mu(1-\alpha)(r_F - r_B) &> P(\mu)\left(r_E - r_F\right). \end{aligned}$$

The last inequality holds because the LHS is positive whereas the RHS is negative. Hence, it dominates V_F for $\lambda = 0$ everywhere.

3. Next, consider the bank. When $\lambda = 1$, then the total bank profits are

$$V_B + V_i = \mu\Pi_B = \mu(1-\alpha)(r_F - r_B). \tag{30}$$

For $\mu < \underline{\mu}_1$ this is correct since $V_B = 0$ and for $\mu > \underline{\mu}_1$ this is correct since the bank is indifferent between winning and losing the bidding game.

When $\lambda = 0$, then the total bank profits are

$$V_B + V_i = \begin{cases} 0 & \text{for } \mu \leq \bar{\mu}_0 \\ P(\mu)r_F - r_B & \text{for } \mu \geq \bar{\mu}_0 \end{cases} \tag{31}$$

For $\mu < \underline{\mu}_0$ this is correct since $V_B = V_i = 0$ and for $\mu \in (\underline{\mu}_0, \bar{\mu}_0)$ this is correct since the bank is indifferent between winning and losing the bidding game. Finally, for $\mu > \bar{\mu}_0$ the bank simply bids r_F and always wins.

To compare the total profits of the bank, we only need to check that at $\mu = 1$ the bank is better off without the partnership funding markets. This is true, since $r_F - r_B > (1-\alpha)(r_F - r_B)$. Hence, there exists a $\mu_B^* \in (\bar{\mu}_0, 1)$ such that

$$\mu_B^*(1-\alpha)(r_F - r_B) = P(\mu_B^*) r_F - r_B \tag{32}$$

and the bank is better off without partnership funding market for $\mu > \mu_B^*$ and is better off with partnership funding market for $\mu < \mu_B^*$.

4. Finally, consider overall welfare.

   Welfare is clearly higher with $\lambda = 1$ vs. $\lambda = 0$. With $\lambda = 1$ the high type projects are always funded at a cost r_B, hence the funding inefficiency does not exist, while it strictly positive for $\lambda = 0$.

   Similarly, lending inefficiency with $\lambda = 1$ is also smaller, since the probability that the bank bids $F_B(x)$ is decreasing in λ.

□

Proof of Corollary 3

With type-I error $e_1 > 0$ the fintech is still sure that it is facing a high-type borrower upon receiving a good signal, i.e., $\mu_g = 1$. Hence, the threshold $\underline{R}_F = r_E$ remains unchanged.

However, curse-free bid of the bank $\underline{R}_B$ is affected through the expected partnership profits. Instead of bidding for all high-type borrowers (μ) the fintech only bids for those that are identified by the good signal ($(1-e_1)\mu$) hence,

$$P(\mu)R_B - r_B \geq (1-e_1)\mu\Pi_B \Rightarrow R_B \geq \underline{R}_B := \frac{r_B + (1-e_1)\mu\Pi_B}{P(\mu)}$$

Direct comparison of $\underline{R}_B$ vs. $\underline{R}_F$ and $\underline{R}_B$ vs. R give rise to the $\bar{\mu}$ and $\underline{\mu}$ respectively:

$$\bar{\mu}_1 = \frac{r_B(1-\lambda\alpha p) - p(1-\lambda\alpha)r_F}{(1-p)r_E - (1-e_1)\lambda(1-\alpha)(r_F - r_B)}$$
$$\underline{\mu}_1 = \frac{r_B - pR}{(1-p)R - (1-\alpha)(1-e_1)(r_F - r_B)}.$$

Equilibrium construction closely follows the proof of Proposition 1 via Lemmas 1 and 2.

Comparative statics of $\bar{\mu}_1$ and $\underline{\mu}_1$ in e_1 is obvious - both thresholds are decreasing in e_1.

Next, turn to equilibrium profits. For $\mu < \underline{\mu}_1$ the fintech's and bank's profits are

$$V_F = (1-e_1)\mu(R - r_E) \qquad V_B + V_i = (1-e_1)\mu\Pi_B$$

respectively, and both are decreasing in e_1.

For $\underline{\mu}_1 < \mu < \bar{\mu}_1$ the fintech's and bank's profits are

$$V_F = (1-e_1)\mu(\underline{R}_B - r_E) \qquad V_B + V_i = (1-e_1)\mu\Pi_B$$

respectively, and both are decreasing in e_1 because $\underline{R}_B$ is also decreasing in e_1.

For $\mu > \bar{\mu}_1$ the fintech's and bank's profits are

$$V_F = 0 \qquad V_B + V_i = P(\mu)r_E - r_B$$

respectively - the are not affected by e_1.

