BORROWING FROM A BIGTECH PLATFORM

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ABSTRACT

We model competition in the credit market between banks and a bigtech platform which offers a marketplace for merchants. We show that, unlike banks, the platform lends to merchants based on their revenues and network externalities. To enforce partial loan repayment, the platform increases borrowers' transaction fees. Credit markets become partially segmented, with the platform targeting borrowers of low and medium credit quality. The platform benefits from advantageous selection at the expense of banks, reducing equilibrium welfare for intermediate-credit-quality merchants. When revenues, network externalities, or advantageous-selection rents are large, the platform does not value superior information about credit quality.

KEYWORDS: Bigtech, platform, advantageous selection, welfare, credit rationing.

JEL CODES: G21, G23, C72, D82.

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1 INTRODUCTION

Bigtech platforms like Amazon, Alibaba, and Paypal provide marketplaces where users exchange goods, services, and money. In recent years, bigtech platforms have ventured also into a very different business: lending to merchants, and thus directly competing with banks and other lenders.[1] Globally, bigtech firms have been expanding their lending activity at a dramatic pace, increasing credit more than fiftyfold from 2013 to 2019. In 2019, bigtech firms lent $572 billion, more than twice the amount lent by fintech firms[2] (Cornelli et al., 2021).

Despite the growing relevance of bigtech platforms in credit markets, there is no theoretical framework to understand their unique lending model. Unlike any other lender, bigtech firms operate a marketplace for merchants. They typically implement revenue-based repayment plans, whereby borrowing merchants pledge a percentage of their sales on the marketplace as loan repayment.[3] Moreover, bigtech platforms often ignore information about borrowers' credit quality, whereas banks and traditional lenders value such information.[4] In this paper, we provide a model to explain these patterns.

Thanks to our model, we identify how a platform acquires an advantage over other lenders in a market with adverse selection. We also investigate the welfare consequences of bigtech platforms entering credit markets. Whereas banks and fintech firms rely heavily on information about a borrower's credit quality, a bigtech platform can exploit marketplace transactions and network externalities to guide its lending decisions (Frost et al., 2019; Financial Stability Board, 2019; Huang et al., 2020; Petralia et al., 2019). So far, no research has theoretically explored the implications of the bigtech lending model. To what extent does a platform rely on transactions and network externalities as opposed to information about credit quality? Does a platform truly benefit from having superior information about a borrower's credit quality? Does a bigtech platform improve social welfare by lending to merchants? Our paper provides answers to these questions.

We model a bigtech platform as a two-sided market where merchants interact with

[1] In the U.S., Amazon, Apple, DoorDash, eBay, and Paypal provide small business loans to their merchants.

[2] According to Frost et al. (2019) and Stulz (2019), bigtech firms are "technology companies with established presence in the market for digital services." Moreover, Petralia et al. (2019) observe that bigtech firms possess "large, developed customer networks established through, for example, e-commerce platforms or messaging services." Bigtech firms are thus distinct from fintech firms. In fact, a fintech firm is "a specialized firm that challenges a specific product line of banks" (Stulz, 2019).

[3] For example, Amazon, Alibaba, Doordash, Paypal, and Stripe implement such repayment plans. Merchant-cash-advance lenders implement similar schemes, whereby repayments are based on daily credit- and debit-card transactions.

[4] On their websites, Doordash, Paypal, and Stripe explicitly state they do not run credit checks to make lending decisions, and instead decide based on the merchant's past transactions on their platforms.

buyers. Merchants enjoy larger revenues when selling on the platform, and buyers benefit from the variety of goods sold by merchants. Hence, by selling in the marketplace, a merchant generates positive network externalities for buyers. The platform charges transaction fees on both types of users and profits from network externalities. In particular, for each additional merchant in the marketplace, the platform gains from buyers' increased willingness to pay to participate.

A merchant needs to borrow to continue operations. As a borrower, the merchant is privately informed of his type: a good merchant is committed to repay the loan, whereas a bad merchant fails to repay any loan balance left after revenues are earned. A merchant's credit quality is thus determined by lenders' prior beliefs that the merchant is good. A merchant may borrow from the platform or from a competitive banking sector. Because of adverse selection, banks ration credit to merchants of low credit quality.

Although banks pay a lower cost of capital than the platform because they issue deposits, a platform profitably competes with them because it controls access to its marketplace. The platform enforces partial loan repayment by charging higher transactions fees on borrowing merchants and deducting the proceeds from the loan's balance. Even a bad merchant willingly pays the increased fees to gain access to the marketplace and the associated revenues. Thus, by increasing transaction fees, the platform partially alleviates the adverse-selection problem. As the monopolistic provider of its own marketplace, the platform extracts a larger surplus from a merchant who benefits more from using the platform, thus implementing revenue-based repayment plans, consistent with industry practice. Banks cannot implement similar revenue-based repayment plans because they do not control access to a merchant's source of revenues. Hence, whereas banks deny loans to a low-credit-quality merchant, a platform still lends to him, provided his revenues in the marketplace are large enough to motivate him to pay high transaction fees. In particular, if the merchant enjoys substantial on-platform revenues, the platform grants loans regardless of the merchant's creditworthiness, also consistent with industry practice.

Our model provides a series of predictions and welfare implications that rely on the same key notion: a bigtech platform controls access to a marketplace. Importantly, our results do not rely on the assumption that a platform possesses superior information. In fact, we study both models with symmetric and asymmetric information between banks and the platform, and we provide a novel theoretical insight: information may be irrelevant, or it may even reduce profits for a bigtech platform that controls access to a marketplace.

In the baseline model where the platform and the banks have the same information, we show that, when a platform competes with banks as lender, credit markets become partially segmented and the platform benefits from *advantagenous selection*. Banks remain the only lenders to merchants of high credit quality, to whom they offer rates below the platform's cost of capital. The platform becomes the sole lender to merchants of low credit quality, provided they generate enough on-platform revenues and hence fees. The platform and banks compete for merchants of intermediate credit quality. In this segment of the market, the platform benefits from advantageous selection: when a bad merchant is offered a loan by both a bank and the platform, he prefers to borrow from the bank to avoid increased fees on the platform. Hence, conditional on public information, the platform lends to a pool of borrowers with lower default rates. Empirically, Liu et al. (2022) finds evidence that bigtech lenders benefit from advantageous selection.

We then evaluate how social welfare changes in the three segments of the credit market. Welfare does not change for merchants of high credit quality, who keep borrowing exclusively from banks. Social welfare improves for merchants of low credit quality, who are now able to borrow and produce if their on-platform revenues are large enough. Finally, for merchants of medium credit quality, social welfare declines for two reasons. First, the platform replaces banks as the lender with positive probability, but the platform has a higher cost of capital. Second, because the platform benefits from advantageous selection at the expense of banks, some merchants are rationed with positive probability by both banks and the platform, whereas absent the platform, they would always receive financing from banks.

We also study how the platform changes its lending behavior based on the strength of the network externalities. In general, the platform lends more liberally when network externalities are stronger, sometimes lending at a loss. It then covers the loss using increased fee revenues from buyers. However, welfare effects are ambiguous. With larger network externalities, more merchants of low credit quality are able to borrow from the platform, and welfare increases in this segment of the market. However, if a merchant of medium credit quality remains rationed with positive probability, he is rationed more frequently when network externalities are stronger.

Finally, we extend the model and allow the platform to acquire additional information about the borrower's type at a cost. We consider the equilibrium when such cost is infinitesimally small. Banks do not observe whether the platform acquires information, but they are aware of the platform's information-acquisition strategy in equilibrium. They therefore suffer from a *winner's curse*: if a borrower accepts their credit offer, they fear the platform observed negative information about the borrower and denied credit. With this extension of the model, we explore the equilibrium in which a bigtech platform uses alternative data and methodologies to assess the borrower's credit quality.[5] In fact, Frost et al. (2019) and Huang et al. (2020) argue bigtech companies possess an informational advantage over banks.

We show revenues and network externalities substitute for information. When competing with banks, the platform acquires information for two main reasons. Either the platform tries to undercut banks after observing good news about a borrower, or it avoids lending to borrowers who are revealed to be bad. However, if on-platform revenues or network externalities are large, the platform optimally chooses not to acquire information in equilibrium, provided the merchant's credit quality is low enough to avoid aggressive competition from banks.

We also show the equilibrium value of information depends on the severity of the advantageous-selection effect. In particular, if the platform profits exclusively from advantageous selection, it earns lower equilibrium profits if given the chance to acquire superior information. That is, in equilibrium, superior information is detrimental for a platform that largely benefits from advantageous selection. In fact, when the platform acquires superior information, banks reduce credit to merchants because of their winner's curse. If banks lend less, the platform has fewer opportunities to collect rents from advantageous selection.

RELATED LITERATURE. To the best of our knowledge, we are the first researchers to identify a complementarity between lending and operating a two-sided market. In particular, within the theoretical literature in finance and economics, our paper is the first to explore the connection between network externalities, market access, and lending activity.

Previous theoretical literature on fintech and bigtech lenders assumes they lend based on superior information. We derive a very different economic insight: information may be irrelevant, or even detrimental, for a bigtech firm operating a platform. He et al. (2020) study lending competition when borrowers can share data with fintech lenders and when the latter can extract information from those data more effectively than banks. Philippon (2019) studies how the use of big data by fintech lenders affects discrimination in the credit market. In Huang (2021), fintech lenders suffer from adverse selection and need superior information to compete with banks, whereas in our model, a platform benefits from advantageous selection, consistent with the empirical evidence in Liu et al. (2022).

[5] Because we focus on lending by a platform, we consider only information about the merchant's credit quality. Kirpalani and Philippon (2020) study the equilibrium in the platform's marketplace when the platform acquires information about consumers' tastes, but does not lend to merchants.

Moreover, we explain why and to what extent a platform offers loans based on the merchant's on-platform revenues and why banks do not, whereas Huang (2021) assumes fintech and banks lend on different terms.

Because we focus on two-sided platforms, our model is suited to study lending by online marketplaces and payment systems. Previous studies of lending by payment services also emphasized the informational advantage of payment processing companies (Parlour et al., 2020; Ghosh et al., 2021). We instead emphasize that, by simply controlling access to the platform, a bigtech firm obtains a crucial advantage as lender, regardless of its information.

Using results from the platform-design literature (Weyl, 2010; Jullien et al., 2021), we characterize how the platform benefits from fees and network externalities by lending to a merchant. Although we take fees as given,[6] our research highlights a new connection between industrial organization and finance: a platform profits not only from designing a two-sided market (Weyl, 2010; Armstrong, 2006; Rochet and Tirole, 2002), but also from financing the activity of market users.

Our research is also related to the literature on trade credit and lending with limited commitment. Similar to the trade-credit literature (Burkart and Ellingsen, 2004; Biais and Gollier, 1997), we emphasize the complementarity between business relations and lending activity. In our case, the merchant has a business relation with the platform because he sells goods on the platform's marketplace. Similar to the limited-commitment literature (Ligon et al., 2002; Alvarez and Jermann, 2000; Kocherlakota, 1996; Kehoe and Levine, 1993), the borrower is motivated to (partially) repay the loan to maintain access to a valuable market which, in our case, is the platform's marketplace instead of the credit market.

There is a increasing empirical literature studying lending by bigtech and fintech firms. Liu et al. (2022) find evidence of advantagenous selection for bigtech lenders, whereas Frost et al. (2019) and Hau et al. (2019) provide evidence that bigtech firms expands credit access in developing countries, consistent with our model that bigtechs are able to reach borrowers who are under-served by traditional banks. Other authors focus on fintech firms, focusing on their lending strategies (Di Maggio and Yao, 2021), and the substitutability (Gopal and Schnabl, 2021; Buchak et al., 2018) or complementary (Beaumont et al., 2021) between bank and fintech loans. Fuster et al. (2019) find fintech firms process mortgage applications faster but have higher default rates. Allen et al. (2020), Berg et al. (2021), Petralia et al. (2019), and Stulz (2019) review recent developments and the literature on bigtech and fintech lending.

[6] Transaction fees and loan terms are typically set by different divisions within a bigtech firm.

2 MODEL WITH SYMMETRIC INFORMATION

We consider a model where a merchant can borrow from competitive banks or a platform. We compare the equilibrium with the one in a benchmark model where the banks are the only lenders, and we assess how welfare changes when a platform enters the lending market.

2.1 SET-UP

We primarily focus on three types of players: a merchant, competitive banks, and a monopolistic platform. The merchant needs to borrow to produce and sell goods, banks provide financing, and the platform provides both financing and a marketplace for the merchant. The merchant has the option to participate in the platform's marketplace and sell goods to buyers, who represent a fourth type of player.

THE MERCHANT. The merchant produces and sells one unit of the consumption good. To produce, the merchant needs to borrow one unit of capital from banks or from the platform. The merchant possesses private information about his type $g \in \{0,1\}$, which denotes whether the merchant is good ($g = 1$) or bad ($g = 0$) as a borrower. A good merchant is committed to repay any loan he obtains. A bad merchant defaults on any loan balance left after he sells the good. The banks and the platform cannot observe the merchant's type, and they have common prior beliefs $p := \mathrm{E}[g]$. Beliefs p measure the creditworthiness of the merchant.[7]

The merchant chooses to sell goods either on the platform's marketplace or on some alternative market. On the marketplace, the merchant sells the good at a price that we normalize to 1, but pays a transaction fee f, thus netting $(1 - f)$. Alternatively, the merchant could sell goods outside the platform and earn revenues equal to $1 - \eta$, here $\eta \leq 1$ is common knowledge among all players. We assume the platform and banks have the same information about the merchant's revenues to highlight how the platform enforces revenue-based repayments by controlling access to the marketplace, and not by possessing superior information about revenues.We call η the merchant's *relative revenues*, because it measures the change in gross revenues for a merchant who switches from the

[7]In our model, the borrower's private type indicates his willingness to repay the loan. For certain small businesses, a lender may be concerned about the borrower's ability to repay. In these cases, the platform and banks are equally unable to obtain repayments from bad borrowers: if a bad borrower does not produce revenues, even a platform cannot implement a successful revenue-based repayment scheme. We therefore focus on a model in which a borrower's private willingness to repay represents the main friction in the credit market.

alternative market to the platform. A merchant with relative revenues $\eta \geq f$ sells on the platform's marketplace. Otherwise, the merchant earns his outside option.

The platform. The platform operates a marketplace where merchants interact with buyers. The platform charges a transaction fee f one the merchant's revenues. Because, in this paper, we focus on the how the platform lends to merchants, we leave transaction fees as exogenous and focus on the platform's lending decisions.[8]

In order to lend to merchants, the platform pays a cost of capital $\bar{R} < 1 - f$. Hence, the platform's cost of capital is low enough that, by lending to a merchant, it generates economic surplus. When a merchant applies for a loan from a platform, the platform issues a credit decision (d_P, R_P) with $d_P \in \{0, 1\}$ and $R_P \in \mathbb{R}$. The credit decision specifies whether the platform agrees to lend to the merchant ($d_P = 1$) or not ($d_P = 0$), and R_P specifies the gross interest rate the merchant has to repay.

By lending to a merchant in need of financing, the platform expands its user pool and fees revenues. If a merchant fails to obtain financing, he will not be able to sell on the marketplace and generate fees f for the platform. Moreover, he will not generate any positive network externality. We discuss this last effect next.

Network Externalities. One of the distinguishing features of a platform's marketplace is its network externalities. When more merchants join the platform, buyers become more eager to join the platform because they benefit from an increased variety of goods and lower search costs. The platform, in turn, profits from the buyers' higher willingness to join by charging higher participation fees to current buyers or by attracting additional fee-paying buyers. In particular, as Jullien et al. (2021) and Weyl (2010) show, when a platform optimally sets its fees, the marginal value of an additional merchant coincides with the sum of merchants' fees, f, and increased fees from buyers, which we denote as β and which capture the strength of the *network externalities* on the platform.[9]

[8] In our framework, the platform sets merchants' and buyers' fees independently of its lending activity. To the best of our knowledge, this is an accurate characterization of the the current business model of big-tech lenders. In particular, we assume the number of merchants who need to borrow capital is small relative to the total number of participants. Therefore, a platform first optimally sets fees for merchants and buyers, as in the models by Armstrong (2006), Rochet and Tirole (2002), and Weyl (2010). It then learns about the merchant's outside option and interaction benefits. Finally, a very small measure of merchants need to borrow to operate on the platform.

[9] The value of β can be microfounded in a variety of ways. For example, with a fixed measure 1 of buyers participating in the marketplace, β represents the benefit buyers enjoy from interacting with an additional merchant. With an additional merchant on the platform, the platform can increase buyers' fees by β and still ensure full participation from buyers. Alternatively, if buyers have heterogeneous interaction benefits and not all buyers participate, β represents the platform's increased fees as more buyers participate when an additional merchant joins the platform while buyers' fees remain fixed. Therefore, β captures, in a very

BANKS. Competitive banks provide loans to the merchant. Although we refer to these lenders as banks, they may represent traditional lenders who do not provide a marketplace. Banks obtain funds at a cost of capital $R_D \in (0, \bar{R})$. We assume banks have lower cost of capital because they can obtain cheap financing from deposits.

Similar to the platform, a bank issues a credit decision (d_B, R_B) to a merchant who applies for a loan, with $d_B \in \{0, 1\}$ and $R_B \in \mathbb{R}$, specifying whether it agrees to lend ($d_B = 1$) or not ($d_B = 0$) and the gross interest R_B rate required for the loan.

BORROWING FROM THE PLATFORM AND REPAYMENT FEES. The merchant may borrow from either the platform or from a bank. Banks are repaid in full by a good borrower but are unable to recover anything from a bad borrower.

Unlike banks, the platform collects part of the loan repayment in the form of increased fees, using a revenue-based repayment plan. When lending to a merchant, the platform specifies an interest rate R_P and a revenue-based repayment $f_P \leq R_P$. To enforce the revenue-based repayment, the platform collects additional fees f_P at the time of the transaction, and applies them to the loan repayment. After selling the good, the merchant owes the balance $(R_P - f_P)$ to the platform. Because revenue-based repayments are collected at the time of the transaction, a bad merchant cannot abscond with them. A bad merchant can, however, fail to repay the balance.