Proof of Corollary 4

With type-II error $e_2 > 0$ the fintech is no longer sure that it is facing a high-type borrower upon receiving a good signal, i.e., $\mu_g = \mu/[\mu + e_2(1-\mu)] < \mu$. Hence, the fintech's zero profit bid is $\underline{R}_F = \frac{r_E}{P(\mu_g)}$.

The curse-free bid of the bank $\underline{R}_B$ is affected through the expected partnership profits. Instead of bidding for only high-type borrowers (μ) the fintech bids for all borrowers those that are identified by the good signal ($\mu + e_2(1-\mu)$) hence,

$$P(\mu)R_B - r_B \geq [\mu + e_2(1-\mu)]\Pi_B \Rightarrow R_B \geq \underline{R}_B := \frac{r_B + [\mu + e_2(1-\mu)]\Pi_B}{P(\mu)}$$

Direct comparison of $\underline{R}_B$ vs. $\underline{R}_F$ and $\underline{R}_B$ vs. R give rise to the $\bar{\mu}$ and $\underline{\mu}$ respectively:

$$\bar{\mu}_2 = \frac{(1-\lambda\alpha p)r_B - p(1-\lambda\alpha)r_F + e_2\Pi_B}{\lambda(1-\alpha p)r_B + [1-p-\lambda(1-\alpha p)]r_F + e_2\Pi_B}$$
$$\underline{\mu}_2 = \frac{r_B - pR + e_2\Pi_B}{(1-p)R - \Pi_B + e_2\Pi_B}.$$

Explicit derivations show that $\underline{\mu}_2$ is increasing in e_2 (since collaborating is becoming more attractive for the bank) and $\bar{\mu}_2$ is decreasing in e_2 (since fintech is becoming less competitive).

Equilibrium construction closely follows the proof of Proposition 1 via Lemmas 1 and 2.

Next, turn to equilibrium profits. For $\mu < \underline{\mu}_2$ the fintech's and bank's profits are

$$V_F = \mu(R - r_E) + e_2(1-\mu)(pR - r_E) \qquad V_B + V_i = [\mu + e_2(1-\mu)]\Pi_B$$

respectively. Bank's profits are increasing in e_2 due to higher volume of partnership lending and fintech's profits are decreasing in e_2 since low-type borrowers are negative NPV.

For $\underline{\mu}_2 < \mu < \bar{\mu}_2$ the fintech's and bank's profits are

$$V_F = \mu(\underline{R}_B - r_E) + e_2(1-\mu)(p\underline{R}_B - r_E) \qquad V_B + V_i = [\mu + e_2(1-\mu)]\Pi_B$$

respectively. Bank's profits are increasing in e_2 due to higher volume of partnership lending. Fintech's profits are decreasing because

$$\frac{d}{de_2}V_F = (1-\mu)\left(\mu\frac{\Pi_B}{P(\mu)} + (p\underline{R}_B - r_E) + e_2 p\frac{(1-\mu)\Pi_B}{P(\mu)}\right) < 0$$

for small enough e_2.

For $\mu > \bar{\mu}_1$ the fintech's and bank's profits are

$$V_F = 0 \qquad V_B + V_i = P(\mu)\frac{r_E}{P(\mu_g)} - r_B$$

respectively. Clearly, bank's profit is increasing in e_2.

Proof of Proposition 4

Proof. Start with the fintech firm. In case of borrowing from a non-competing bank, fintech's profits are

$$V_F^{NC} = \begin{cases} \mu(R - r_E) & \text{for } \mu < \underline{\mu}_{NC}; \\ \mu\left(\frac{r_B}{P(\mu)} - r_E\right) & \text{for } \mu \in [\underline{\mu}_{NC}, \bar{\mu}_{NC}]; \\ 0 & \text{for } \mu > \bar{\mu}_{NC}. \end{cases}$$

And in case of a partnership the profits are

$$V_F = \begin{cases} \mu(R - r_E) & \text{for } \mu < \underline{\mu}; \\ \mu\left(\frac{r_B + \mu\Pi_B}{P(\mu)} - r_E\right) & \text{for } \mu \in [\underline{\mu}, \bar{\mu}]; \\ 0 & \text{for } \mu > \bar{\mu}. \end{cases}$$

Both profit functions have a hump shape, and have the same linear part for μ close to 0. However, V_F has a longer linear part ($\underline{\mu} > \underline{\mu}_{NC}$), has a higher non-linear part ($(r_B + \mu\Pi_B)/P(\mu) > r_B/P(\mu)$), and hits zero later ($\bar{\mu} > \bar{\mu}_{NC}$). Hence, we have $V_F(\mu) \geq V_F^{NC}(\mu)$ for all $\mu \in [0, 1]$. Moreover, for $\mu \in (\underline{\mu}_{NC}, \bar{\mu})$ the profits in case of partnership are strictly higher, i.e., $V_F(\mu) > V_F^{NC}(\mu)$.