Therefore, if a good merchant obtains a loan with gross interest R_j from lender $j \in \{P, B\}$ with a revenue-based repayment fees f_j (where we set $f_B = 0$), his profits when selling on the platform are

$$1 - f - R_j, \tag{1}$$

and he obtains profits equal to $(1 - \eta - R)$ when selling outside the platform. If a bad merchant obtains the same loan, his profits when selling on the platform are

$$1 - f - f_j, \tag{2}$$

because a bad merchant defaults on the loan balance $(R_j - f_j)$, whereas its off-platform profits are $1 - \eta$.

For a given R_P, a good merchant is indifferent between any pair of interest rate and revenue-based repayment (R_P, f_P) because, eventually, he fully repays R_P, regardless of the amount he prepays in the form of fees. However, a bad merchant strictly prefers loan terms (R_P, f_P) characterized by lower f_P, because he does not repay the balance $R_P - f_P$. In particular, if f_P is large enough, the bad merchant, when borrowing from the platform,

general way, the marginal value of one additional merchant to the platform via the network effect.

chooses to leave the platform, forfeit revenues, and default on the entire loan.

Thus, the platform faces an incentive-compatibility constraint when designing a revenue-based repayment plan. It must set repayment fees f_P low enough that a bad merchant prefers to sell on the platform at the increased fees than leave the platform. That is, revenue-based repayment fees must satisfy

$$f_P \leq \eta - f. \tag{3}$$

As long as this constraint holds, the platform receives larger repayments from bad merchants when f_P is larger. Moreover, for a given rate R_P, good merchants are not deterred from borrowing if f_P increases. As a result, the constraint binds and the platform charges higher repayment fees to merchants with larger relative revenues.

As a lender, the platform benefits from its power to control access to its marketplace. Effectively, the platform increases transaction fees for borrowing merchants from f to $f + f_P$, and the difference is applied towards loan repayment. A merchant must forfeit access to the platform in order to avoid paying the increased fees. Empirically, bigtech platforms such as Amazon, Alibaba, and Paypal take advantage of this option and obtain partial loan repayments in the form of increased transaction fees.

Banks, on the other hand, are unable to charge merchants to access a product market. A bank may try to seize a fraction of the cash inflows to the merchant's accounts, for example, with a fee on incoming deposits. However, merchants may easily open accounts at other banks without forfeiting access to their ultimate source of revenues.

2.2 Benchmark Models: Borrowing from One Type of Lender

We start by considering a merchant who may borrow only from banks or only from the platform. With no competition between banks and the platform, we illustrate the relative advantages and disadvantages of borrowing from either type of lenders.

In this paper, we focus exclusively on a merchant with $\eta \geq f$. Such a merchant joins the platform in equilibrium, and the platform can profitably compete with banks to lend to them. Any merchant with $\eta < f$ does not sell on the platform and is more efficiently served by the competitive banking sector.

2.2.1 Banks as the only lenders.

Suppose the platform charges a fee f to the merchant but does not offer any loans. Banks can profitably lend to the merchant only if good borrowers are willing to accept their loan offers, that is, when $R_B \leq 1 - f$ and net revenues exceed the interest rate. Otherwise, only bad merchants would borrow and default on the entire loan. Because banks are competitive, they issue a credit decision (d_B, R_B) that maximizes the good merchant's welfare subject to earning non-negative profits:

$$\max_{R_B, d_B \in \{0,1\}} d_B \max\{1 - f - R_B, 0\} \tag{4}$$

$$\text{s.t.} \quad d_B[p\mathbb{I}(R_B \leq 1 - f)R_B - R_D] \geq 0, \tag{5}$$

where $\mathbb{I}$ is the indicator function. Thus, if $p \geq R_D/(1 - f)$, banks agree to lend and offer rate

$$R_B = \frac{R_D}{p}.$$

If instead, $p < R_D/(1 - f)$, banks refuse to lend, because the break-even rate exceeds $1-f$. We therefore highlight the following remark.

Remark 1. When banks are the only lenders, only merchants with credit quality $p \geq R_D/(1 - f)$ receive funding. In particular, banks' lending decisions are entirely based on the merchant's credit quality p, and not on the merchant's (relative) revenues η.

Because of adverse selection, banks ration credit based on the merchant's credit quality. However, because merchants generate value by borrowing and producing, the allocation is inefficient: low-credit-quality merchants are unable to borrow and produce value. Figure 1 provides an illustration of the set of parameters for which a merchants receives funding from banks.

2.2.2 Platform as the only lender.

We now assume the platform is a monopolistic lender. The platform chooses the revenue-based repayment f_P and issues a credit decision (d_P, R_P) to maximize its profit,

$$\max_{f_P, R_P \leq 1-f, d_P \in \{0,1\}} d_P[p\mathbb{I}(R_P \leq 1 - f)R_P + (1 - p)\min\{f_P, R_P\} - \bar{R} + f + \beta] \tag{6}$$

$$\text{s.t.(3)}$$

Similar to banks, the platform will lend up to rate $1 - f$. Otherwise, only bad merchants would borrow and default on the balance. Conditional on lending at $R_P \leq 1 - f$, the platform obtains full repayment R_P if the merchant is good. It instead can only recover up to the fees f_P if the merchant is bad. In either case, the platform pays a cost of capital equal

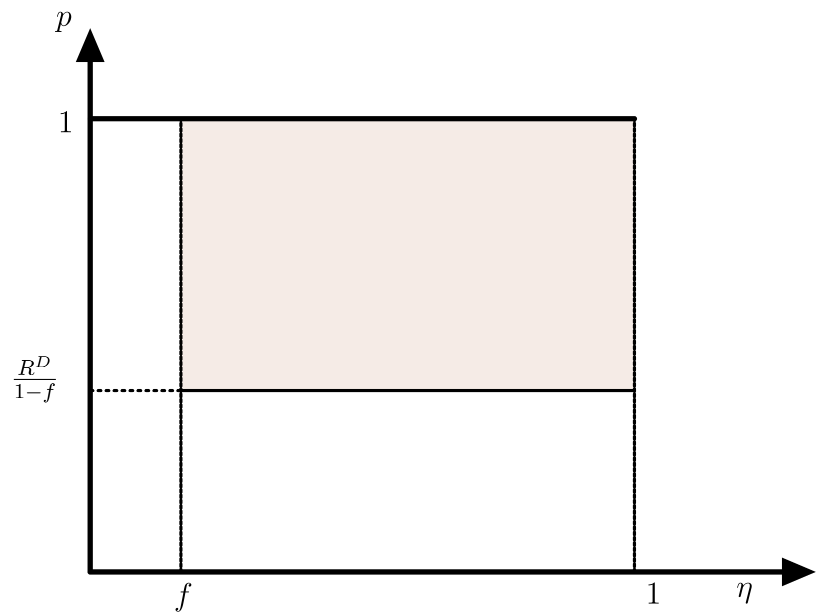

Figure 1: Equilibrium with banks as the only lenders. This figure illustrates the equilibrium when only banks lend to merchants. The x-axis is the merchant's relative revenue η and the y-axis is the merchant's credit quality p. The shaded area denotes parameters for which a merchant receives credit from banks.

to $\bar{R}$ and benefits from transaction fees f and network externalities β when a merchant borrows and participates.

As discussed earlier, (3) binds. In fact, the objective function in problem (6) is weakly increasing in f_P. Moreover, with no competition from banks, the platform can extract all the surplus of a good merchant by setting interest rate $R_P = 1 - f$. We describe the platform's lending behavior in the following remark.

REMARK 2. When the platform is the only lender, a merchant with credit quality p receives funding if and only if

$$p + (1-p)\eta + \beta \geq \bar{R}. \tag{7}$$

In particular, a merchant with $\eta \geq \bar{R} - \beta$ receives a loan regardless of his credit quality.

Remark 2 is crucial to understand the platform's unique behavior and advantage as lender, especially when compared with Remark 1. First, unlike banks, the platform accounts for both credit quality and relative revenues when deciding whether to lend to a merchant or not. For a given credit quality, a merchant who benefits more from selling on the platform (i.e., a merchant with higher η) is more profitable to lend to. Second, the platform ignores credit quality when lending to a merchant who benefits substantially from being on the platform, that is, a merchant with $\eta \geq \bar{R} - \beta$. In this case, the repayment fees $f_P = \eta - f$ are sufficient to cover the platform's cost of capital.

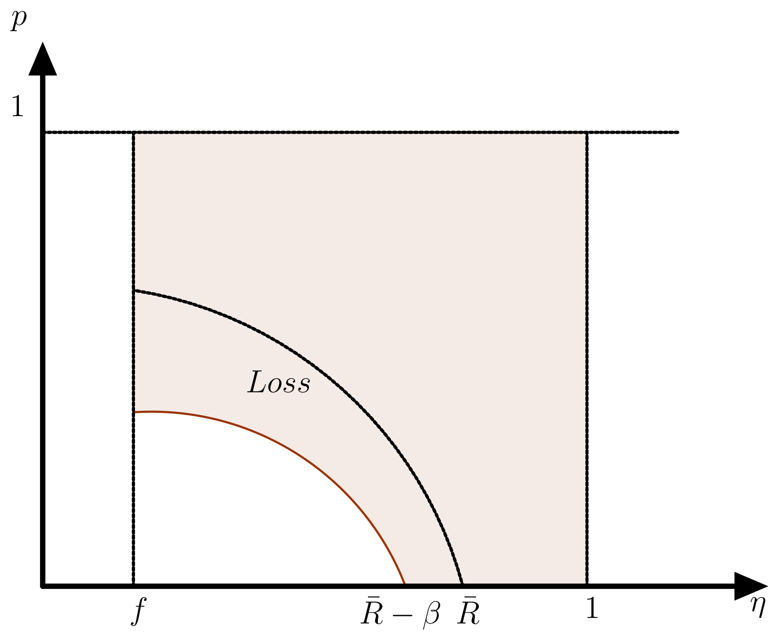

Figure 2: Equilibrium with platform as monopolistic lender. This figure illustrates the equilibrium when only the platform lends to merchants. The x-axis is the merchant's relative revenue η and the y-axis is the merchant's credit quality p. The shaded area denotes parameters for which a merchant receives credit from the platform. The red curved line denotes points for which $p + (1 - p)\eta + \beta = \bar{R}$. The black curved line denotes points for which $p + (1 - p)\eta = \bar{R}$.

Crucially for these observations to hold, the platform controls the product marketplace. The platform not only internalizes the transaction fees and network externalities generated by a merchant who borrows and participates in the marketplace, but also forces a bad borrower to repay an amount equal to $f_P = \eta - f$ using revenue-based repayments. Hence, the platform suffers from a less severe adverse-selection problem compared to banks. The adverse-selection problem is further alleviated when η increases, because the platform obtains larger repayments from bad borrowers. Hence, lending decisions are revenue-based and depend on η.

Figure 2 provides an illustration of the set of merchants who receive financing from the platform based on their credit quality p and relative revenues η. From the figure and equation (7), we observe that a larger set of merchants qualify for credit when network externalities, β, are stronger. Because of network externalities, the platform may even experience a loss on its loan, but it then earns increased fees from buyers who value the merchant's participation in the marketplace.

2.3 BORROWING WHEN THE PLATFORM COMPETES WITH BANKS

We now study the equilibrium when the platform competes with banks in the credit market. Unlike section 2.2, where lenders used pure strategies, here the equilibrium will be characterized by mixed strategies. See Lemma 2 below. Moreover, the merchant may now choose from several banks and the platform. We therefore further specify the timing and structure of the model, and we introduce some important notation.

First, competitive banks announce their lending mechanisms. A lending mechanism specifies the probability the bank offers a loan, $m_B = P(d_B = 1)$, and the distribution of the interests rate R_B offered conditional on extending a loan, $F_B(R) \coloneqq P(R_B \leq R)$. The platform also uses a lending mechanism for which it lends with probability $m_P = P(d_P = 1)$, and, conditional on lending, it offers interest rate R_P according to the distribution $F_P(R) \coloneqq P(R_P \leq R)$. It also charges repayment fees f_P satisfying (3). We define the following functions:

$$G_B(R) \coloneqq P(R_B \geq R) = 1 - \lim_{\varepsilon \to 0^+} F_B(R - \varepsilon)$$
$$G_P(R) \coloneqq P(R_P > R) = 1 - F_P(R).$$

The merchant selects a bank and simultaneously applies for a loan from it and from the platform. We assume the merchant suffers a non-pecuniary cost when applying to multiple banks.[10] The bank and the platform thus issue their lending decisions, (d_B, R_B) and (d_P, R_P), at the same time.

No good merchant accepts a credit offer with $R_J > 1 - f$. Hence, we assume without loss of generality that $F_B(1-f) = F_P(1-f) = 1$. If a good merchant receives offers from both lenders, that is, $d_B = d_P = 1$, he chooses to borrow at the lowest rate. Because a bad merchant does not repay the balance due, he chooses to borrow from the bank whenever $d_B = d_P = 1$ in order to avoid the increased transaction fees on the platform. If only one lender $J \in \{P, B\}$ agrees to lend, either type of merchant borrows from that lender. Finally, if both lenders deny credit, that is, $d_B = d_P = 0$, the merchant does not produce goods and obtains his outside option. The expected profit of a good merchant facing lending mechanisms (m_B, F_B) and (m_P, F_P) is thus

$$\begin{aligned} U(m_B, m_P, F_B, F_P) \coloneqq & [1 - (1-m_B)(1-m_P)](1-f) \\ & - m_B(1-m_P)\int_0^{1-f} R\, dF_B(R) - (1-m_B)m_P \int_0^{1-f} R\, dF_P(R) \end{aligned}$$

[10] Typically, when multiple banks pull the credit report of the borrower, the perceived credit quality of the borrower will be negatively affected going forward.

$$- m_B m_P \int_0^{1-f} \int_0^{1-f} \min\{R, R'\} \, dF_B(R) \, dF_P(R').$$

Conditional on lending at rate $R \leq 1 - f$, the expected profits of the platform are thus

$$L_P(R, m_B, G_B; p) := m_B p G_B(R)(R - \bar{R}) + (1 - m_B)[pR + (1 - p)\min\{\eta - f, R\} - \bar{R}] + f + \beta, \quad (8)$$

where we explicitly denote the dependence of the platform's profits on the merchant's credit quality. With probability m_B, the bank lends and the platform will be able to attract only good borrowers provided that $R \geq R_B$. With probability $(1 - m_B)$, the bank denies credit, and thus, the merchant necessarily borrows from the platform. With probability p, the merchant is good and will fully repay the loan. With probability $1 - p$, the merchant is bad and the platform can recover only the repayment fees f_P. In (8), we substituted $f_P = \eta - f$ because the incentive-compatibility constraint (3) binds. Regardless of whether the merchant is good or not, the platform enjoys revenues from transaction fees f and network externalities β.

Unlike section 2.2, where the platform earns zero profits when it does not lend, here the platform enjoys a better outside option. If the platform does not lend, it still earns from transaction fees, f, and network externalities, β, if a bank lends to the merchant, which happens with probability m_B. Hence, the payoff of a platform that does not lend is $m_B(f + \beta)$ instead of 0.

Conditional on lending at rate $R \leq 1 - f$, a bank obtains the following profits:

$$L_B(R, m_P, G_P; p) := p m_P G_P(R)(R - R_D) + p(1 - m_P)(R - R_D) - (1 - p)R_D. \quad (9)$$

With probability p, the merchant is good. If the platform offers a loans, the good merchant borrows from the bank only if $R_P > R$. If the platform does not offer a loan, the merchant necessarily borrows from the bank. With probability $1 - p$, the merchant is bad, and he borrows from the bank regardless of the interest rate and defaults. A bank that decides not to lend earns its outside option equal to 0.

Let $\Delta([0, 1 - f])$ be the set of non-decreasing, right-continuous functions satisfying $F(x) = 0$ for all $x < 0$ and $F(x) = 1$ for all $x \geq 1 - f$ for any $F \in \Delta([0, 1 - f])$. In this setting, we define an equilibrium as follows.

DEFINITION 1 (Equilibrium). *An equilibrium is a set of lending probabilities* $(m_P^*, m_B^*) \in [0, 1]^2$ *and rate distributions by the platform and the banks* $F_P^* \in \Delta([0, 1 - f])$ *and* $F_B^* \in \Delta([0, 1 - f])$ *with supports* $\mathcal{R}_P^*$ *and* $\mathcal{R}_B^*$ *and with* $G_B^*(R) := 1 - \lim_{\varepsilon \to 0^+} F_B^*(R - \varepsilon)$ *and* $G_P^*(R) := 1 - F_P^*(R)$*, such that:*

1. *Lenders set rates optimally:*

$$\mathcal{R}_P^* = \arg\max_{R \le 1-f} L_P(R, m_B^*, G_B^*; p)$$
$$\mathcal{R}_B^* = \arg\max_{R \le 1-f} L_B(R, m_P^*, G_P^*; p).$$

2. *Banks offer a competitive lending mechanism:*

$$(F_B^*, m_B^*) \in \arg\max_{F_B \in \Delta([0,1-f]), m_B \in [0,1]} U(m_B, m_P^*, F_B, F_P^*)$$
$$\text{s.t.} \quad L_B(R, m_P^*, G_P^*; p) \ge 0 \quad \text{for all } R \in \mathcal{R}_B^*.$$

3. *Lenders extend credit optimally:*

$$m_P^* \in \arg\max_{m_P \in [0,1]} \{m_P L_P(R, m_B^*, G_B^*; p) + (1 - m_P) m_B^*(f + \beta)\} \qquad \text{for any } R \in \mathcal{R}_P^*$$
$$m_B^* \in \arg\max_{m_B \in [0,1]} m_B L_B(R, m_P^*, G_P^*; p) \qquad \text{for any } R \in \mathcal{R}_B^*.$$

According to part Part 1, lenders select their rates in the set of best responses. According to Part 2, competitive banks offer the most attractive lending mechanism to the merchant subject to earning non-negative profits. Finally, according to Part 3, lenders decide whether to lend or not optimally when comparing profits from lending activity with their outside option.