Next, consider the bank. With third party financing the total bank profits are given by

$$V_B^{NC} + V_i^{NC} = \begin{cases} 0, & \text{if } \mu < \bar{\mu}^{NC} \\ P(\mu)r_E - r_B, & \text{if } \mu > \bar{\mu}^{NC} \end{cases}$$

And in case of a partnership the profits are

$$V_B + V_i = \begin{cases} \mu\Pi_B & \text{if } \mu < \bar{\mu}; \\ P(\mu)r_E - r_B, & \text{if } \mu > \bar{\mu} \end{cases}$$

Both profit functions have a piece-wise linear shape, and are equal to each other for $\mu > \bar{\mu}$. However, in case of partnership lending the bank earns positive profits for $\mu < \bar{\mu}_{NC}$ (as opposed to 0) and has higher joint direct and partnership profits if $\mu \in (\bar{\mu}_{NC}, \bar{\mu})$. Hence, we have $V_B + V_i(\mu) \geq V_B^{NC} + V_i^{NC}(\mu)$ for all $\mu \in [0, 1]$. Moreover, for $\mu \in (0, \bar{\mu})$ the profits in case of partnership are strictly higher, i.e., $V_B + V_i(\mu) > V_B^{NC} + V_i^{NC}(\mu)$.

Finally, consider the borrowers who face the bid distributions

$$F_F^{NC}(x) = \frac{P(\mu)x - r_B}{\mu(x - r_B)} \qquad F_B^{NC}(x) = \frac{x - r_B/P(\mu)}{x - r_E}$$
$$F_F(x) = \frac{P(\mu)x - r_B - \mu\Pi_B}{\mu(x - r_B - \Pi_B)} \qquad F_B(x) = \frac{x - (r_B + \mu\Pi_B)/P(\mu)}{x - r_E}$$

Moving from third party lending to the case with partnership funding reduces both F_F and F_B in the FOSD sense. Hence the borrowers suffer from higher bids by both the fintech firm and the bank.

□

A.2 Detailed Analysis of Subsection 4.2

Fintech firm has the convenience benefits only. Consider the model in which the fintech firm does not have information advantage and only has the convenience advantage. That is, both bank and fintech firm share a common prior that the fraction of high-type borrowers in the pool is μ. Moreover, when faced with a bid R_B from a bank and R_F from a fintech firm the borrowers will choose the bank whenever $R_B < R_F - \Delta_F$. The partnership funding market allows the fintech firm to obtain funding at a lower rate and creates an additional source of profits for the bank. Similar to the main model the fintech firm's effective funding rate is r_E and the per loan partnership funding profits of the bank are Π_B.

Define the following thresholds: $\underline{\mu}_C < \hat{\mu}_C$ as the solutions of

$$R \cdot P(\underline{\mu}_C) = r_B \qquad \text{and} \qquad R \cdot P(\hat{\mu}_C) = r_E$$

respectively.

For $\mu < \underline{\mu}_C$ we have $R \cdot P(\mu) < r_B < r_E$, hence neither lender participates.

For $\mu \in (\underline{\mu}_C, \hat{\mu}_C)$ we have $r_B < R \cdot P(\mu) < r_E$, hence only the bank participates and charges a rate R.

For $\mu > \hat{\mu}_C$ we have $r_B < r_E < R \cdot P(\mu)$, hence both lenders could participate. Who wins the bidding game depends on the size of the fintech firm's convenience advantage. Due to the presence of the partnership funding market when $\mu > \hat{\mu}_C$, the lowest rate the bank is willing to charge is $\underline{R}_B(\mu) \equiv \frac{r_B + \Pi_B}{P(\mu)}$ (the outside option is to retreat to the partnership funding market) and the fintech firm is willing to go as low as $\underline{R}_F(\mu) \equiv \frac{r_E}{P(\mu)}$ (the outside option is not participating and generating zero profit). Note that for $\mu > \hat{\mu}_C$ we have $\underline{R}_B(\mu) \leq \underline{R}_F(\mu) < R$ and the inequality is strict whenever $\lambda < 1$. The fintech firm can undercut the bank whenever $\underline{R}_F(\mu) < \underline{R}_B(\mu) + \Delta_F$ or, equivalently, whenever $P(\mu)\Delta_F > (1 - \lambda)(r_F - r_B)$. This inequality gives rise to a cut-off $\bar{\mu}_C$ such that for $\mu > \bar{\mu}_C$ the fintech firm is able to successfully undercut the bank and lend, and for $\mu \in (\hat{\mu}_C, \bar{\mu}_C)$ the bank is able to undercut the fintech firm and lend. In particular, $\overline{\mu}_C$ is given by

$$\overline{\mu}_C \equiv \frac{(1 - \lambda)(r_F - r_B)}{\Delta_F(1 - p)} - \frac{p}{1 - p}.$$