Based on definition 1, one can immediately notice banks earn zero profits in equilibrium. If $L_B(R, m_P^*, G_P^*; p) > 0$ for all $R \in \mathcal{R}_B^*$, a competitive bank could increase the good merchant's expected profits and still be profitable by offering a better rate distribution, that is, a distribution $\hat{F}_B$ such that $\hat{F}_B(R) = F_B^*(R + \varepsilon)$ for a small enough $\varepsilon > 0$. We summarize this observation in the following remark.

REMARK 3. In equilibrium, banks earn zero profits, that is $m_B^* L_B(R, m_P^*, G_P^*; p) = 0$ for any $R \in \mathcal{R}_B^*$.

2.3.1 MARKET SEGMENTATION AND ADVANTAGEOUS SELECTION

We begin by exploring the general features of the equilibrium and the welfare implication of competition in the credit market. The following lemma establishes that, in equilibrium, the market will be segmented based on the merchant's credit quality.

Lemma 1 (Partial Segmentation). *For $p < \frac{R_D}{1-f}$, banks do no lend to the merchant, but if* (7) *holds, the platform lends with probability 1 at rate $1-f$. For $p > \frac{R_D}{\bar{R}}$, the merchant borrows exclusively from banks which offer loans with probability 1 at rate $\frac{R_D}{p}$.*

If $p < \frac{R_D}{1-f}$, all banks refuse to lend to the merchant, similar to Remark 1. Thus, the platform remains the only lender as long as (7) is satisfied. If $p > \frac{R_D}{\bar{R}}$, the platform cannot profitably compete with banks. When banks offer loans at the most competitive rate $\frac{R_D}{p}$, the platform could attract good borrowers by matching or undercutting the banks' interest rate. However, if $p > \frac{R_D}{\bar{R}}$, the platform's cost of capital exceeds the banks' competitive rate. Hence, because of banks' lower cost of capital, the platform cannot profitably compete with them for borrowers of high credit quality.

According to Lemma 1, when both banks and the platform compete as lenders, credit markets become partially segmented. Merchants of high credit quality borrower exclusively from banks, whereas merchants of low credit quality borrow exclusively from the platform, provided their relative revenues satisfy (7).

Markets are only partially segmented because, as we show in the next lemma, the platform and banks compete for borrowers of intermediate credit quality, $p \in \left[R_D/p, R_D/\bar{R}\right]$.

Lemma 2 (Mixed Strategies). *For $p \in \left[R_D/1-f, R_D/\bar{R}\right]$, banks offer loans with probability $m_B^* \in (0,1)$ and the platform offers loans with probability $m_P^* \in (0,1]$. Moreover, R_D/p is the minimum rate lenders are willing to offer; that is, $R_D/p = \min \mathcal{R}_B^* = \min \mathcal{R}_P^*$. Finally, lenders randomize rates over $[R_D/p, 1-f]$ so that $G_B^*(\cdot)$ and $G_P^*(\cdot)$ are strictly decreasing in $[R_D/p, 1-f]$.*

The platform and banks compete for borrowers of intermediate credit quality, and any equilibrium is characterized by mixed strategies. On the one hand, the platform lowers the interest rates it offers because of competition. On the other hand, compared with the benchmark model with only banks, merchants now pay higher rates with strictly positive probability. Moreover, merchants are rationed with positive probability if $1-(1-m_B^*)(1-m_P^*) < 0$. Whereas higher rates represent a transfer from merchants to lenders, credit rationing represents an unambiguous welfare loss.

Banks ration credit and increase rates because they suffer from a worse adverse selection problem compared with the benchmark model. Wheres good borrowers prefer the lender offering the lowest rate, bad borrowers prefer banks in order to avoid the increased fees in the marketplace. Therefore, conditional on public information, banks lend to a worse pool of borrowers than the platform.

By implementing revenue-based repayments through increased fees, the platform thus benefits from a form of *advantageous selection*, whereby bad borrowers self-exclude from borrowing from the platform when bank credit is available. Banks suffer the consequences in the form of an even more severe adverse selection problem.

The platform takes leverages on advantageous selection to enlarge the set of merchants it lends to. Compared with the benchmark model where the platform is a monopolistic lender, the platform now extends credit to a $p + (1-p)\eta + \beta \leq \bar{R}$, provided $p \geq R_D/(1-f)$. For this set of merchants, the platform profits exclusively from advantageous selection at the expense of banks. We further characterize the platform behavior in the following lemma.

LEMMA 3 (Platform Behavior). *Consider a merchant characterized by* $p \in [R_D/(1-f), R_D/\bar{R}]$. *If* $p+(1-p)\eta+\beta > \bar{R}$, *the platform lends with probability* $m_P^* = 1$. *If* $p+(1-p)\eta+\beta \leq \bar{R}$, *the platform is indifferent between offering a loan or not; that is,* $L_P(R_P, m_B^*, G_B^*; p) = m_B^*(f+\beta)$ *for any* $R_P \in \mathcal{R}_P^*$.

If a monopolistic platform profitably lends to a merchant, and hence, $p+(1-p)\eta+\beta > \bar{R}$, the platform keeps lending with probability 1 also when it competes with banks. If instead, the platform did not lend to a merchant because $p + (1-p)\eta + \beta \leq \bar{R}$, but $p \in [R_D/(1-f), R_D/\bar{R}]$, the platform collects rents from lending because of advantageous selection. In equilibrium, the rents are just enough to leave the platform indifferent between lending and not lending. Importantly, the amount of rents the platform can collect increases with the probability a bank lends, m_B^*.

We next fully characterize the equilibrium when $p \in [R_D/(1-f), R_D/\bar{R}]$. Based on Lemma 3, we distinguish two cases:

A: $p + (1-p)\eta + \beta > \bar{R}$ and $p \in [R_D/(1-f), R_D/\bar{R}]$;

B: $p + (1-p)\eta + \beta \leq \bar{R}$ and $p \in [R_D/(1-f), R_D/\bar{R}]$.

Figure 3 provides a graphical illustration of these two cases in the merchant's parameter space.

2.3.2 EQUILIBRIUM WITH COMPETITION: CASE A

We start with case A. By Lemma 3, the platform optimally lends with probability $m_P^* = 1$ even when competing against banks. By Lemma 2 and by Remark 3 with $m_P^* = 1$ and $m_B^* \in (0,1)$, the distribution of rates offered by the platform must be such that $L_B(R, 1, G_P^*; p) = 0$ for any $R \in [R_D/p, 1-f)$. This condition implies $P(R_P = 1-f) = \lim_{R \to (1-f)^-} G_P^*(R) = \frac{(1-p)R_D}{p(1-f-R_D)} > 0$. Hence, $1-f \in \mathcal{R}_P^*$.

Combining this observation with Lemma 2, we conclude the platform offers rates over the entire interval $[R_D/p, 1-f]$. Therefore, in equilibrium, banks must lend according to a

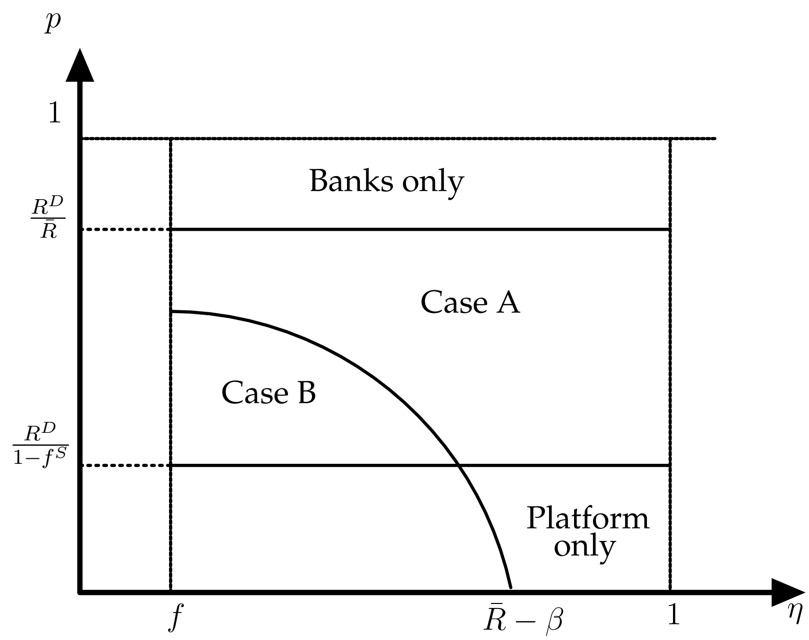

Figure 3: Equilibrium with Competition. The figure illustrates the equilibrium when the platform and banks are competing in the credit market. The x-axis is the merchant's relative revenue η and the y-axis is the merchant's credit quality p. The curved line denotes points such that $p + (1-p)\eta + \beta = \bar{R}$.

mechanism that leaves the platform indifferent between lending at any rate in $[R_D/p, 1 - f]$. We leverage on this observation to characterize the equilibrium.

PROPOSITION 1. *Consider a merchant with parameters satisfying case A. The equilibrium is uniquely characterized as follows.*

1. *Banks extend credit with probability*

$$m_B^* = \frac{p(1-f) - (1-p)\min\{R_D/p - (\eta - f), 0\} - R_D}{p(1-f) - (1-p)\min\{R_D/p - (\eta - f), 0\} - p\bar{R}} \tag{10}$$

   and, conditional on making an offer, they choose a rate from the support $\mathcal{R}_B^* = [R_D/p, 1-f)$ so that $P(R_B > R) = G_B^*(R)$, where

$$G_B^*(R) = \frac{R_D/p - \bar{R}}{R - \bar{R}} \frac{p(1-f-R) - (1-p)\min\{R - (\eta - f), 0\}}{p(1-f) - (1-p)\min\{R_D/p - (\eta - f), 0\} - R_D}. \tag{11}$$

2. *The platform extends credit with probability $m_P^* = 1$ and, conditional on making an offer, it chooses a rate from the support $\mathcal{R}_P^* = [R_D/p, 1-f]$ so that $P(R_P \geq R) = G_P^*(R)$, where*

$$G_P^*(R) = \frac{(1-p)R_D}{p(R - R_D)} \tag{12}$$

Compared with the benchmark model where the same merchant could borrow only from banks, banks are now offering worse terms to the merchant because, as discussed above, they suffer from worsened adverse selection. They therefore deny credit ($1-m_B^* > 0$) and offer rates strictly above R_D/p with positive probability. Although all merchants receive credit offers from at least one lender, merchants suffer from a welfare loss, because they now pay interest rates above R_D/p. Social welfare also declines, as we discus in section 2.3.4.

2.3.3 EQUILIBRIUM WITH COMPETITION: CASE B

We now consider merchants with parameters satisfying case B. With these parameters, the platform is unwilling to lend to merchants when it is the only lender in the market. However, as shown in Lemma 3, the platform is now indifferent between lending and not lending in equilibrium.

Thanks to advantageous selection in lending, the platform is able to extract rents from banks and cover its cost of capital. In particular, because the platform is indifferent between lending at any rate in $\mathcal{R}_P^*$ and not lending, from $L(R, m_B^*, G_B^*; p) = m_B^*(f + \beta)$, we obtain

$$G_B^*(R) = \frac{1 - m_B^*}{m_B^*} \frac{\bar{R} - pR - (1-p)(\eta - f) - f - \beta}{p(R - \bar{R})},$$

for any $R \in \mathcal{R}_P^*$. Because $m_B^* \in (0, 1)$ and $\sup \mathcal{R}_P^* = 1 - f$, we have $\lim_{R \to 1-f} G_B^*(R) > 0$. Therefore, banks offer the monopolistic rate $1 - f$ with strictly positive probability. Intuitively, the adverse-selection problem is so severe for banks that they occasionally lend at the monopolistic rate in equilibrium. By lending at the monopolistic rate, banks obtain profits when the platform denies credit to merchants. They use these profits to cover the losses they experience when the platform offers credit and benefits from advantageous selection.

The following proposition characterizes the equilibrium.

PROPOSITION 2. *Consider a merchant with parameters satisfying case B.The equilibrium is uniquely characterized as follows:*

1. *Banks extend credit with probability*

$$m_B^* = \frac{\bar{R} - R_D - (1-p)(\eta - f) - f - \beta}{(1-p)[\bar{R} - (\eta - f)] - f - \beta} \tag{13}$$

and, conditional on making an offer, they choose a rate from the support $\mathcal{R}_B^* = [R_D/p, 1 - f]$

so that $P(R_B \geq R) = G_B^*(R)$*, where*

$$G_B^*(R) = \frac{R_D/p - \bar{R}}{(R - \bar{R})} \frac{\bar{R} - pR - (1-p)(\eta - f) - f - \beta}{\bar{R} - R_D - (1-p)(\eta - f) - f - \beta}. \tag{14}$$

2. *The platform extends credit with probability*

$$m_P^* = \frac{1 - f - R_D/p}{1 - f - R_D} \tag{15}$$

and, conditional on making an offer, it chooses a rate from the support $\mathcal{R}_P^* = [R_D/p, 1-f]$ *so that* $P(R_P > R) = G_P^*(R)$*, where*

$$G_P^*(R) = \frac{(1-p)R_D}{p(1-f) - R_D} \frac{1 - f - R}{R - R_D}. \tag{16}$$

The merchant is rationed with probability $(1-m_B^*)(1-m_P^*) > 0$, whereas if banks were the only lenders, the merchants would always obtain financing. Furthermore, conditional on receiving a loan, the rate exceeds R_D/p with strictly positive probability.

In this case, the platform lends solely because it expects to profit from advantageous selection at the expense of banks. Banks thus lend more conservatively by denying credit and demanding higher rates, thus hurting borrowing merchants. In equilibrium, the platform earns enough profits to partially cover lending losses and be indifferent between lending and not lending.[11]

2.3.4 Welfare and Network Externalities

When the platform enters the lending market and competes with banks, it alters social welfare in equilibrium. We now study how welfare changes depending on the merchant's credit quality and revenues and on the strengthen of network externalities. We define *social welfare* as the expected added value in the market, that is, the expected gross revenues of the merchant minus the expected cost of capital required to finance the merchant. Social welfare, in equilibrium, also coincides with

$$U(m_B^*, m_P^*, F_B^*, F_P^*) + m_P^* L_P(R, m_B^*, G_B^*; p) + (1 - m_P^*)(f + \beta) \quad \text{for any } R \in \mathcal{R}_P^*,$$

because banks earn zero profits in equilibrium. We also study how the welfare of good a merchant, $U(m_B^*, m_P^*, F_B^*, F_P^*)$, changes when the platform enters the lending market.

[11] The platform makes lending losses equal to $(1-m_B^*)(f+\beta)$. However, it recovers $f+\beta$ from merchants' and buyers' fees, thus leaving the platform indifferent between lending and not.

The following corollary illustrates how welfare and, merchant's profit change when the platform enters the lending market.

COROLLARY 1. *Relative to the bank-only economy, when the platform competes with the banks, welfare changes as follows:*

1. *For merchants of high credit quality with $p > R_D/\bar{R}$, social welfare and good merchants' welfare remain unchanged.*
2. *For merchants of intermediate credit quality with $\frac{R^D}{1-f} < p \leq R_D/\bar{R}$, social and the good merchants' welfare decrease.*
3. *For merchants of low credit quality with $p \leq \frac{R^D}{1-f}$, social welfare increases for merchants satisfying* (7). *Otherwise, social welfare remains unchanged. In either case, good merchants' welfare remains unchanged.*

We omit the proof of this corollary and provide the justification here. A merchant with high credit quality continues to borrow exclusively from banks, even when the platform enters the market as a borrower. Therefore, we observe no change in welfare or the merchant's profit.

Merchants with intermediate credit quality may obtain financing from either banks or the platform. However, because the platform has a higher cost of capital, social welfare declines. Moreover, because of the platform's advantageous selection effect, a merchant with parameters satisfying case B is rationed with positive probability, lowering social welfare even further. Moreover, a good merchant also suffers from higher rates as banks require higher interest to cover for the additional losses they experience when the platform extracts advantageous-selection rents.

Finally, a merchant of low credit quality gains access to credit and generates revenues provided (7) holds. However, because the platform is a monopolistic lender in this region, it extracts the entire surplus from a good borrowers, leaving him with zero profits.

To conclude, we assess how network externalities affect the equilibrium in the lending market.

COROLLARY 2. *As the network externalities becomes stronger, that is as β increases, the region of merchants receiving loans with probability 1 increases. However, if a merchant remains rationed (i.e., $(1-m_B^*)(1-m_P^*) > 0$) after the increase in β, he will be rationed more frequently and will receive higher rates on average.*

When network externalities are stronger, the platform earns larger revenues when a merchant sells in the marketplace. Thus, the platform willingly takes larger financial losses on the loan and covers them with the increased marketplace revenues. Hence, a wider set of merchants satisfy case A and receive loans with probability 1. However, if a merchant still falls within case B and remains rationed, he will be rationed more frequently when the network externality is stronger. Intuitively, if the equilibrium lending probability of banks, m_B^*, remained fixed, the platform would enjoy larger advantageous-selection rents, $m_B^*(f+\beta)$, when network externalities are stronger. Banks would then have an incentive to lend more conservatively by lowering m_B^* and increasing rates.

3 Model with Information Acquisition

Another important feature of the bigtechs is their information advantage. In this section, we consider a platform that can acquire superior information about the borrower's credit quality. The platform and banks share a common prior p, but the platform can acquire an informative signal of the borrower's type at a cost $c > 0$. We study the equilibrium in the credit market when the cost of information acquisition is arbitrarily small.

3.1 Information-Acquisition Technology and The Winner's Curse

By paying a cost $c > 0$, the platform acquires a private signal s that is informative about the borrower's type g. Similar to He et al. (2020), we assume the platform may observe either a high or a low signal, and hence, $s \in \{h, l\}$.

The low signal fully reveals the borrower is bad, whereas the high signal offers increased (although not conclusive) evidence that the merchant is good. That is,

$$P(s = l|g = 1) = 0 \text{ and } P(s = l|g = 0) > 0.$$

Let

$$\psi := p + (1-p)P(s = h|g = 0)$$

be the probability the platform observes a high signal. Also let

$$p^h := P(g = 1|s = h) = \frac{p}{\psi}$$

be the platform's posterior belief after observing a high signal. When the platform observes a low signal, its posterior belief is $p^l := P(g = 1|s = l) = 0$.

The platform chooses whether to acquire the signal or not at a cost $c > 0$. The merchant and banks do not observe whether the platform acquires information. We allow for mixed strategies, and $a \in [0, 1]$ denotes the probability the platform acquires information.

We call a platform *uninformed* when it does not acquire information. If the platform acquires information and observes a high signal, we refer to it as *optimistic*. If it acquires information and observes a low signal, we refer to it as *pessimistic*. We denote the three types of the platform with subscript $i \in \{u, h, l\}$ respectively and define $p^u := p$.

When banks compete with a platform that acquires superior information, they suffer from the *winner's curse*. Banks cannot observe the information the platform acquires. When a borrower accepts their credit offer, they therefore fear the platform observed a low signal about the borrower and refused to lend. Banks will therefore lend more conservatively when the platform acquires information in equilibrium.

3.2 Benchmark Model: Information Acquisition without Bank Competition

Before studying the equilibrium with competition in the credit market, we start from a benchmark model where the platform is a monopolistic lender. When $\eta \geq \bar{R} - \beta$, the platform lends regardless of the merchant's creditworthiness. Even if the merchant is revealed to be bad, the platform lends nevertheless because transaction fees, network externalities, and revenue-based repayments are sufficient to cover the cost of capital for the loan. Because the platform lends at the monopolistic rate $1 - f$ regardless of the available information, it optimally chooses to *not* acquire information when $\eta \geq \bar{R} - \beta$, even if the cost of information acquisition c is infinitesimally small.

When $\eta < \bar{R} - \beta$, the platform values additional information because, after receiving a low signal, it may exercise the option to deny credit and avoid losses. First, consider a merchant with $p + (1-p)\eta + \beta \geq \bar{R}$. The platform profitably lends to this merchant when uninformed. However, if the merchant is bad, the platform will experience a loss. As a result, the platform optimally acquires information if the option value of identifying and denying credit to a bad merchant offsets the cost of information acquisition:

$$(1 - \psi)[\bar{R} - \eta - \beta] \geq c.$$

As long as the signal is informative and $\psi < 1$, the platform acquires information when c is small enough.

Next, consider $p + (1-p)\eta + \beta < \bar{R}$. In this situation, the platform would not lend if uninformed. However, it optimally acquires information if the option of observing a high signal and lending under optimistic belief p^h justifies the cost of information acquisition. That is,

$$\psi[p^h + (1 - p^h)\eta + \beta - \bar{R}] \geq c.$$

If $p^h + (1-p^h)\eta + \beta - \bar{R} > 0$, the platform optimally acquires information when $c \to 0$. It then lends only after observing a high signal. Finally, if $p^h + (1-p^h)\eta + \beta - \bar{R} \leq 0$, the platform chooses not to acquire information because it cannot expect positive profits even under optimistic beliefs.

We summarize the results in the following remark.

REMARK 4. Suppose the platform is a monopolistic lender and the cost of information acquisition is arbitrarily small. If $\eta \geq \bar{R} - \beta$, the platform does not acquire information and lends at rate $R_P = 1 - f$. If $\eta < \bar{R} - \beta$, the platform acquires information only if $p^h + (1-p^h)\eta + \beta - \bar{R} > 0$; it then lends at rate $R_P = 1 - f$ after observing a high signal, and it denies credit after observing a low signal. If, instead, $p^h + (1-p^h)\eta + \beta - \bar{R} \leq 0$, the platform refuses to lend and does not acquire information.

Note that as the degree of network externality β increases, the platform chooses to remain uninformed for a larger set of merchants. In section 3.3, we find analogous effects when the platform competes with banks.

3.2.1 WELFARE IMPLICATIONS

When the platform possesses the option to acquire information, social welfare changes whenever the option is exercised, that is, when $\eta < \bar{R} - \beta$. However, the effect is different for different borrowers. On the one hand, social welfare improves for both merchants characterized by $p^h + (1-p^h)\eta + \beta - \bar{R} > 0$ and $p + (1-p)\eta + \beta - \bar{R} < 0$: without the option to acquire information, the platform would deny credit to this merchant. However, when the platform can acquire information, it lends to this merchant only if it observes a high signal.

On the other hand, welfare deteriorates for a merchant with $p + (1-p)\eta + \beta - \bar{R} \geq 0$ and $\eta < \bar{R} - \beta$. Absent information acquisition, this merchant receives a loan offer with probability 1. With information acquisition, the platform denies credit after observing a bad signal. The platform enjoys larger profits because it denies credit to bad borrowers, but social welfare declines because profitable investment opportunities are foregone.

Finally, if $\eta \geq \bar{R} - \beta$, welfare remains unchanged when the platform is offered the option to acquire information at a cost. For these parameters, the platform optimally chooses to remain uninformed and lends to all merchants, regardless of credit quality.

3.2.2 SUBSTITUTABILITY BETWEEN NETWORK EXTERNALITIES AND INFORMATION

The model highlights that network externalities substitute for superior information when making loans. In particular, when the platform enjoys larger network externalities β, it chooses to remain uninformed for a larger set of parameters, because the set $\eta \geq \bar{R} - \beta$ expands as β increases. With larger network externalities, the platform enjoys larger benefits from merchants borrowing and selling in the marketplace. The platform thus relaxes its screening standards and willingly foregoes the opportunity to acquire information.

3.3 Information Acquisition and Competition

We now consider a platform and competitive banks offering loans to merchants. The platform and the banks possess a common prior p. The platform may then acquire an informative signal as discussed in section 3.1. The platform needs to pay a cost $c > 0$ to acquire the signal, and we consider the equilibrium in the limit where $c \to 0$.

Banks are unable to acquire the platform's signal. We therefore think of p as the best assessment of the merchant's credit quality based on standard credit-evaluation models. We interpret the platform's signal-acquisition technology as an evaluation model relying on innovative methodologies or alternative data. Banks do not observe whether the platform acquires the signal.

Similar to section 2.3, each bank announces a lending mechanism for which it lends with probability $m_B = E[d_B] \in [0, 1]$ and offers rates according to the distribution $F_B(R) := P(R_B \leq R)$. The merchant thus chooses one bank to apply for credit. We maintain the assumption the merchant faces large non-pecuniary costs that prevent him from applying to multiple banks.

After receiving an application, the platform privately acquires the signal with probability a. A platform of type $i \in \{u, h, l\}$ chooses a lending mechanism for which it lends with probability $m_{P,i} \in [0, 1]$ and offers rates according to a distribution $F_{P,i} := P(R_{P,i} \leq 0)$. Like in section 2, we define

$$
\begin{aligned}
G_B(R) &:= P(R_B \geq R) = 1 - \lim_{\varepsilon \to 0^+} F_B(R - \varepsilon) \\
G_{P,i}(R) &:= P(R_{P,i} > R) = 1 - F_{P,i}(R) \quad \text{for } i \in \{u, h, l\}.
\end{aligned}
$$

The merchant simultaneously receives credit decisions from the bank and the platform. If both extend credit, a good merchant selects the the offer with the lowest rate. We maintain the convention that, if rates are identical, the good merchant borrows from the platform. Because the merchant does not know whether the platform acquires information or not, the good merchant's expected utility is

$$
U^I(a, m_B, m_{P,u}, m_{P,h}, m_{P,l}, F_B, F_{P,u}, F_{P,h}, F_{P,l}) :=
$$

$$(1-a)U(m_B, m_{P,u}, F_B, F_{P,u}) + a[\psi U(m_B, m_{P,h}, F_B, F_{P,h}) + (1-\psi)U(m_B, m_{P,h}, F_B, F_{P,h})].$$

A bad merchant always selects the bank's offer if both lenders offer credit.

Given posterior p^i, the platform's profits conditional on lending at rate R are still given by the function $L_P(R, m_B, G_B; p^i)$ defined in (8) in section 2.3. In fact, conditional on lending at a given rate R, profits vary across platform types only because different types possess different beliefs.

Conditional on lending at rate R, a bank's profits now depend on the distribution of lending decisions of the three types of platform and on the probability the platform acquires information, a. If a bank offers a loan at rate R, its expected profits are thus

$$\begin{aligned} L_B^I(R, a, m_{P,u}, m_{P,h}, G_{P,u}, G_{P,h}; p) =& (1-a)p\left\{m_{P,u}G_{P,u}(R)(R-R_D) + (1-m_{P,u})(R-R_D)\right\} \\ &+ a\psi p^h\left\{m_{P,h}G_{P,h}(R)(R-R_D) + (1-m_{P,h})(R-R_D)\right\} \\ &- (1-p)R_D. \end{aligned}$$

With probability $1-a$, the platform does not acquire information, and if the merchant is good, he chooses the bank only if $R < R_P$ or if the platform does not lend, that is, $d_P = 0$. With probability a, the platform acquires information and, with probability ψ, it observes a high signal. A good merchant will, once again, choose the bank only if $R < R_P$ or $d_P = 0$. Regardless of whether the platform acquires information or not, a bad merchant always borrows from the platform and never repays.

In this framework, we define an equilibrium when the platform can acquire information at cost c.

DEFINITION 2 (Equilibrium with Information Acquisition)**.** *An equilibrium with information acquisition is an information-acquisition probability $a^{I*} \in [0,1]$, lending probabilities for the three platforms types and for banks, $(m_{P,u}^{I*}, m_{P,h}^{I*}, m_{P,l}^{I*}, m_B^{I*}) \in [0,1]^4$, distributions of the rates offered by the three types of the platform and by banks, $(F_{P,u}^{I*}, F_{P,h}^{I*}, F_{P,l}^{I*}, F_B^{I*}) \in \Delta([0, 1-f])^4$ with supports $\mathcal{R}_{P,u}^{I*}$, $\mathcal{R}_{P,h}^{I*}$, $\mathcal{R}_{P,l}^{I*}$, and $\mathcal{R}_B^{I*}$ and with $G_B^{I*}(R) := 1 - \lim_{\varepsilon \to 0^+} F_B^{I*}(R-\varepsilon)$ and $G_{P,i}^{I*}(R) := 1 - F_{P,i}^{I*}(R)$, such that:*

1. *Lenders set rates optimally:*

$$\mathcal{R}_{P,i}^{I*} = \arg\max_{R \le 1-f} L_P(R, m_B^{I*}, G_B^{I*}; p^i) \quad \textit{for } i \in \{u, h, l\}$$

$$\mathcal{R}_B^{I*} = \arg\max_{R \le 1-f} L_B^I(R, a^{I*}, m_{P,u}^{I*}, m_{P,h}^{I*}, G_{P,u}^{I*}, G_{P,h}^{I*}; p).$$

2. *Banks offer a competitive lending mechanism:*

$$(F_B^{I*}, m_B^{I*}) \in \arg \max_{F_B \in \Delta([0,1-f]), m_B \in [0,1]} U^I(a^{I*}, m_B, m_{P,u}^{I*}, m_{P,h}^{I*}, m_{P,l}^{I*}, F_B, F_{P,u}^{I*}, F_{P,h}^{I*}, F_{P,l}^{I*})$$
$$\text{s.t.} \quad L_B^I(R, a^{I*}, m_{P,u}^{I*}, m_{P,h}^{I*}, G_{P,u}^{I*}, G_{P,h}^{I*}; p) \geq 0 \quad \textit{for all } R \in \mathcal{R}_B^{I*}.$$

3. *Lenders extend credit optimally:*

$$m_{P,i}^{I*} \in \arg \max_{m_P \in [0,1]} \left\{ m_P L_P(R, m_B^{I*}, G_B^{I*}; p^i) + (1 - m_P) m_B^{I*}(f + \beta) \right\} \quad \textit{for any } R \in \mathcal{R}^{P,i}$$

for $i \in \{u, h, l\}$, *and*

$$m_B^{I*} \in \arg \max_{m_B \in [0,1]} m^B L_B^I(R, a^{I*}, m_{P,u}^{I*}, m_{P,h}^{I*}, G_{P,u}^{I*}, G_{P,h}^{I*}; p^u) \quad \textit{for any } R \in \mathcal{R}^B.$$

4. *The platform acquires information optimally:*

$$a^{I*} \in \arg \max_{a \in [0,1]} \Big\{ a[\psi L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h) + (1 - \psi) L_P^{I*}(m_B^{I*}, G_B^{I*}; p^l) - c] \tag{17}$$
$$+ (1 - a) L_P^{I*}(m_B^{I*}, G_B^{I*}; p^u) \Big\}, \tag{18}$$

where

$$L_P^{I*}(m_B^{I*}, G_B^{I*}; p^i) := m_{P,i}^{I*} L_P(R, m_B^{I*}, G_B^{I*}; p^i) + (1 - m_{P,i}^{I*}) m_B^{I*}(f + \beta)$$
$$\textit{for any } R \in \mathcal{R}^{P,i}, i \in \{u, h, l\}.$$

Similar to section 2.3, competitive banks earn zero profits in equilibrium.

REMARK 5. In equilibrium, banks earn zero profits, that is

$$m_B^{I*} L_B^I(R, a^{I*}, m_{P,u}^{I*}, m_{P,h}^{I*}, G_{P,u}^{I*}, G_{P,h}^{I*}; p) = 0 \quad \text{for any } R \in \mathcal{R}_B^{I*}.$$

Moreover, the nature of the equilibrium depends on the prior belief about the creditworthiness of the merchants, p, and the relative revenues of the merchants, η. Before solving for the equilibrium, we characterize some general properties in the following lemmas.

LEMMA 4 (Lending with Optimistic Beliefs). *If* $a^{I*} \in (0, 1]$, *then* $m_{P,h}^{I*} = 1$. *That is, if the platform acquires information with positive probability, then it lends after observing a high signal.*

Intuitively, if the platform weakly prefers to abstain from lending after observing good news about the borrower, it would strictly prefer to deny credit with no or worse news. Because not lending is the platform's optimal strategy regardless of information, costly information acquisition is sub-optimal. We therefore rule out equilibria where the platform denies credit after acquiring a high signal. Thus, hereafter, we consider $m_{P,h}^{I*} = 1$.

Next, we observe that Lemma 1 holds also for an equilibrium with information acquisition. When $p > \frac{R_D}{\bar{R}}$, banks remain the only lenders because the platform's cost of capital exceeds banks' competitive rate R_D/p. When $p < R_D/(1-f)$, banks are unwilling to enter the lending market because the merchant's creditworthiness is too low to justify the loan, even if the platform were not competing. Hence, like in 2.3, the platform is a monopolistic lender when $p < R_D/(1-f)$.

We also obtain the counterpart of Lemma 2.

LEMMA 5 (Mixed Strategies with Information Acquisition)**.** *Banks offer loans with probability $m_B^{I*} \in (0,1)$. Moreover, banks and the platform offer rates so that $G_B^{I*}(\cdot)$ and $(1-a^{I*})G_{P,u}^{I*}(\cdot) + a^{I*}G_{P,h}^{I*}(\cdot)$ are strictly decreasing in $[R_D/p, 1-f]$ and $R_D/p = \min \mathcal{R}_B^{I*} = \min\{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\}$.*

Banks always deny credit with positive probability and offer rates in a continuous interval exceeding the competitive rate R_D/p. The uniformed platform and the optimistic platform *combined* also offer rates that span the entire interval from R_D/p to $1-f$. However, the uninformed and optimistic platform may offer rates over different supports, as Lemma 6 ahead shows.

Going forward, we focus on situations in which the platform and banks compete in the lending market; that is, $p \in [R_D/(1-f), R_D/\bar{R}]$. For these parameters, we need to distinguish the following four cases:

I.A: $\eta \geq \bar{R} - \beta$ and $p \in [R_D/(1-f), R_D/(\eta - f)]$;

I.B: $\eta < \bar{R} - \beta$, $p \in [R_D/(1-f), R_D/\bar{R}]$, and $p^h + (1-p^h)\eta + \beta > \bar{R}$;

I.C: $\eta < \bar{R} - \beta$, $p \in [R_D/(1-f), R_D/\bar{R}]$, and $p^h + (1-p^h)\eta + \beta \leq \bar{R}$;

I.D: $p \in [R_D/(1-f), R_D/\bar{R}]$ and $p > R_D/(\eta - f)$.

Figure 4 provides an illustration of how these cases partition the parameter space.

In cases I.A, I.B, and I.C, parameters satisfy $p \leq R_D/(\eta - f)$, whereas in case I.C, we have $p > R_D/(\eta - f)$. The following lemma shows the platform's equilibrium behavior changes between these two sets of parameters.

Lemma 6 (Interest-Rate Strategy). *For merchants with prior* $p \leq R_D/(\eta - f)$, $\mathcal{R}^{I*}_{P,u} = \mathcal{R}^{I*}_{P,h}$ *and* $\mathcal{R}^{I*}_{P,l} = [R_D/p, 1-f]$. *For merchants with* $p \in \big(R_D/(\eta - f), R_D/\bar{R}\big]$, $\sup \mathcal{R}^{I*}_{P,h} \leq \inf \mathcal{R}^{I*}_{P,u}$ *and* $\mathcal{R}^{I*}_{P,l} = [\eta - f, 1-f]$.