Hence, generically, the equilibrium has four regions: $\mu < \underline{\mu}_C$ - no lending (N); $\mu \in (\underline{\mu}_C, \hat{\mu}_C)$ - monopoly bank lending (MB); $\mu \in (\hat{\mu}_C, \bar{\mu}_C)$ - competitive bank lending (CB); $\mu \in (\bar{\mu}_C, 1]$ - competitive fintech lending

(CF).

Depending on the model parameters either of the regions (CB) or (CF) maybe be absent depending on how $\bar{\mu}_C$ compares with 1 and $\hat{\mu}_C$. If $\bar{\mu}_C \geq 1$, or $\Delta_F \leq (1-\lambda)(r_F - r_B)$, then the region (CF) is absent. If $\bar{\mu}_C \leq \hat{\mu}_C$, or $\Delta_F \geq (1-\lambda)(r_F - r_B) \cdot \frac{R}{r_E}$, then the region (CB) is absent. In the remaining case $\bar{\mu}_C \in (\hat{\mu}_C, 1)$ both regions (CB) and (CF) are present.

Fintech Convenience Benefits with Screening Advantage. The logic of Proposition 1 goes through in case fintech has additional convenience benefits.

To proceed, we need to assume the fintech firm's convenience benefit is small enough compared with the financing cost, i.e., $(1-p)(r_E - \Delta_F) - \Pi_B > 0$. There are three cases:

1. When $\underline{R}_B(\mu) + \Delta_F \geq R$, or
$$\mu \leq \underline{\mu} \equiv \frac{r_B - p(R - \Delta_F)}{(1-p)(R - \Delta_F) - \Pi_B},$$
the bank never lends and only derives profit from the partnership; the fintech firm offers a rate R if and only if the good signal arrives.

2. When $\underline{R}_F < \underline{R}_B(\mu) + \Delta_F < R$, or or $\mu \in (\underline{\mu}, \overline{\mu})$ with
$$\overline{\mu} \equiv \frac{r_B - p(r_E - \Delta_F)}{(1-p)(r_E - \Delta_F) - \Pi_B},$$
the bank retreats from the competition with a positive probability mass, and the fintech firm's support of mixed strategy starts with $\underline{R}_B + \Delta_F$.

3. When $\underline{R}_B(\mu) + \Delta_F < \underline{R}_F$, or $\mu \in [\overline{\mu}, 1)$ the bank always outbids the fintech firm and offers an interest rate $\underline{R}_F - \Delta_F$.

Sticky Banking Relationships. Suppose now that the bank has a convenience benefit $\Delta_B > 0$, i.e., it wins the bid as long as $R_B + \Delta_B < R_F$; while the fintech firm retains the informational advantage as in the benchmark model. This setting essentially lowers the minimal bid of the bank and extends the range of beliefs that the bank can undercut the fintech firm. We can follow the logic of Proposition 1:

1. When $\underline{R}_B(\mu) \geq R$ (low average quality, dominant information advantage), or
$$\mu \leq \underline{\mu} \equiv \frac{r_B - pR}{(1-p)R - \Pi_B},$$
the bank never lends and only derives profit from the partnership; the fintech firm offers a rate R if and only if the good signal arrives;

2. When $\underline{R}_F + \Delta_B < \underline{R}_B(\mu) < R$ (intermediate quality, comparable banking and information advantage), or $\mu \in (\underline{\mu}, \overline{\mu})$ with
$$\overline{\mu} \equiv \frac{r_B - p(r_E + \Delta_B)}{(1-p)(r_E + \Delta_B) - \Pi_B},$$

the bank retreats from the competition with a positive probability mass, and the bank's support of mixed strategy starts with $\underline{R}_B$.

3. When $\underline{R}_B(\mu) \leq \underline{R}_F + \Delta_B$ (high average quality, dominant banking advantage), or $\mu \in [\overline{\mu}, 1)$, the bank always outbids the fintech firm and offers an interest rate $\min\{\underline{R}_F + \Delta_B, R\}$.