Therefore, in cases I.A, I.B, and I.C, the rates that maximize the platform's profit do not depend on information. Therefore, the platform has an incentive to acquire information only if information helps the platform avoid bad borrowers. In case I.D, the platform offers different rates depending on the signal it receives. With superior information, the platform better tailors rate offers to compete with banks. In other words, the platform uses superior information to undercut banks after acquiring positive information about the merchant.

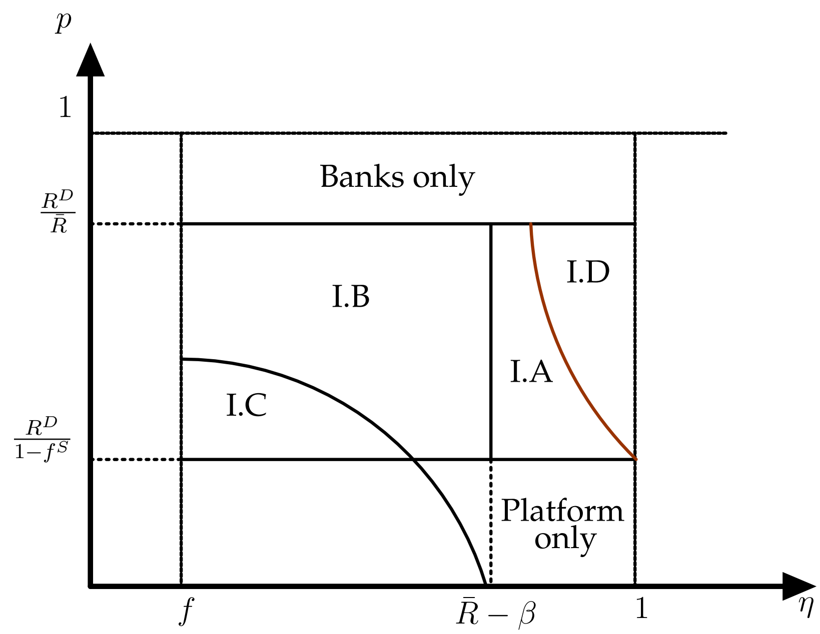

Figure 4: Equilibrium with Competition and Information Acquisition. This figure illustrates the equilibrium for different merchant types when the platform has superior information-acquisition technology and is competing with banks. The x-axis is the merchant's relative revenue η and the y-axis is the merchant's credit quality p. The black curved line denotes points such that $\frac{p}{\psi} + (1 - \frac{p}{\psi})\eta + \beta = \bar{R}$. The red curved line denotes points such that $p = \frac{R_D}{\eta - f}$.

3.3.1 Case I.A: High revenues and mid-low prior

We first consider case I.A. These merchants enjoy sufficiently large relative revenues such that fees alone cover the platform's cost of capital. Moreover, by Lemma 6, the optimal response of the platform R_P^{I*} is independent of its information; hence, we have

$$\psi L(R_P^{I*}, m_B^{I*}, G_B^{I*}, p^h) + (1-\psi) L(R_P^{I*}, m_B^{I*}, G_B^{I*}, p^l) - c < L(R_P^{I*}, m_B^{I*}, G_B^{I*}, p^u).$$

As a result, with any positive cost of information acquisition, the platform optimally chooses not to acquire information, and the equilibrium is the same as described in Proposition 10.

PROPOSITION 3. *Consider a merchant with parameters satisfying I.A. For any $c > 0$, the equilibrium is uniquely characterized by $a^{I*} = 0$ and $m_{P,u}^{I*} = 1$. Moreover, $G_{P,u}^{I*}(R) = G_P^*(R)$, $m_B^{I*} = m_B^*$, and $G_B^{I*}(R) = G_B^*(R)$ as given, respectively, by equations* (11), (10), *and* (11).

When a merchants enjoys large relative revenues or generates large network externalities, the platform chooses not to acquire information, even if information is arbitrarily cheap. Thus, even when competing with banks, on-platform revenues and network externalities substitute for information. However, as we discuss in case I.D ahead, an exception applies for merchants with high credit quality, for whom banks compete aggressively.

3.3.2 CASE I.B: LOW REVENUES AND MID-HIGH PRIOR

We next consider case I.B. For these parameters, the platform obtains positive profits only when lending to a good borrower. Hence, after acquiring information, a platform will deny credit if the merchant is revealed to be bad. It will extend credit if the signal is good. For an arbitrarily low cost of information acquisition c, the value of the option to screen borrowers exceeds the cost, as discussed in the benchmark model in section 3.2, and the platform thus acquires information.

The following proposition characterizes the equilibrium for case I.B.

PROPOSITION 4. *Consider a merchant with parameters satisfying I.B. There exists $\epsilon > 0$ such that, for any $c \in (0, \epsilon)$, the equilibrium is characterized uniquely as follows:*

1. *The platform acquires information with probability $a^{I*} = 1$.*

2. *A pessimistic platform offers loans with probability $m_{P,l}^{I*} = 0$, whereas an optimistic platform offers loans with probability $m_{P,h}^{I*} = 1$. The optimistic platform chooses a rate from the support $\mathcal{R}_{P,h}^{I*} = [R_D/p, 1-f]$ so that $G_{P,h}^{I*}(R) = G_P^*(R)$ as given by* (11).

3. *Banks offer loans with probability $m_B^{I*} = m_B^*$ as given by* (10) *and, conditional on making an offer, they choose a rate from the support $\mathcal{R}_B^{I*} = [R_D/p, 1-f)$ so that $G_B^{I*}(R) = G_B^*(R)$ as given by* (11).

Similar to section 3.2, the platform acquires information and lends only after observing a high signal. The banks' lending probability and distribution of rate offers is identical to case A of section 2.3. Moreover, the optimistic platform offers interest rates from the same distribution of the uninformed platform in case A of section 2.3, when the platform had no option to acquire information. However, now, the platform lends only with probability $\psi < 1$, because it refuses to lend if the merchant is revealed to be bad. Whereas the merchant was not rationed in case A, he is now rationed with probability $(1-\psi)(1-m_B^{I*}) > 0$.

3.3.3 Case I.C: Low revenues and mid-low prior

We now study a merchant whose parameters satisfy I.C. Unlike the previous two cases, the platform would not extend credit even after observing a high signal if it were a monopolistic lender. However, similar to case B in section 2.3, the platform benefits from advantageous selection at the expense of banks. It therefore lends with positive probability in equilibrium to extract advantageous-selection rents.

We first rule out equilibria with no information acquisition. Such equilibria would be like those in Proposition 4, where the uninformed platform is indifferent between lending at a rate $[R_D/p, 1-f]$ and not lending. For a small enough c, the platform would profitably deviate by acquiring information and earn positive profit. In fact, for any $R \in [R_D/p, 1-f]$ as $c \to 0$,

$$\begin{aligned}
&\psi L_P^{I*}(m_b^{I*}, G_b^{I*}; p^h) + (1-\psi) L_P^{I*}(m_b^{I*}, G_b^{I*}; p^l) - c \\
>&\psi L(R, m_b^{I*}, G_b^{I*}; p^h) + (1-\psi) L(R, m_b^{I*}, G_b^{I*}; p^l) - c = L^{I*}(m_b^{I*}, G_b^{I*}; p^u).
\end{aligned}$$

So the platform would strictly prefer to acquire information.

The following proposition characterizes the equilibrium and shows that the platform acquires information with probability strictly between 0 and 1.

Proposition 5. *Consider a merchant with parameters satisfying I.C. There exists $\epsilon > 0$ such that, for any $c \in (0, \epsilon)$, the equilibrium is uniquely characterized as follows:*

1. *The platform acquires information with probability $a^{I*} \in (0,1)$ equal to m_P^* from equation* (15).
2. *The uninformed and the pessimistic platform do not lend; that is, $m_{P,u}^{I*} = m_{P,l}^{I*} = 0$. The optimistic platform lends with probability $m_{P,h}^{I*} = 1$ and offers rates in $\mathcal{R}_{P,h}^{I*} = [R_D/p, 1-f]$ so that $G_{P,h}^{I*}(R) = G_P^*(R)$ as given by* (16).

3. *The bank lends with probability* $m_B^{I*} \in (0,1)$ *given by* (A.5) *in Appendix A and offers rates in* $\mathcal{R}_B^{I*} = [R_D/p, 1-f]$ *so that* $G_B^{I*}(R)$ *is given by* (A.6) *in Appendix A. Moreover,* $m_B^{I*} < m_B^*$*, where* m_B^* *is given as in* (13).

The platform acquires information with probability a^{I*} that is equal to its lending probability in case B of section 2.3. However, it denies credit at a higher probability, to equal $1 - a^{I*}\psi$. Moreover, banks offer loans with lower probability than in case B. Therefore, credit is rationed more often when the platform can acquire information, because of the combined effect of the platform's better screening and of banks' reluctance to lend because of their winner's curse.

3.3.4 CASE I.D: HIGH REVENUES AND MID-HIGH PRIOR

Finally, we consider parameters satisfying I.D. For this set of parameters, we have $\eta > f + \bar{R} > \bar{R} - \beta$. Therefore, with no competition from banks, the platform would not acquire information, as shown in Remark 4.

When banks compete with the platform, however, the result changes. A merchant with $p > R_D/(\eta - f)$ enjoys large relative revenues, and the platform could charge high repayment fees to cover its cost of capital. However, the merchant is also of relatively high credit quality, and banks compete aggressively to lend to him. As a result, the platform has an incentive to acquire information to gain an additional advantage over banks.

We begin by observing that, in this case, the platform acquires information with probability strictly between 0 or 1. If the platform never acquired information, the equilibrium would be like the one in Proposition 3, where the (uninformed) platform is indifferent between lending at any rate in $[R_D/p, 1-f]$. Because of the parameters considered in this case, we have that, if $R_1 < R_2$ and

$$L(R_1, m_B^{I*}, G_B^{I*}; p^u) = L(R_2, m_B^{I*}, G_B^{I*}; p^u),$$

then

$$L(R_1, m_B^{I*}, G_B^{I*}; p^h) \geq L(R_2, m_B^{I*}, G_B^{I*}; p^h)$$

with strict inequality if $R_1 < \eta$. We have also that

$$L(R_1, m_B^{I*}, G_B^{I*}; p^l) \leq L(R_2, m_B^{I*}, G_B^{I*}; p^l).$$

Therefore, if c is small enough, a platform would profitably deviate by acquiring information and lending at rate R_D/p if it observes a high signal, or lending at rate $1-f$ if it observes a low signal.

If instead, the platform acquired information with probability 1, by lemma 5, the optimistic platform would be indifferent between rates in $[R_D/p, 1-f]$. Similar to the reasoning above, $1-f$ would belong to the set of best responses of the platform, regardless of information. The platform would thus choose to deviate by not acquiring information.

Therefore, the platform acquires information with probability $a^{I*} \in (0,1)$ when the cost of information acquisition, c, is sufficiently small. The following proposition fully characterizes the equilibrium.

PROPOSITION 6. *Consider a merchant with parameters satisfying I.D. There exists $\epsilon > 0$ such that, for any $c \in (0, \epsilon)$, the equilibrium is uniquely characterized as follows.*

1. *The platform acquires information with probability $a^{I*} \in (0,1)$ given by* (A.8) *in Appendix A.*

2. *The platform lends with probability 1 regardless of its information; that is $m^{I*}_{p,u} = m^{I*}_{p,h} = m^{I*}_{p,l} = 1$. Moreover, there exists $R^{I*}_c \in (R_D/p, 1-f)$, whose expression is given by* (A.12) *in Appendix A, such that the uninformed platform offers rates in $\mathcal{R}^{I*}_{P,u} = [R^{I*}_c, 1-f]$ so that*

$$G^{I*}_{P,u}(R) = \frac{R^{I*}_c - R_D}{R - R_D} \tag{19}$$

and the optimistic platforms offers rates in $\mathcal{R}^{I*}_{P,h} = [R_D/p, R^{I*}_c]$ so that

$$G^{I*}_{P,h}(R) = \frac{(1-p)R_D(R^{I*}_c - R)}{(pR^{I*}_c - R_D)(R - R_D)}. \tag{20}$$

The pessimistic platform offers rates in $\mathcal{R}^{I*}_{P,h} = [\eta - f, 1]$ so that $P(R^l \geq \eta - f) = 1$.

3. *The bank lends with probability $m^{I*}_B \in (0,1)$ given by* (A.9) *in Appendix A and offers rates in $\mathcal{R}^{I*}_B = [R_D/p, 1-f)$ so that G^{I*}_B is a continuous function given by* (A.10) *for $R \leq R^{I*}_c$ and given by* (A.11) *for $R \geq R^{I*}_c$. Moreover, $m^{I*}_B < m^*_B$, where m^*_B is given as in* (10).

In this case, the platform acquires information in order to undercut banks and more aggressively compete for merchants with high revenues and good credit quality. The platform lends regardless of the information it has. However, it offers lower rates to merchants it believes to be of better credit quality. In response, banks lend less frequently because they fear losses due to their winner's curse.

3.3.5 VALUE OF INFORMATION AND ADVANTAGEOUS SELECTION

As the results in this section illustrate, the platform does not always value information, even when it competes with banks with a lower cost of capital. In particular, in case I.A, the platform does not acquire information when a merchant has large relative revenues or generates strong network externalities, provided his credit quality is not too high.

Only in case I.B does the platform strictly prefer to acquire information in equilibrium. Compared with an equilibrium where the platform cannot acquire information, its profits increase by at least[12]

$$(1-\psi)(1-m_B^{*I})[\bar{R}-\eta-\beta]-c,$$

as we show in the proof of Corollary 3 ahead. The platform benefits from information because, after observing a low signal, it avoids lending to a bad merchant and loses $\bar{R}-\eta-\beta$ when the bank denies credit.

In cases I.C and I.D, the platform acquires information with positive probability, but, in equilibrium, it is indifferent between being informed or uninformed. In case I.D, the platform uses information to offer lower rates after observing a high signal, thus increasing the chances of undercutting banks. When we compare case I.D and case A of section 2, in both situations, the platform's equilibrium profits are

$$m_B p(R_D/p-\bar{R})+(1-m_B)(R_D/p-\bar{R})+f_S+\beta,$$

with $m_B = m_B^{I*}$ in case $I.D$ and $m_B = m_B^*$ in case A. Because $m_B^{I*} < m_B^*$, equilibrium profits increase when the platform has the option to acquire information.

In case I.C, the platform uses information to avoid lending to bad merchants. For a small c, equilibrium profits in case I.C and in case B of section 2 are

$$m_B(f+\beta),$$

with $m_B = m_B^{I*}$ in case I.C and $m_B = m_B^*$ in case B. Because $m_B^{I*} < m_B^*$, the platform earns lower equilibrium profits when it has the option to acquire information. The following corollary summarizes the results on the value of information in equilibrium.

COROLLARY 3 (Value of Information in Equilibrium)**.** *The equilibrium value of information for the platform depends on parameters.*

1. *In case I.A, the platform earns the same profits with or without the option to acquire information.*

2. *In cases I.B and I.D, the platform earns higher equilibrium profits when it has the option to acquire information.*

[12]The platform may also obtain additional benefits if information allows expansion of the pool of borrowers or profitable lending in the absence of advantageous selection.

3. *In case I.C, the platform earns lower equilibrium profits when it has the option to acquire information.*

Therefore, the platform does not necessarily value the option to acquire information. Information is valuable when banks compete aggressively for high-revenues borrowers (case I.D) or when the platform can avoid bad borrowers in a situation of moderate advantageous selection (case I.C). In other cases, information is either useless or detrimental in equilibrium. In case I.A, banks do not compete fiercely enough for borrowers with large relative revenues to justify the (infinitesimal) cost of acquiring information. In case I.D, the platform profits solely because of advantageous selection. When the platform can acquire information, banks suffer also from a winner's curse. They thus lend less frequently, reducing the scope for the platform to collect advantageous-selection rents.

To better understand the important role of advantageous selection for the profitability of information, compare cases I.C and I.D. In both cases, the platform acquires information with positive probability. In both cases, because of the winner's curse, banks reduce their lending probability compared with the equilibrium in section 2. However, profits for the platform change in different ways: profits increase in case I.D and decline in case I.C.

In case I.D, the platform earns profits by lending to merchants even if it is a monopolistic lender. Hence, when banks reduce credit, the platform benefits from lower competition in a profitable lending business. In case I.C, the platform profits only because of advantageous selection: absent banks, the platform is unwilling to lend. As banks reduce credit because of their winner's curse, the platform sees reduced opportunities to collect rents from advantageous selection.

4 CONCLUSIONS

As a monopolistic provider of the marketplace, a platform increases transaction fees for borrowing merchants, who willingly pay the additional fees to maintain access to the marketplace. The platform thus implements a revenue-based repayment plan. It can therefore extend credit to merchants of low credit quality that are fully rationed by banks, increasing social welfare in this segment of the market.

For merchants of intermediate credit quality, the platform competes with banks and benefits from advantageous selection. In this segment of the credit market, social welfare declines when merchants have the option to borrow from the platform. In particular, banks lend more conservatively by denying credit more often and increasing rates. Banks do so to cover the losses they incur when the platform extracts advantageous-selection rents from them. When merchants generate larger network externalties on the platform's marketplace, the platform lends more liberally but banks restrict credit, generating ambiguous welfare effects.

We show merchants' revenues and network externalities substitute for information. When a merchant's on-platform revenues or network externalities are large enough, the platform optimally forfeits the option to acquire information about a merchant's credit quality, provided banks do not compete too fiercely for such a merchant. Furthermore, when the platform profits exclusively by extracting advantageous-selection rents from banks, its equilibrium profits decline when it is given the option to acquire superior information.

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A Proofs

A.1 Proof of Lemma 1

When $p < R_D/(1-f)$, for any $R \leq 1-f$ we have

$$L_B(R, m_P^*, G_P^*; p) \leq p(1-f) - R_D < 0$$

and, hence, banks prefer not lend and, hence, $m_B^* = 0$. The platform is thus a monopolistic lender for a merchant provided (7) is satisfied, and the results of section 2.2.2 apply. In particular, $m_P^* = 1$ and $\mathcal{R}_P^* = \{1-f\}$ if (7) holds, and $m_P^* = 0$ otherwise.