Note that in the third range, $\Pi_B \equiv 0$ because the fintech firm never lends, and that $\underline{R}_B(\mu)$ should have been changed accordingly to $r_B/P(\mu)$. However, the original condition $\underline{R}_B(\mu) \leq \underline{R}_F + \Delta_B$ implies $r_B/P(\mu) < \underline{R}_F + \Delta_B$, since Π_B jumps to 0 at the cutoff. As a result, this does not impact the discussion of the cutoffs of μ.

A.3 Detailed Analysis of Section 4.4

Let us first provide the specific thresholds.

$$\begin{aligned}
\underline{R}_B^{2F} &= \frac{r_B + \mu(1-e_1^2)\Pi_B}{\mu + (1-\mu)p} \\
\underline{R}_F^{2F} &= r_E \\
\bar{\mu}^{2F} &= \frac{r_B - pr_E}{r_E(1-p) - (1-e_1^2)\Pi_B} \\
\underline{\mu}^{2F} &= \frac{r_B - p[e_1 R + (1-e_1)r_E]}{(1-p)[e_1 R + (1-e_1)r_E] - (1-e_1^2)\Pi_B}.
\end{aligned}$$

The threshold $\bar{R}_B^{2F}$ is determined from Equation (34) and (40) later in this subsection.

Similar to the analysis of Section 3. Define $\underline{R}_B^{2F}$ as the lowest rate the bank is willing to bid in the absence of the winner's curse:

$$P(\mu)\underline{R}_B^{2F} - r_B = \mu(1-e_1^2)\Pi_B \Rightarrow \underline{R}_B^{2F} := \frac{r_B + \mu(1-e_1^2)\Pi_B}{\mu + (1-\mu)p},$$

where e_1 is the Type I error. With only Type I error, conditional on receiving a good signal, a fintech is certain that it is facing a high-quality borrower. Consequently, the lowest rate it is willing to offer is

$$\underline{R}_F^{2F} = r_E.$$

The signals that the two competing fintechs receive generate three events: (g, g) - both fintechs receive good signals, (b, b) - both fintechs receive bad signals, and (g, b) - fintechs receive conflicting signals. The ex-ante probabilities of these events and the corresponding posteriors are as follows:

$$\begin{aligned}
&q_{gg} = \mu(1-e_1)^2 \qquad q_{bg} = \mu e_1(1-e_1) \qquad q_{bb} = \mu e_1^2 + (1-\mu) \\
&\mu_{gg} = \mu_{bg} = 1 \qquad\qquad\qquad\qquad\qquad \mu_{bb} = \frac{\mu e_1^2}{q_{bb}}
\end{aligned}$$

Throughout, we assume e_1 is sufficiently low such that even a single negative signal turns the project into negative NPV. Consequently, fintechs will bid only after a positive signal.

Proof of Proposition 5

Proof. Start with **Case 3**: suppose that $\underline{R}_B^{2F} < \underline{R}_F^{2F}$ or, equivalently, that

$$\mu \geq \bar{\mu}^{2F} := \frac{r_B - pr_E}{(1-p)r_E - (1-e_1^2)\Pi_B}. \tag{33}$$

In this parametric region, the bank has a dominant cost advantage. The bank always bids $\underline{R}_F^{2F}$ and wins. Fintechs bid in $(\underline{R}_F^{2F}, R]$ make zero profits and sometimes do not participate.

We only need to satisfy the bank's indifference constraint so that the bank does not bid above $\underline{R}_F^{2F}$:

$$\begin{aligned} P(\mu)\underline{R}_F^{2F} - r_B \geq\ & q_{gg}[(1-F_F(\tilde{R}))^2(\tilde{R}-r_B) + (1-(1-F_F(\tilde{R}))^2)\Pi_B] \\ & + 2q_{bg}[(1-F_F(\tilde{R}))(\tilde{R}-r_B) + F_F(\tilde{R})\Pi_B] + q_{bb}[P(\mu_{bb})\tilde{R} - r_B]. \end{aligned}$$

In the case that the constraint binds, we get $F_F(\underline{R}_F^{2F}) = 0$ and $F_F(R) < 1$. The remaining mass $1 - F_F(R)$ is the probability that each fintech lender does not participate.

Case 2: next, suppose that $\underline{R}_F^{2F} < \underline{R}_B^{2F} \leq e_1 R + (1-e_1)\underline{R}_F^{2F}$ or, equivalently, $\underline{\mu}^{2F} \leq \mu < \bar{\mu}^{2F}$. In this parametric region bank's cost advantage and fintechs' information advantage are comparable in magnitudes. We construct a mixed strategy equilibrium: the bank bids in $[\underline{R}_B^{2F}, \bar{R}_B^{2F}]$ and a mass probability of not bidding and receiving $\mu(1-e_1^2)\Pi_B$ that are identical to the outside option, fintech lenders bid in $[\underline{R}_B^{2F}, R]$ and make positive profits.

In region $[\underline{R}_B^{2F}, \bar{R}_B^{2F}]$, everyone bids. The bank's indifference condition is:

$$\begin{aligned} \mu(1-e_1)^2\Pi_B =\ & q_{gg}[(1-F_F(\tilde{R}))^2(\tilde{R}-r_B) + (1-(1-F_F(\tilde{R}))^2)\Pi_B] \\ & + 2q_{bg}[(1-F_F(\tilde{R}))(\tilde{R}-r_B) + F_F(\tilde{R})\Pi_B] + q_{bb}[P(\mu_{bb})\tilde{R} - r_B]. \end{aligned} \tag{34}$$

We start with bank's IC, for $\tilde{R} = \underline{R}_B^{2F}$ it holds when

$$F_F(\underline{R}_B^{2F}) = 0.$$

Then we keep solving it for any $\tilde{R}$ in the interval to pin down $F_F(\tilde{R})$ for $\tilde{R} \in [\underline{R}_B^{2F}, \bar{R}_B^{2F}]$.

Next, consider the fintech's indifference condition in $\tilde{R} \in [\underline{R}_B^{2F}, \bar{R}_B^{2F}]$:

$$\underline{R}_B^{2F} - r_E = (1 - F_B(\tilde{R})) \cdot [(1-e_1)(1-F_F(\tilde{R})) + e_1](\tilde{R} - r_E). \tag{35}$$

Fintech's IC then pins down the bank's bidding CDF F_B:

$$\frac{\underline{R}_B^{2F} - r_E}{\tilde{R} - r_E} \cdot \frac{1}{(1-e_1)(1-F_F(\tilde{R})) + e_1} = 1 - F_B(\tilde{R}),\ \tilde{R} \in [\underline{R}_B^{2F}, \bar{R}_B^{2F}]. \tag{36}$$

In the region $[\bar{R}_B^{2F}, R]$ only the fintechs bid, so only their condition is tight:

$$\begin{aligned}\underline{R}_B^{2F} - r_E &= (1 - F_B(\bar{R}_B^{2F})) \cdot [(1-e_1)(1 - F_F(\tilde{R})) + e_1](\tilde{R} - r_E) \\ \frac{1}{1-e_1} \cdot \left(\frac{\underline{R}_B^{2F} - r_E}{\tilde{R} - r_E} \cdot \frac{1}{1 - F_B(\bar{R}_B^{2F})} - e_1 \right) &= 1 - F_F(\tilde{R}).\end{aligned} \tag{37}$$

Since we also need to have $F_F(R) = 1$ and cannot have a mass probability at R (otherwise fintechs would undercut each other), it must be that

$$\frac{\underline{R}_B^{2F} - r_E}{R - r_E} \cdot \frac{1}{e_1} = 1 - F_B(\bar{R}_B^{2F}) \tag{38}$$

Since $F_B(\bar{R}_B^{2F}) \geq 0$ the last equation pins down $\underline{\mu}^{2F}$ as:

$$\frac{\underline{R}_B^{2F} - r_E}{R - r_E} \cdot \frac{1}{e_1} \leq 1$$

$$\mu \geq \underline{\mu}^{2F} := \frac{r_B - p[e_1 R + (1-e_1) r_E]}{(1-p)[e_1 R + (1-e_1) r_E] - (1-e_1)^2 \Pi_B}$$

Moreover, plugging (38) into (37), we get

$$\frac{e_1}{1-e_1} \left(\frac{R - r_E}{\tilde{R} - r_E} - 1 \right) = 1 - F_F(\tilde{R}),\ \tilde{R} \in [\bar{R}_B^{2F}, R]. \tag{39}$$

At $\bar{R}_B^{2F}$ the CDF F_F needs to satisfy the bank's IC (34) and the equation above, i.e.

$$\frac{e_1}{1-e_1} \left(\frac{R - r_E}{\bar{R}_B^{2F} - r_E} - 1 \right) = 1 - F_F(\bar{R}_B^{2F}) \tag{40}$$

simultaneously. Notice that this constraint always pins down $\bar{R}_B^{2F}$ in $[\underline{R}_B^{2F}, R]$. Since the solution of (34) is an increasing in $\tilde{R}$ functions that satisfies $F_F(\underline{R}_B^{2F}) = 0$ and $F_F(R) > 1$. While $\frac{e_1}{1-e_1} \left(\frac{R - r_E}{\tilde{R} - r_E} - 1 \right)$ is a decreasing function of $\tilde{R}$ with an above 1 value at $\underline{R}_B^{2F}$ (corresponding F_F is negative) and 0 at R (corresponding F_F equals to 1).