Consider now $p > R_D/\bar{R}$. From (8) and Definition 1, we have that $R \notin \mathcal{R}_P^*$ if $R < \bar{R}$. Therefore, $\mathcal{R}_P^* \subseteq [\bar{R}, 1-f]$. Because $\inf \mathcal{R}_P^* \geq \bar{R} > R_D/p$, the competitive lending mechanism satisfying condition 2 of Definition 1 is given by $F_B^*(R) = 1$ for $R \in [R_D/p, 1-f]$ and $m_B^* = 1$. That is, banks always lend at their competitive rate R_D/p. Because $\inf \mathcal{R}_P^* > \sup \mathcal{R}_B^* = R_D/p$, both the good and the bad merchant borrow exclusively from banks in equilibrium. □

A.2 Proof of Lemma 2

By way of contradiction, suppose $m_B^* = 0$. Then $\mathcal{R}_P^* = \{1-f\}$ and $G_P^*(R) = \mathbb{I}(R < 1-f)$. Then, for any $m_P^* \in [0,1]$ and $\varepsilon \in (0, 1-f-R_D/p)$, $L_B(R_D/p + \varepsilon, m_P^*, G_P^*; p) > 0$, contradicting that $m_B^* = 0$ is the bank's equilibrium strategy.

Similarly, suppose $m_P^* = 0$, then $\mathcal{R}_B^* = \{R_D/p\}$ and $m_B^* = 1$. For a small enough $\varepsilon > 0$, $L_P(R_D/p - \varepsilon, 1, G_B^*; p) > 0$, which contradicts $m_P^* = 0$. Hence $m_P^* > 0$.

Because $m_B^* > 0$, by Remark 3 we have $L_B(R, m_P^*, G_P^*; p) = 0$ for all $R \in \mathcal{R}_B^*$. Therefore

$$G_P^*(R) \leq \frac{1-m_P^*}{m_P^*} \frac{R_D - pR}{p(R-R_D)} + \frac{(1-p)R_D}{p(R-R_D)}, \tag{A.1}$$

with equality for $R \in \mathcal{R}_B^*$ and strict inequality for $R \notin \mathcal{R}_B^*$.

We then need to show that, in any equilibrium, $G_B^*(\cdot)$ and $G_P^*(\cdot)$ are strictly decreasing in $[R_D/p, 1-f]$ and that $R_D/p = \min \mathcal{R}_B^* = \min \mathcal{R}_P^*$. First, we show that $\inf \mathcal{R}_B^* = R_D/p$. We proceed by contradiction and assume that there exists $R_1 = \inf \mathcal{R}_B^*$ such that $R_1 > R_D/p$. Then $L_P(R_1, m_B^*, G_B^*; p) > L_P(R, m_B^*, G_B^*; p)$ for all $R < R_1^*$. Hence $\inf \mathcal{R}_P^* \geq R_1$ and $G_P^*(R) = 1$ for any $R < R_1$. But then $L_B(R_1 - \varepsilon, 1, G_P^*; p) > 0$, contradicting that $\mathcal{R}_B^*$ is the set of the banks' best responses. Therefore $R_D/p = \inf \mathcal{R}_B^*$.

Next, we show $R_D/p \in \mathcal{R}_B^*$. We proceed by contradiction again and assume that $R_D/p \notin \arg\max_R L_B(R, m_P^*, G_P^*; p)$. Then, by (A.1), $G_P^*(R_D/p) < 1$. Because $R_D/p = \inf \mathcal{R}_B^*$, there exists a sequence $(\varepsilon_n)_n$ with $\varepsilon_n > 0$ and $\varepsilon_n \to 0$ such that $R_D/p + \varepsilon_n \in \mathcal{R}_B^*$ for all n. Hence, by (A.1), $G_P^*(R_D/p + \varepsilon_n) \to 1 > G_P^*(R_D/p)$. But this results contradicts the assumption that $F_P^*(\cdot) = 1 - G_P^*$ is a non-decreasing function. Hence, $R_D/p \in \mathcal{R}_B^*$.

To continue with the proof, we observe that, because of (A.1), if $R \in \mathcal{R}_B^*$, then for every $\varepsilon > 0$, $G_P^*(R+\varepsilon) < G_P^*(R)$. Hence, there exists $R' \in (R, R+\varepsilon)$ such that $R' \in \mathcal{R}_P^*$.

Using this observation, we show that $G_B^*(\cdot)$ is strictly decreasing in $[R_D/p, 1-f]$. Suppose, for sake of contradiction, $R_1 \in \mathcal{R}_B^*$ and $\delta > 0$ exist such that $G_B^*(R) = G_B^*(R')$

for any $(R, R') \in (R_1, R_1 + \delta)^2$. By the previous observation, $G_P^*(R_1 + \varepsilon) < G_P^*(R_1)$ for ε small enough and there exists $R'' \in (R_1, R_1 + \varepsilon)$ such that $R'' \in \mathcal{R}_P^*$. However, $L_P(R_1 + \delta, m_B^*, G_B^*; p) > L_P(R'', m_B^*, G_B^*; p)$, contradicting that R'' is a platform's best response. Therefore, $G_B^*(\cdot)$ is strictly decreasing in $[R_D/p, 1-f]$ and $[R_D/p, 1-f) \subseteq \mathcal{R}_B^*$.

To show that $G_P^*(R)$ is strictly decreasing $[R_D/p, 1-f]$, notice that (A.1) holds as an equality over $[R_D/p, 1-f)$ and, hence, $G_P^*(R)$ is strictly decreasing. Therefore, we also have $(R_D/p, 1-f) \subseteq \mathcal{R}_P^*$.

We then show $R_D/p = \min \mathcal{R}_P^*$. Because we showed $R_D/p = \min \mathcal{R}_B^*$, then $L_(R_D/p, m_B^*, G_B^*; p) > L_(R, m_B^*, G_B^*; p)$ for any $R < R_D/p$. Moreover, because $(R_D/p, 1-f) \subseteq \mathcal{R}_P^*$, $R_D/p = \inf \mathcal{R}_P^*$. For sake of contradiction, suppose $R_D/p \notin \mathcal{R}_P^*$ and, hence, $L_P(R_D/p, m_B^*, G_B^*; p) < L_P(R, m_B^*, G_B^*; p)$ for any $R \in \mathcal{R}_P^*$. Then, there exists a sequence $(R_n)_n$ converging to R_D/p such that $R_n > R_D/p$ and $R_n \in \mathcal{R}_P^*$ for all n. However, $L_P(R_D/p, m_B^*, G_B^*; p) < \lim_{n\to\infty} L_P(R_n, m_B^*, G_B^*; p)$ implies $G_B^*(R_D/p) < \lim_{n\to\infty} G_B^*(R_n)$, which contradicts the assumption that $G_B^*(\cdot)$ is a non-increasing function. Hence, $R_D/p = \min \mathcal{R}_B^*$.

It remains to show that $m_B^* < 1$. By way of contradiction, suppose $m_B^* = 1$. Then, $L_P(R, 1, G_B^*; p) = pG_B^*(R)(R - \bar{R}) = p(R_D/p - \bar{R}) > 0$ for any $R \in [R_D/p, 1-f) \subseteq \mathcal{R}_P^*$. Hence $m_P^* = 1$, $G_B^*(R) = \frac{R_D/p - \bar{R}}{R - \bar{R}}$ and, in particular, $\lim_{R\to 1-f} G_B^*(R) > 0$, thus implying that $1-f \in \mathcal{R}_B^*$. However, $L_B(1-f, 1, G_P^*; p) < 0$, contradicting that $1-f \in \mathcal{R}_B^*$. Therefore, $m_B^* < 1$. □

A.3 Proof of Lemma 3

We first consider a merchant with $p + (1-p)\eta + \beta > \bar{R}$. To establish our claim, we prove that there exists $R \in [R_D/p, 1-f]$ such that $L_P(R, m_B^*, G_B^*; p) > 0$. Consider $R = 1 - f - \epsilon$, where $\epsilon > 0$ is small enough that $p + (1-p)\eta + \beta - \epsilon > \bar{R}$ and $1 - f > \bar{R} + \varepsilon$. Then,

$$L_P(1-f, m_B^*, G_B^*; p) \geq m_B^* p G_B^*(1-f-\varepsilon)(1-f-\epsilon-\bar{R}) > 0,$$

where we used that $m_B^* \in (0,1)$ and that $G_B^*(1-f-\varepsilon) > 0$ because $G_B^*(\cdot)$ is strictly decreasing in $[R_D/p, 1-f]$. Therefore, $m_P^* = 1$.

Next, we consider $p + (1-p)\eta + \beta \leq \bar{R}$. We proceed by contradiction and assume that $\max_R L_P(R, m_B^*, G_B^*; p) > m_B^*(f + \beta)$. In this case $m_P^* = 1$. Moreover, because $L_B(1-f, 1, G_P^*; p) < 0$, we must have $1 - f \notin \mathcal{R}_B^*$. Furthermore, because $m_P^* = 1$ and $[R_D/p, 1-f) \subseteq \mathcal{R}_B^*$, (A.1) implies

$$G_P^*(R) = \frac{(1-p)R_D}{p(R - R_D)}$$

for all $R \in [R_D/p, 1-f)$. Because $\lim_{R\to 1-f} G_P^*(R) > 0$, thus $1 - f \in \mathcal{R}_P^*$. However, if $1 - f \notin \mathcal{R}_B^*$,

$$L_P(1-f, m_B^*, G_B^*; p) = (1 - m_B^*)[p(1-f) + (1-p)(\eta - f) - \bar{R}] + \beta + f \leq m_B^*(\beta + f),$$

which contradicts the assumption that $L_P(R, m_B^*, G_B^*; p) > m_B^*(f + \beta)$ for any $R \in \mathcal{R}_P^*$. We must therefore have $\max_R L_P(R, m_B^*, G_B^*; p) \leq m_B^*(f + \beta)$.

To conclude that $\max_R L_P(R, m_B^*, G_B^*; p) = m_B^*(f + \beta)$, we proceed again by contradiction, and assume now that $\max_R L_P(R, m_B^*, G_B^*; p) < m_B^*(f+\beta)$. We would therefore have $m_P^* = 0$ and $m_B^* = 1$, with $G_B^*(R) = \mathbb{I}(R \leq R_D/p)$. However, given this strategy by banks, $L_P(R_D/p, 1, G_B^*; p) \geq m_B^*(f+\beta)$. □

A.4 Proof of Proposition 1

By Lemma 2, $[R_D/p, 1-f) \subseteq \mathcal{R}_B^*$ and, by Lemma 3, $m_P^* = 1$. Starting from (A.1), we therefore obtain (12) holds for $R \in [R_D/p, 1-f)$. Note $\lim_{R\to(1-f)^-} G_P^*(R) = \frac{(1-p)R_D}{p(1-f-R_D)} > 0$. Hence, $1-f \in \mathcal{R}_P^*$.

To characterize banks' equilibrium strategy, observe that $L_B(1-f, 1, G_P^*; p) < 0$ and, hence, $\mathcal{R}_B^* = [R_D/p, 1-f)$ and $G_B^*(1-f) = 0$. Next, because $\mathcal{R}_P^* = [R_D/p, 1-f]$, the following system must hold:

$$L_P(R_D/p, m_B^*, G_B^*; p) = L_P(1-f, m_B^*, G_B^*; p)$$
$$L_P(R_D/p, m_B^*, G_B^*; p) = L_P(R, m_B^*, G_B^*; p) \text{ for all } R \in (R_D/p, 1-f).$$

Solving the system, we obtain (10) and (11).

A.5 Proof of Proposition 2

Combining Lemmas 2 and 3, the platform is indifferent between lending at rate R_D/p and not. Using the indifference condition

$$L_P(R_D/p, m_B^*, G_B^*; p) = m_B^*(f+\beta)$$

we obtain (13). Because $[R_D/p, 1-f) \subseteq \mathcal{R}_P^*$, we also have that

$$L_P(R_D/p, m_B^*, G_B^*; p) = m_B^*(f+\beta) \quad \text{for all } R \in [R_D/p, 1-f).$$

Using (13), we therefore solve for $G_B^*(R)$ and obtain (14) for any $R \in [R_D/p, 1-f)$. Because $\lim_{R\to(1-f)^-} G_B^*(R) > 0$, we have $1-f \in \mathcal{R}_B^*$ and, in particular, $\mathcal{R}_B^* = [R_D/p, 1-f]$.

Note also that, because $G_B^*(\cdot)$ is a left-continuous function,

$$L_P(1-f, m_B^*, G_B^*; p) = \lim_{R\to(1-f)^-} L_P(R, m_B^*, G_B^*; p) = m_B^*(f+\beta).$$

Therefore, $\mathcal{R}_P^* = [R_D/p, 1-f]$.

To derive the platform's strategy, we consider Remark 3 and $1-f \in \mathcal{R}_B^*$ which, together, imply $L_B(1-f, m_P^*, G_P^*; p) = 0$. Because $G_P^*(1-f) = 0$, we obtain (15). Similarly, because of Remark 3 and $\mathcal{R}_B^* = [R_D/p, 1-f]$, we have

$$L_B(R, m_P^*, G_P^*; p) = 0 \quad \text{for all} R \in [R_D/p, 1-f].$$

Using (15), we obtain (16).

A.6 Proof of Corollary 2

Because case A is characterized by $p + (1-p)\eta + \beta > \bar{R}$, the set of parameters satisfying case A expands as the network effect β becomes larger. Because merchants satisfying case A receive financing with probability 1 in equilibrium, less merchants are rationed when network externalities increase.

In case B, the platform's strategy is independent of β. However, banks offer credit with probability m_B^* given by (13) which is decreasing in β because

$$\frac{dm_B^*}{d\beta} = \frac{\bar{R} - R_D - (1-p)(\eta - f) - (1-p)[\bar{R} - (\eta - f)]}{[(1-p)[\bar{R} - (\eta - f)] - f - \beta]^2} < 0.$$

Therefore, with stronger network externalities, banks lend less frequently and the probability of rationing, $(1-m_B^*)(1-m_P^*)$ declines. Moreover, banks offer higher interest rates because

$$\frac{dG_B^*(R)}{d\beta} = \frac{R_D/p - \bar{R}}{(R - \bar{R})} \frac{R_D - pR}{(\bar{R} - R_D - (1-p)(\eta - f) - f - \beta)^2} > 0.$$

In particular, the average interest rate is increasing in β.

A.7 Proof of Lemma 4

We proceed by contradiction and assume that $L_P(R, m_B^{I*}, G_B^{I*}; p^h) \leq m_B^{I*}(f+\beta)$ for all $R \in [R_D/p, 1-f]$. Because $L_P(R, m_B^{I*}, G_B^{I*}; p)$ is increasing in p, we have $L_P(R, m_B^{I*}, G_B^{I*}; p^i) \leq m_B^{I*}(f+\beta)$ for $i \in \{u, l\}$. Therefore, for $i \in \{u, h, l\}$, $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^i) = m_B^{I*}(f+\beta)$ and the maximizer in (17) is $a^{I*} = 0$, contradicting $a^{I*} \in (0, 1]$. □

A.8 Proof of Lemma 5

If the equilibrium is characterized by $a^{I*} = 0$, then Lemma 2 applies and the result is immediately established.

We the consider an equilibrium where $a^{I*} \in (0, 1]$. We first prove $m_B^{I*} \in (0, 1)$. By way of contradiction, assume $m_B^{I*} = 0$. Then $\mathcal{R}_{P,i}^{I*} = \{1-f\}$, and $G_{P,i}^{I*}(R) = \mathbb{I}(R < 1-f)$ for $i \in \{u, h, l\}$. Then, for any $\varepsilon \in (0, 1-f-R_D/p)$, $L_B^I(R_D/p + \varepsilon, a^{I*}, 1, 1, G_{P,u}^{I*}, G_{P,h}^{I*}; p) > 0$, contradicting that $m_B^{I*} = 0$ is the bank's equilibrium strategy.

Again by way of contradiction, assume that $m_B^{I*} = 1$. For $i \in \{u, h, l\}$ and $R \geq R_D/p$, $L_P(R, 1, G_B^{I*}; p^i) = p^i G_B^{I*}(R)(R - \bar{R}) + f + \beta > m_B^{I*}(f+\beta)$. Hence, $\mathcal{R}_{P,u}^{I*} = \mathcal{R}_{P,h}^{I*} = \mathcal{R}_{P,l}^{I*}$ and $m_{P,i}^{I*} = 1$. Therefore, $L_P(1, G_B^{I*}; p^u) = \psi L_P(1, G_B^{I*}; p^h) + (1-\psi) L_P(1, G_B^{I*}; p^l)$, and thus $a^{I*} = 0$, which contradicts with the assumption that $a^{I*} \in (0, 1]$.

Because $m^B \in (0, 1)$ and because $m_{P,h}^{I*} = 1$ by Lemma 4,

$$L_B^I(R, a^{I*}, m_{P,u}^{I*}, 1, G_{P,u}^{I*}, G_{P,h}^{I*}; p^u) \leq 0$$

and, in particular,

$$G_a^{I*}(R;a^{I*}) \coloneqq a^{I*}G_{P,h}^{I*}(R)+(1-a^{I*})G_{P,u}^{I*}(R) \leq \frac{(1-p)R_D}{p(R-R_D)}-(1-a^{I*})(1-m_{P,u}^{I*})(1-G_{P,u}^{I*}(R)), \tag{A.2}$$

with equality for $R \in \mathcal{R}_B^{I*}$ and strict inequality for $R \notin \mathcal{R}_B^{I*}$.

The proof is then similar to the proof of Lemma 2. First, we show that $\inf \mathcal{R}_B^{I*} = R_D/p$. We proceed by contradiction and assume that $R_1 \coloneqq \inf \mathcal{R}_B^{I*} > R_D/p$. Then $L_P(R_1, m_B^{I*}, G_B^{I*}; p^i) > L_P(R, m_B^{I*}, G_B^{I*}; p^i)$ for all $R < R_1$ and for $i \in \{u, h\}$. Hence $\inf \mathcal{R}_{P,i}^{I*} \geq R_1$ and hence, for a small enough ε, $G_a^{I*}(R-\varepsilon; a^{I*}) = 1$. But then $L_B^I(R_1 - \varepsilon, a^{I*}, m_{P,u}^{I*}, m_{P,h}^{I*}, G_{P,u}^{I*}, G_{P,h}^{I*}; p^u) > 0$, contradicting Remark 5. Therefore $R_D/p = \inf \mathcal{R}_B^{I*}$.

Next, we show $R_D/p \in \mathcal{R}_B^{I*}$. We proceed by contradiction and assume that $R_D/p \notin \arg\max_R L_B^I(R, a^{I*}, m_{P,u}^{I*}, m_{P,h}^{I*}, G_{P,u}^{I*}, G_{P,h}^{I*}; p^u)$. Then,

$$a^{I*}G_{P,h}^{I*}(R_D/p) + (1-a^{I*})m_{P,u}^{I*}G_{P,u}^{I*}(R_D/p) < \frac{(1-p)R_D}{p(R-R_D)} - (1-a^{I*})(1-m_{P,u}^{I*}).$$

Because $R_D/p = \inf \mathcal{R}_B^{I*}$, there exists a sequence $(\varepsilon_n)_n$ with $\varepsilon_n > 0$ and $\varepsilon_n \to 0$ such that $R_D/p + \varepsilon_n \in \mathcal{R}_B^{I*}$ for all n. Hence,

$$\begin{aligned} a^{I*}G_{P,h}^{I*}(R_D/p+\varepsilon_n;a^{I*})+(1-a^{I*})m_{P,u}^{I*}G_{P,u}^{I*}(R_D/p+\varepsilon_n;a^{I*}) &\to \frac{(1-p)R_D}{p(R-R_D)}-(1-a^{I*})(1-m_{P,u}^{I*}) \\ &> a^{I*}G_{P,h}^{I*}(R_D/p) + (1-a^{I*})m_{P,u}^{I*}G_{P,u}^{I*}(R_D/p). \end{aligned}$$

But this contradicts the assumption that $G_{P,u}^{I*}$ and $G_{P,h}^{I*}$ are non-increasing functions. Hence, $R_D/p \in \mathcal{R}^B$.

Next, we show that $1 - f = \sup \mathcal{R}_B^{I*}$. We proceed by contradiction and assume that $R_2 \coloneqq \sup \mathcal{R}_B^{I*} < 1 - f$. Note that, in general, if $R \in \mathcal{R}_B^{I*}$, then for every $\varepsilon > 0$, $G_a(R + \varepsilon; a^{I*}) < G_a(R; a^{I*})$. Hence, there exists $R' \in (R, R+\varepsilon)$ such that $R' \in \mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}$. Based on this observation, there exists $R' \in (R_2, 1-f)$ such that $R' \in \mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}$. However, $L_P(1 - f, m_B^{I*}, G_B^{I*}, p^i) > L_P(R', m_B^{I*}, G_B^{I*}, p^i)$ for $i \in \{u, h\}$, contradicting that R' is a platform's best response. Therefore, $1 - f = \sup \mathcal{R}_B^{I*}$.

Finally, we show that $G_B^{I*}(R)$ strictly decreasing in $[R_D/p, 1-f]$. Suppose there exist $R_1 < R_2$ such that $G_B^{I*}(R_1) = G_B^{I*}(R_2)$. Let $R_1' \coloneqq \inf\{R : G_B^{I*}(R) = G_B^{I*}(R_1)\}$. If $R_1' = R_D/p$, then $R_1' \in \mathcal{R}_B^{I*}$. Otherwise, $G_B^{I*}(R_1') < G_B^{I*}(R)$ for all $R < R_1'$ and thus there exists a sequence $(\epsilon_n)_n$ with $\varepsilon_n > 0$ and $\varepsilon_n \to 0$ such that $R_1' - \varepsilon_n \in \mathcal{R}_B^{I*}$. In either case, by the previous observation, $G_a(R_1' + \varepsilon; a^{I*}) < G_a(R_1'; a^{I*})$ for any $\varepsilon > 0$ and there exists $R' \in (R_1', R_1' + \varepsilon)$ such that $R' \in \mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}$. However, $L_P(R_2, m^B, G^B, p^i) > L_P(R', m^B, G^B, p^i)$ for $i \in \{u, h\}$, contradicting that R' is a platform's best response. Therefore, $G_B^{I*}(R)$ must be strictly decreasing $[R_D/p, 1-f]$.

We then show that $G_a^{I*}(\cdot; a^{I*})$ is also strictly decreasing in $[R_D/p, 1-f]$. Suppose, by way of contradiction, that $R_1 < R_2$ exists such that $[R_1, R_2] \subseteq [R_D/p, 1-f]$ and $G_a^{I*}(R_1; a^{I*}) = G_a^{I*}(R_2; a^{I*})$. Because G_B^{I*} is strictly decreasing in $[R_D/p, 1-f]$, there exist $R_1' \in [R_1, (R_1+R_2)/2 - \delta]$ and $R_2' \in [R_1 + R_2)/2 + \delta, R_2]$ for any $\delta \in (0, (R_2 - R_1)/2)$ such that $R_1' \in \mathcal{R}_B^{I*}$ and $R_2' \in \mathcal{R}_B^{I*}$ and, in particular,

$$G_a^{I*}(R_1'; a^{I*}) = \frac{(1-p)R_D}{p(R_1' - R_D)} - (1 - a^{I*})(1 - m_{P,u}^{I*})[1 - G_{P,u}^{I*}(R_1')]$$
$$> \frac{(1-p)R_D}{p(R_2' - R_D)} - (1 - a^{I*})(1 - m_{P,u}^{I*})[1 - G_{P,u}^{I*}(R_2')] = G_a^{I*}(R_2'; a^{I*}).$$

But this contradicts the assumption that $G_a^{I*}(R_1; a^{I*}) = G_a^{I*}(R_2; a^{I*})$ for $R_1 \leq R_1'$ and $R_2 \leq R_2'$. Hence, $G_a^{I*}(\cdot; a^{I*})$ must be strictly decreasing in $[R_D/p, 1-f]$.

It remains to show that $R_D/p = \min\{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\}$. Because $R_D = \min \mathcal{R}_B^{I*}$, $L(R, m_B^{I*}, G_B^{I*}; p^i) < L(R_D/p, m_B^{I*}, G_B^{I*}; p^i)$ for any $R < R_D/p$ for $i \in \{u, h, l\}$. Moreover, because $G_P^{I*}(\cdot; a^{I*})$ is strictly decreasing in $[R_D/, 1-f]$, we have that $(R_D/, 1-f) \subseteq \mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}$ and, thus, $R_D/p = \inf\{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\}$. By way of contradiction, assume $R_D/p \notin \{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\}$ and, hence, $L(R_D/p; m_B^{I*}, G_B^{I*}; p^i) < L(R; m_B^{I*}, G_B^{I*}; p^i)$ for any $R_i \in \mathcal{R}_{P,i}^{I*}$ for any $i \in \{u, h\}$. Because $R_D/p = \inf\{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\}$, there exists $i \in \{u, h\}$ and a sequence $(R_n)_n$ converging to R_D/p such that $R_n \in \mathcal{R}_{P,i}^{I*}$ and $R_n > R_D/p$ for any n. However, $L(R_D/p; m_B^{I*}, G_B^{I*}; p^i) < \lim_{n\to\infty} L(R_n; m_B^{I*}, G_B^{I*}; p^i)$ implies $G_B^{I*}(R_D/p) < \lim_{n\to\infty} G_B^{I*}(R_n)$, contradicting the assumption that $G_B^{I*}(\cdot)$ is a non-increasing function. Therefore, $R_D/p = \min\{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\}$. $\square$

A.9 Proof of Lemma 6

When $p \leq \frac{R_D}{\eta - f}$, we have $\eta - f \leq R$ for any $R \in \mathcal{R}_{P,i}^{I*}$, for $i \in \{u, h, l\}$. Therefore

$$L_P(R, m_B^{I*}, G_B^{I*}; p_i) = p_i[m_B^{I*} G_B^{I*}(R)(R - \bar{R}) + (1 - m_B^{I*})R] + (1 - m_B^{I*})[(1 - p^i)(\eta - f) - \bar{R}] + f + \beta$$

Therefore, $\arg\max_R L_P(R, m_B, G_B; p^h) = \arg\max_R L_P(R, m_B, G_B; p^u)$. Moreover, $[R_D/p, 1-f] = \arg\max_R L_P(R, m_B, G_B; p^l)$.

We then consider $p > \frac{R_D}{\eta - f}$. In this case,

$$L_P(R, m_B^{I*}, G_B^{I*}; p_i) = p_i[m_B^{I*} G_B^{I*}(R)(R - \bar{R}) + (1 - m_B^{I*})R] + (1 - m_B^{I*})[(1 - p^i)\min\{\eta - f, R\} - \bar{R}] + f + \beta.$$

For a pessimistic platform, we thus have

$$\mathcal{R}_{P,l}^{I*} = \arg\max_{R < 1-f} L_P(R, m_B^{I*}, G_B^{I*}; p_i) = [\eta - f, 1 - f].$$

To show $\sup \mathcal{R}_{P,h}^{I*} \leq \inf \mathcal{R}_{P,u}^{I*}$, consider $R_h \in \mathcal{R}_{P,h}^{I*}$. Then,

$$L_P(R_h, m_B^{I*}, G_B^{I*}; p^h) - L_P(R, m_B^{I*}, G_B^{I*}; p^h) \geq 0$$

for any R, which implies

$$m_B^{I*}[G_B^{I^*}(R_h)(R_h - \bar{R}) - G_B^{I^*}(R)(R - \bar{R})] \geq -\frac{(1 - m_B^{I^*})}{p^h}[R_h - R - (1 - p^h)\min\{0, \eta - f - R\}]$$

Consider $R < R_h$ and the profits of an uninformed platform. Using the above inequality, we have

$$
\begin{aligned}
&L_P(R_h, m_B^{I*}, G_B^{I*}; p) - L_P(R, m_B^{I*}, G_B^{I*}; p) \\
&= pm_B^{I*}[G_B^{I*}(R_h)(R_h - \bar{R}) - G_B^{I*}(R)(R - \bar{R})] + (1 - m_B^{I*})[R_h - R - (1-p)\min\{0, \eta - f - R\}] \\
&\geq (1 - m_B^{I*})(1 - \psi)[R_h - R - \min\{0, \eta - f - R\}].
\end{aligned}
$$

If $R_h \leq \eta - f$, then also $R \leq \eta - f$ and $R_h - R - \min\{0, \eta - f - R\} > 0$. If, instead, $R > \eta - f$, either $R \leq \eta - f$ and $R_h - R - \min\{0, \eta - f - R\} > 0$ or $R > \eta - f$ and $R_h - R - \min\{0, \eta - f - R\} = R_h - \eta + f > 0$. Hence, $R \notin \mathcal{R}_{P,u}^{I*}$.

Because $R_h \in \mathcal{R}_{P,h}^{I*}$ was arbitrary, and because R was also arbitrary provided that $R < R_h$, we have that $\sup \mathcal{R}_{P,h}^{I*} \leq \inf \mathcal{R}_{P,u}^{I*}$. $\square$

A.10 Proof of Proposition 3

Because $\eta > \bar{R} - \beta$ and $\eta - f \leq R_D/p$, the profits for a pessimistic platform are

$$\max_{R \leq 1-f} L_P(R, m_B^{I*}, G_B^{I*}; p^l) = (1 - m_B^{I*})(\eta - f - \bar{R}) + f + \beta > m_B^{I*}(f + \beta)$$

Hence, $m_{P,l}^{I*} = 1$. Because $L_P(R, m_B^{I*}, G_B^{I*}; p)$ is increasing in p, then also $m_{P,u}^{I*} = m_{P,h}^{I*} = 1$.

By Lemmas 5 and 6, there is $R \in (R_D/p, 1 - f)$ such that $R \in \mathcal{R}_{P,i}^{I*}$ for $i \in \{u, h, l\}$. If the platform acquires information, its expected profits are

$$
\begin{aligned}
\psi L_P(R, &m_B^{I*}, G_B^{I*}; p^h) + (1 - \psi) L_P(R, m_B^{I*}, G_B^{I*}; p^l) \\
&= m_B^{I*} p G_B^{I*}(R)(R - \bar{R}) + (1 - m_B^{I*})[pR + (1-p)(\eta - f) - \bar{R}] \\
&= L_P(R, m_B^{I*}, G_B^{I*}; p),
\end{aligned}
$$

where the first equality follows from $\psi p^h = p$.

For arbitrarily small but positive c,

$$\psi L_P(R, m_B^{I*}, G_B^{I*}; p^h) + (1 - \psi) L_P(R, m_B^{I*}, G_B^{I*}; p^l) - c < L_P(R_P^{I*}, m_B, G_B; p) \tag{A.3}$$

Hence $a^{I*} = 0$. The equilibrium is thus as in Proposition 1.

A.11 Proof of Proposition 4

In this case, we have $p < \frac{R_D}{\bar{R}} < \frac{R_D}{\eta - f}$. Hence by Lemma 6, $\mathcal{R}_{P,u}^{I*} = \mathcal{R}_{P,h}^{I*}$. Because $\eta \leq \bar{R} - \beta$ and $m_B^{I*} \in (0, 1)$ by Lemma 5, we have $L_P(R, m_B^{I*}, G_B^{I*}; p^l) < m_B^{I*}(f + \beta)$ for any $R \in [R_D/p, 1 - f]$ and hence, $m_{P,l}^{I*} = 0$. Because $p^h + (1 - p^h)\eta + \beta > \bar{R}$ we also have $L_P(1 - f, m_B^{I*}, G_B^{I*}; p^h) > m_B^{I*}(f + \beta)$ and hence, $m_P^{I*} = 1$.

Consider $R \in \mathcal{R}_{P,u}^{I*} = \mathcal{R}_{P,h}^{I*}$. The platform's expected profit from acquiring information is,

$$\psi L(R, m_B^{I*}, G_B^{I*}; p^h) + (1 - \psi) m_B^{I*}(f + \beta) - c$$

The platform's expected profit when not acquiring information is

$$L^{I*}(m_B^{I*}, G_B^{I*}; p^l) = \max\{L_P(R, m_B^{I*}, G_B^{I*}; p), m_B^{I*}(f+\beta)].$$

Because $L(R, m_B^{I*}, G_B^{I*}; p) = \psi L(R, m_B^{I*}, G_B^{I*}; p^l) + (1-\psi) L(R, m_B^{I*}, G_B^{I*}; p^l)$ and because $L(R, m_B^{I*}, G_B^{I*}; p^l > m_B^{I*}(f+\beta) > L_P(R, m_B^{I*}, G_B^{I*}; p^l)$, we have that, for a small enough c,

$$\psi L(R, m_B^{I*}, G_B^{I*}; p^h) + (1-\psi) m_B^{I*}(f+\beta) - c > L^{I*}(m_B^{I*}, G_B^{I*}; p^l).$$

Hence, $a^{I*} = 1$.

Combining Remark 5 with Lemma 5 showing that $m_B^{I*} \in (0,1)$, we have

$$L_B^I(R, 1, \cdot, 1, \cdot, G_{P,h}^{I*}; p) = (1-\psi)(-R_D) + \psi[p^h G_{P,h}^{I*}(R)(R - R_D) - (1-p)R_D] = 0$$

for any $R \in [R_D/p, 1-f)$,[13] which implies

$$G_{P,h}^{I*}(R) = \frac{(1-p)R_D}{p(R - R_D)}.$$

Note that $L_B^I(1-f, 1, \cdot, 1, \cdot, G_{P,h}^{I*}; p) < 0$ and hence, $1 - f \notin \mathcal{R}_B^{I*}$.

By Lemma 6 with $a^{I*} = 1$, we have $(R_D/p, 1-f) \subseteq \mathcal{R}_{P,h}^{I*}$. Note that $\lim_{R \to (1-f)^-} G_{P,h}^{I*}(R) > 0$ and hence, $1 - f \in \mathcal{R}_{P,h}^{I*}$. Moreover, because G_B^{I*} is a non-decreasing function, $L(R_D/p, m_B^{I*}, G_B^{I*}; p^h) \geq \lim_{R \to R_D/p^-} L(R_D/p, m_B^{I*}, G_B^{I*}; p^h)$ and, therefore, $R_D/p \in \mathcal{R}_{P,h}^{I*}$. Hence, $\mathcal{R}_{P,h}^{I*} = [R_D/p, 1-f]$. We thus obtain the following system of indifference conditions:

$$\begin{aligned} &L_P(R_D/p, m_B^{I*}, G_B^{I*}; p^h) = L_P(1-f, m_B^{I*}, G_B^{I*}; p^h) \\ &L_P(R_D/p, m_B^{I*}, G_B^{I*}; p^h) = L_P(R, m_B^{I*}, G_B^{I*}; p^h) \qquad \text{for any } R \in (R_D/p, 1-f). \end{aligned}$$

Using $G_B^{I*}(R_D) = 1$ and $G_B^{I*}(1-f) = 0$ because $1 - f \notin \mathcal{R}_B^{I*}$, we solve the system and obtain

$$m_B^{I*} = \frac{1 - f - R_D/p}{1 - f - \bar{R}}$$

and

$$G_B^{I*} = \frac{R_D/p - \bar{R}}{1 - f - R_D/p} \frac{1 - f - R}{R - \bar{R}}.$$

□

A.12 Proof of Proposition 5

We first exclude $a^{I*} = 0$. If $a^{I*} = 0$, the equilibrium is as described in Proposition 2. In particular, there exists $R \in [R_D/p, 1-f]$ such that $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^u) = L_P(R, m_B^{I*}, G_B^{I*}; p^u) = m_B^{I*}(f+\beta)$. But then, for a small enough c,

[13] In the proof of Lemma 5, we show that $R_D/p \in \mathcal{R}_B^{I*}$.

$$\psi L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h) + (1-\psi) L_P^{I*}(m_B^{I*}, G_B^{I*}; p^l) - c$$
$$> \psi L_P(R, m_B^{I*}, G_B^{I*}; p^h) + (1-\psi) L_P(R, m_B^{I*}, G_B^{I*}; p^l) - c = L^{I*}(m_B^{I*}, G_B^{I*}; p^u),$$

where the inequality follows because $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h) \geq L_P(R, m_B^{I*}, G_B^{I*}; p^h)$ for any $R \in [R_D/p, 1-f]$ and because $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^l) \geq m_B^{I*}(f+\beta) = L_P(R, m_B^{I*}, G_B^{I*}; p^u) > L_P(R, m_B^{I*}, G_B^{I*}; p^l)$. Hence, the platform has a strict incentive to acquire information, contradicting $a^{I*} = 0$.