To make sure that this construction is an equilibrium we only need to verify that the bank does not want to bid in $(\bar{R}_B^{2F}, R]$. This holds by construction since $\bar{R}_B^{2F}$ is the intersection of the bank's IC with the CDF F_F implied by the fintech's IC (which is higher). Higher CDF implies a stronger winner's curse and makes the outside option more attractive relative to bidding. Technically, this follows from the single crossing of the two curves defined by equations (34) and (39) which we show below.

Case 1: finally, suppose that $\underline{R}_B^{2F} > e_1 R + (1-e_1)\underline{R}_F^{2F}$ or, equivalently, $\mu < \underline{\mu}^{2F}$. In this parametric region, fintechs' information advantage and resulting winner's curse dissuade the bank from participating in the market.

We construct a mixed strategy equilibrium: the bank never bids and fintech lenders bid in $[\underline{R}, R]$ and make positive profits with $\underline{R} = (1-e_1)\underline{R}_F^{2F} + e_1 R$. Since fintechs play a mixed strategy, their IC constraint should bind fintech's indifference condition:

$$\underline{R} - r_E = [(1-e_1)(1-F_F(\tilde{R})) + e_1](\tilde{R} - r_E), \tag{41}$$

which gives

$$F_F(\tilde{R}) = \frac{\tilde{R} - \underline{R}}{\tilde{R} - r_E} \cdot \frac{1}{1-e_1}. \tag{42}$$

The lower bound of the fintechs' bidding distribution is pinned down implicitly by

$$F_F(R) = 1. \tag{43}$$

Hence $\underline{R} = (1-e_1)\underline{R}_F^{2F} + e_1 R$.

To ensure the bank's non-participation we must have the following:

$$\begin{aligned}\mu(1-e_1)^2\Pi_B > q_{gg}&[(1-F_F(\tilde{R}))^2(\tilde{R} - r_B) + (1-(1-F_F(\tilde{R}))^2)\Pi_B] \\ &+ 2q_{bg}[(1-F_F(\tilde{R}))(\tilde{R} - r_B) + F_F(\tilde{R})\Pi_B] \\ &+ q_{bb}[P(\mu_{bb})\tilde{R} - r_B]\end{aligned} \tag{44}$$

for all $\tilde{R} \in [\underline{R}_B^{2F}, R]$. This inequality holds here by extending the argument from Case 2. It follows directly from the single crossing of the two curves defined by equations (34) and (39) which we show below.

Single Crossing of the Two CDFs. We will now verify that the two CDF curves defined by equations (34) and (39) satisfy single crossing property. The first CDR define by (34) is

$$\begin{aligned}\mu(1-e_1)^2\Pi_B = q_{gg}&[(1-F_1(x))^2(x - r_B) + (1-(1-F_1(x))^2)\Pi_B] \\ &+ 2q_{bg}[(1-F_1(x))(x - r_B) + F_1(x)\Pi_B] \\ &+ q_{bb}[P(\mu_{bb})x - r_B]\end{aligned} \tag{45}$$

Take d/dx to get

$$\begin{aligned}0 = q_{gg}&(1-F_1(x))^2 + 2q_{gg}[\Pi_B - (x - r_B)](1-F_1(x))F_1'(x) \\ &+ 2q_{bg}(1-F_1(x)) + 2q_{bg}[\Pi_B - (x - r_B)]F_1'(x) \\ &+ q_{bb}P(\mu_{bb})\end{aligned} \tag{46}$$

and rewrite it as

$$(x - r_B - \Pi_B)F_1'(x) - (1-F_1(x)) = \frac{q_{bb}P(\mu_{bb}) - q_{gg}(1-F_1(x))[x - r_B - \Pi_B]F_1'(x)}{q_{gg}(1-F_1(x)) + 2q_{bg}} \tag{47}$$

The second CDF define by (39) is

$$e_1(R - r_E) = [(1 - e_1)(1 - F_2(x)) + e_1](x - r_E), \tag{48}$$

With d/dx equals to

$$0 = (1 - e_1)(1 - F_2(x)) + e_1 - (1 - e_1)(x - r_E)F_2'(x) \tag{49}$$

or

$$(x - r_E)F_2'(x) - (1 - F_2(x)) = \frac{e_1}{1 - e_1} \tag{50}$$

We want to show that $F_2'(x) > F_1'(x)$ whenever $F_2(x) = F_1(x)$. Notice that for small p and e_1 the r.h.s. of (47) is smaller than the r.h.s. of (50) because $q_{bb}P(\mu_{bb}) \sim e_1^2$. At the same time, the second term in the l.h.s. of (47) $1 - F_1$ is the same as the second term in the l.h.s. of (50) $1 - F_2$. Finally, recall that $x - r_E < x - r_B - \Pi_B$. Hence, a smaller multiplier $x - r_E$ on $F_2'(x)$ in (50) results in bigger r.h.s. than (47) - this is only possible if $F_2'(x) > F_1'(x)$.

□

B Case Studies

We present some real-world cases of competition and collaboration between banks and fintech firms.

OnDeck

OnDeck is an online small business lending company in the United States. Enova International acquired it in 2020. Below, we will describe the credit products and funding structure of OnDeck.

Credit products. OnDeck offers both term loans (a general lien on business assets) and (unsecured) credit lines to small businesses with low to fair credit history. The first loan was made in 2007. The limit of the credit lines varies between \$6,000 and \$100,000, with a 12-month repayment schedule that is reset after each drawdown. The size of the term loans varies between \$5,000 and \$250,000, with a repayment schedule of up to 12 months. Both programs have a nice feature of instant or same-day funding transfers, which is a big advantage over the standard ACH bank transfers that can take up to three business days.

Borrower eligibility. OnDeck imposes the following minimum requirements: 1 year in business, a personal FICO score of 625, an annual revenue of \$100,000, and a business bank account. Both credit programs have a starting APR of around 29.9%. As of March 31, 2022, the average APR for credit lines is 48.9%, and the one for term loans is 62.1%.

Credit allocation criteria. OnDeck has a proprietary small business credit scoring system, named "OnDeck Score", to assess the creditworthiness of a small business in real-time. The OnDeck Score uses machine learning and other statistical techniques to automate and optimize credit assessment, and the algorithm evolves continuously. The data include both information submitted by the customer and data from third parties. The data points include customer bank activity shown on their bank statements, government filings, tax and census data, reputation, and social data. Moreover, borrowers with an excellent payment history on prior loan products with OnDeck can enjoy the lowest rates. OnDeck claims that their OnDeck Score system is much more accurate in assessing credit risks than using only personal credit scores.

Competition and collaboration with banks. Several banks have collaborations with OnDeck, albeit in different forms. These include:

- Direct funding through credit lines. In 2013, it received a credit line from Deutsche Bank, Key Bank, and Square 1 Bank. In 2016 and 2018, OnDeck received revolving credit lines from Credit Suisse. In 2019, OnDeck established a revolving credit facility of \$85 million with SunTrust Bank, Silicon Valley Bank, MB Financial Bank, and Congressional Bank.
- Funding partnerships. OnDeck partners with Celtic, a Utah-Chartered Bank, in making small-business loans. During the pandemic, they provide emergency relief loans to small businesses through the Paycheck Protection Program. The loans can be issued by either OnDeck or by Celtic Bank.[12] The website

[12] https://www.ondeck.com/short-term-loans

of OnDeck (https://www.ondeck.com/resources/top-10-faqs) suggests that whether OnDeck or Celtic issues the loan depends mostly on the state where the business is located and other attributes. It remains unclear what these other attributes are. The borrowing firm will figure this out before it signs the loan agreement. According to the 10-K Form filed by Enova in 2021, if Celtic issues the loan, OnDeck receives marketing fees, while the issuing bank (Celtic) receives origination fees and certain program fees. Meanwhile, OnDeck may also purchase these loans from Celtic. According to the 10-Q form filed by Enova in 2020 Q1, OnDeck purchased loans of $109.7 million from Celtic in the three months that ended March 31, 2020. If OnDeck originates the loan or if OnDeck purchases the loan, it is exposed to default risks.

Besides Celtic, JP Morgan Chase also had a three-year partnership with OnDeck which began in 2015 but ended early in 2019. This partnership is also about small business loans. In 2019, JP Morgan Chase launched its own small business lending platform called "Quick Accept". This platform could be seen as a competitor to OnDeck.

- Interestingly, the Celtic bank also provides financing for small businesses. In fact, the Celtic bank has ranked in the top ten SBA lenders nationally every year since 2013.[13] It issues loans to small firms from hundreds of industries nationwide.[14] Interestingly, the website of the Celtic bank does not explicitly mention its partnership with OnDeck.

[13] https://www.celticbank.com/company

[14] https://www.celticbank.com/