We then exclude $a^{I*} = 1$ by contradiction. If $a^{I*} = 1$, we also have $m_{P,h}^{I*} = 1$ by Lemma 4. Moreover, banks' profits are

$$L_B(R, 1, m_{P,u}^{I*}, 1, G_{P,u}^{I*}, G_{P,h}^{I*}; p^u) = p G_{P,h}^{I*}(R)(R - R_D) - (1-p) R_D$$

and, in particular, $\lim_{R \to 1-f} G_{P,h}^{I*}(R) > 0$ and $1 - f \in \mathcal{R}_{P,h}^{I*}$, but $1 - f \notin \mathcal{R}_B^{I*}$, so that $G_B^{I*}(1-f) = 0$. Under these conditions, however, $L_P(1-f, m_B^{I*}, G_B^{I*}; p^h) < 0$, which contradicts $m_{P,h}^{I*} = 1$. Therefore, we have $a^{I*} \in (0,1)$.

We then show that the payoff of an uniformed platform must be $m_B^{I*}(f+\beta)$. Suppose, by way of contradiction, that an uniformed platform has a strict gain from lending and $m_{P,u}^{I*} = 1$. By Lemma 6, $\mathcal{R}_{P,u}^{I*} = \mathcal{R}_{P,h}^{I*}$. The bank's profits are

$$L_B(R, a^{I*}, 1, 1, G_{P,u}^{I*}, G_{P,h}^{I*}; p^u) = p G_a^{I*}(R; a^{I*})(R - R_D) - (1-p) R_D$$

We thus have $\lim_{R \to 1-f} G_a^{I*}(R; a^{I*}) > 0$, $1 - f \in \mathcal{R}_{P,u}^{I*}$. Moreover, $1 - f \notin \mathcal{R}_B^{I*}$, so that $G_B^{I*}(1-f) = 0$ and $L_P(1-f, m_B^{I*}, G_B^{I*}; p^u) < 0$. This result contradicts $m_{P,u}^{I*} = 1$. Therefore, we have $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^u) = m_B^{I*}(f+\beta)$.

Because $a^{I*} \in (0,1)$, the platform is indifferent between acquiring and not acquiring the signal. Using $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^u) = L_P^{I*}(m_B^{I*}, G_B^{I*}; p^l) = m_B^{I*}(f+\beta)$, we thus have

$$L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h) = m_B^{I*}(f+\beta) + \frac{c}{\psi}, \tag{A.4}$$

which implies that, for any $R \in \mathcal{R}_{P,h}^{I*}$, $L(R, m_B^{I*}, G_B^{I*}; p^h) > m_B^{I*}(f+\beta)$. According Lemma 6, the same R satisfies $R \in \mathcal{R}_{P,u}^{I*}$. Moreover,

$$L(R, m_B^{I*}, G_B^{I*}; p^u) < L(R, m_B^{I*}, G_B^{I*}; p^h) - (p^h - p)(1 - m_B^{I*})(R - \eta + f).$$

Hence, for a small enough $c > 0$, we have that $L_P(R, m_B^{I*}, G_B^{I*}; p^u) < m_B^{I*}(f+\beta)$ and, hence, $m_{P,u}^{I*} = 0$.

By Lemma 5, we therefore have that $G_{P,h}^{I*}$ is strictly decreasing in $[R_D/p, 1-f]$. In particular, $(R_D/p, 1-f) \subseteq \mathcal{R}_{P,h}^{I*}$. Consider the limits of $L_P(R, m_B^{I*}, m = G_B^{I*}; p)$ as $R \to R_D/p^+$ and as $R \to (1-f)^-$. Because G_B^{I*} is left-continuous, then $1 - f \in \mathcal{R}_{P,h}^{I*}$. Moreover, because G_B^{I*} is non-increasing, we must also have $R_D/p \in \mathcal{R}_{P,h}^{I*}$ Using $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h) = L_P(R_D/p, m_B^{I*}, G_B^{I*}; p^h)$ and (A.4), we obtain

$$m_B^{I*} = \frac{\bar{R} + c/\psi - p^h R_D/p - (1-p^h)(\eta - f) - f - \beta}{(1-p^h)[\bar{R} - (\eta - f)] - f - \beta} \tag{A.5}$$

. Using (A.5) and the condition

$$L_P(R, m_B^{I*}, G_B^{I*}; p^h) = m_B^{I*}(f+\beta) + \frac{c}{\psi} \quad \text{for any } R \in [R_D/p, 1-f],$$

we obtain

$$G_B^{I*}(R) = \frac{\bar{R} + c/\psi - p^h R - (1-p^h)\eta - f - \beta}{\bar{R} + c/\psi - p^h R_D/p - (1-p^h)\eta - f - \beta} \frac{R_D/p - \bar{R} - c/p}{R - \bar{R}} + \frac{c}{p(R-\bar{R})}. \qquad \text{(A.6)}$$

Taking the limit $\lim_{R\to 1-f} G_B^{I*}(R) > 0$, we conclude that $1 - f \in \mathcal{R}_B^{I*}$. Using that $m_{P,h}^{I*} = 1$ and $m_{P,u}^{I*} = m_{P,l}^{I*} = 0$, we use

$$L_B^I(1-f, a^{I*}, 0, 1, G_{P,u}^{I*}, G_{P,h}^{I*}; p^u) = 0$$

to obtain $a^{I*} = \frac{1-f-R_D/p}{1-f-R_D}$, which coincides with m_P^{I*} in equation (15).

Finally, using this expression for a^{I*} and

$$L_B^I(R, a^{I*}, 0, 1, G_{P,u}^{I*}, G_{P,h}^{I*}; p^u) = 0 \quad \text{for any } R \in [R_D/p, 1-f],$$

we obtain $G_{P,h}^{I*}(R) = \frac{(1-p)R_D}{p(1-f)-R_D} \frac{1-f-R}{R-R_D}$, which coincides with $G_P^{I*}(R)$ in equation (16).

To conclude the proof, it remains to show that $m_B^{I*} < m_B^{I*}$. Define the function

$$M_1(x; c) \coloneqq \frac{\bar{R} - xR_D/p - (1-x)(\eta - f) - f - \beta + c/\psi}{(1-x)[\bar{R} - (\eta - f)] - f - \beta}.$$

One can immediately verify that $m_B^{I^{I*}} = M_1(p^h; c)$ and that $m_B^{I*} = M_1(p; 0)$.

We the compute the derivative

$$\frac{\partial M_1(x; 0)}{\partial x} = -\frac{(R_D - \bar{R})(\bar{R} - \eta - \beta)}{(1-x)[\bar{R} - (\eta - f)] - f - \beta} < 0,$$

where the inequality follows because we are considering parameters such that $p < R_D/\bar{R}$ and $\eta < \bar{R} - \beta$. Because $p^h > p$, for a small enough $c > 0$, we therefore have $m_B^{I*} < m_B^{I*}$. $\square$

A.13 Proof of Proposition 6

We start by observing that, because $\eta > \bar{R} - \beta$, we have $m_{P,i}^{I*} = 1$ and $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^i) > m_B^{I*}(f+\beta)$ for $i \in \{u, h, l\}$. We also immediately verify that $\mathcal{R}_{P,l}^{I*} = [\eta - f, 1-f]$ and hence, in equilibrium $P(R^l \geq \eta - f) = 1$. Moreover, we can also immediately verify that $1 - f \notin \mathcal{R}_B^{I*}$.

Next, we exclude $a^{I*} = 0$ and we proceed by contradiction. If $a^{I*} = 0$, the equilibrium the equilibrium is as described in Proposition 4. In particular, R_1 and R_2 exist such that $R_1 < \eta - f < R_2$ exist such that $R_1, R_2 \in \mathcal{R}_{P,u}^{I*}$. Because $p^l < p < p^h$, we thus have

$$L_P(R_1, m_B^{I*}, G_B^{I*}; p^h) > L_P(R_2, m_B^{I*}, G_B^{I*}; p^h),$$

and

$$L_P(R_1, m_B^{I*}, G_B^{I*}; p^l) \leq L_P(R_2, m_B^{I*}, G_B^{I*}; p^l).$$

Hence

$$\begin{aligned}
&\psi L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h) + (1-\psi) L_P^{I*}(m_B^{I*}, G_B^{I*}; p^l) \\
&> \psi L_P(R_2, m_B^{I*}, G_B^{I*}; p^h) + (1-\psi) L_P(R_2, m_B^{I*}, G_B^{I*}; p^l) \\
&= L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h). \qquad \text{(A.7)}
\end{aligned}$$

For a small enough $c > 0$, the thus obtain

$$\psi L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h) + (1-\psi) L_P^{I*}(m_B^{I*}, G_B^{I*}; p^l) - c > L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h),$$

contradicting the assumption that $a^{I*} = 0$.

We also exclude $a^{I*} = 1$. If $a^{I*} = 1$, by lemma 5 we have that $1 - f \in \mathcal{R}_{P,h}^{I*}$. Because $p^l < p < p^h$, we thus have

$$L_P(1-f, m_B^{I*}, G_B^{I*}; p^i) > L_P(R, m_B^{I*}, G_B^{I*}; p^i),$$

for $i \in \{u, l\}$ and for any $R \in [R_D/p, 1-f]$. Therefore, $1 - f \in \mathcal{R}_{P,h}^{I*}$ and $L_P(1 - f, m_B^{I*}, G_B^{I*}; p^i) > m_B^{I*}(f + \beta)$ for $i \in \{u, h, l\}$. Hence,

$$\psi L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h) + (1-\psi) L_P^{I*}(m_B^{I*}, G_B^{I*}; p^l) - c < L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h),$$

contradicting that $a^{I*} = 1$. We therefore conclude that $a^{I*} \in (0, 1)$.

Combining lemma 5 and lemma 6, there is an $R_c^{I*} \in [R_D/p, 1-f]$ such that $G_{P,u}^{I*}(R) = 1$ for $R < R_c^{I*}$ and such that $G_{P,h}^{I*}(R) = 0$ for $R \geq R_c^{I*}$.

Using $L_B(R, a^{I*}, 1, 1, G_{P,u}^{I*}, G_{P,h}^{I*}; p^u) = 0$ we obtain

$$\begin{aligned}
a^{I*} G_{P,h}^{I*}(R) + (1 - a^{I*}) &= \frac{1-p}{p} \frac{R_D}{R - R_D} \qquad \text{for } R < R_c^{I*} \\
(1 - a^{I*}) G_{P,u}^{I*}(R) &= \frac{1-p}{p} \frac{R_D}{R - R_D} \qquad \text{for } R \geq R_c^{I*}.
\end{aligned}$$

Taking limits, we thus conclude that $\lim_{R \to R_c^{I*-}} G_{P,h}^{I*}(R) = \lim_{R \to R_c^{I*+}} [G_{P,u}^{I*}(R) - 1] = 0$ and that a^{I*} is given by

$$a^{I*} = \frac{R_c^{I*} - R_D/p}{R_c^{I*} - R_D}. \qquad \text{(A.8)}$$

Using the same two equations along with (A.8), we also obtain (19) and (20).

By Lemma 5 and Lemma 6, we have $R_D/p \in \mathcal{R}_{P,h}^{I*}$ and $1 - f \in \mathcal{R}_{P,u}^{I*}$. Moreover, because $a^{I*} \in (0, 1)$,

$$\psi L_P(R_D/p, m_B^{I*}, G_B^{I*}; p^h) + (1-\psi)[(1 - m_B^{I*})(\eta - f - \bar{R}) + f + \beta] - c = L_P(1-f, m_B^{I*}, G_B^{I*}; p^u).$$

Using $G_B^{I*}(R_D/p) = 1$ and $G_B^{I*}(1-f) = 0$ in the last equation, we obtain

$$m_B^{I*} = \frac{p^h + (1-p^h)\eta - R_D/p - f + c/\psi}{p^h - (1-p^h)R_D/p + (1-p^h)\eta - f - p^h\bar{R}}. \tag{A.9}$$

Next, note that, because $G_B^{I*}(R)$ is left-continuous and $R \in \mathcal{R}_{P,h}^{I*}$ for all $R \in [R_D/p, R_c^{I*}]$, then $R_c^{I*} \in \mathcal{R}_{P,h}^{I*}$. Hence $\mathcal{R}_{P,h}^{I*} = [R_D/p, R_c^{I*}]$ and $L_P(R, m_B^{I*}, G_B^{I*}; p^h) = L_P(R_D/p, m_B^{I*}, G_B^{I*}; p^h)$ for $R \leq R_c^{I*}$, imply

$$G_B^{I*}(R) = 1 - \frac{R - R_D/p}{R - \bar{R}} \cdot \frac{p^h + (1-p^h)\eta - f - \bar{R} - c(1-p^h)/p}{p^h + (1-p^h)\eta - R_D/p - f - c/\psi} \quad \text{for } R \leq R_c^{I*} \tag{A.10}$$

Furthermore, $L_P(R, m_B^{I*}, G_B^{I*}; p^u) = L_P(1-f, m_B^{I*}, G_B^{I*}; p^h)$ for $R > R_c^{I*}$, implies

$$G_B^{I*}(R) = \frac{R_D/p - \bar{R} - c}{R - \bar{R}} \cdot \frac{p(1-f-R) - (1-p)\min\{R - (\eta - f), 0\}}{p + (\psi - p)\eta - \psi R_D/p - \psi f + c} \quad \text{for } R > R_c^{I*}, \tag{A.11}$$

whereas $L_P(R, m_B^{I*}, G_B^{I*}; p^u) < L_P(1-f, m_B^{I*}, G_B^{I*}; p^h)$ for $R \notin \mathcal{R}_{P,u}^{I*}$, implies

$$G_B^{I*}(R) < \frac{R_D/p - \bar{R} - c}{R - \bar{R}} \cdot \frac{p(1-f-R) - (1-p)\min\{R - (\eta - f), 0\}}{p + (\psi - p)\eta - \psi R_D/p - \psi f + c} \quad R \notin \mathcal{R}_{P,u}^{I*},$$

Because $G_B^{I*}(R)$ is decreasing and $\inf \mathcal{R}_{P,u}^{I*} = R_c^{I*}$, we must have $R_c^{I*} \in \mathcal{R}_{P,u}^{I*}$ because, otherwise, $G_B^{I^*}(R_c^{I*}) < \lim_{R \to R_c^{I*-}} G_B^{I^*}(R_c^{I*})$.

We therefore have that $\lim_{R \to R_c^{I*+}} G_B^{I*}(R) = \lim_{R \to R_c^{I*-}} G_B^{I*}(R)$ where $G_B^{I*}(\cdot)$ is defined by (A.10) and (A.11). We then solve for R_c^{I*} and obtain

$$R_c^{I*} = \frac{p + (1-p)\eta - f - \psi\frac{R_D}{p}}{1-\psi} - \frac{p + (\psi - p)\eta - \psi R_D/p - \psi f + c}{R_D/p - \bar{R} - c/p} \cdot \frac{R_D/p - \bar{R}}{1 - \psi}. \tag{A.12}$$

To conclude the proof, it remains to show that $m_B^{I*} > m_B^{I*}$. Define the function

$$M_2(x; c) \coloneqq \frac{x + (1-x)\eta - R_D/p - f + c/\psi}{x - (1-x)R_D/p + (1-x)\eta - f - x\bar{R}}.$$

One can immediately verify that $m_B^{I^{I*}} = M_2(p^h; c)$. Because, for the parameters under consideration in this proposition we have $\eta - f > R_D/p$, we also have that $m_B^{I*} = M_2(p; 0)$.

We the compute the derivative

$$\frac{\partial M_2(x; 0)}{\partial x} = -\frac{(R_D/p - \bar{R})(\eta - f - R_D/p)}{(x - (1-x)R_D/p + (1-x)\eta - f - x\bar{R})^2} < 0,$$

where the inequality follows because we are considering parameters such that $p < R_D/\bar{R}$ and $\eta > f + R_D/p$. Because $p^h > p$, for a small enough $c > 0$, we therefore have $m_B^{I*} < m_B^{I*}$. □

A.14 PROOF OF COROLLARY 3

We omit the proof for cases I.A, I.C, and I.D because the discussion preceding the corollary contains the derivation of the results. Here, we focus on case I.B.

In case I.B, expected profits in equilibrium are

$$\begin{aligned}\psi L_P(R_D/p, m_B^{I*}, G_B^{I*}; p^h) &+ (1-\psi) m_B^{I*}(f+\beta) - c \\ &= R_D - m_B^{I*} p\bar{R} + (1-m_B^{I*})[(1-p)(\eta - f) - \bar{R}] + f + \beta \\ &\qquad + (1-\psi)(1-m_B^{I*})(\bar{R} - \eta - \beta) - c,\end{aligned} \tag{A.13}$$

where we used the fact that $R_D/p \in \mathcal{R}_{P,h}^{I*}$.

Profits in case I.B need to be compared to profits in case A from section 2 when $p + (1-p)\eta + \beta > \bar{R}$, whereas they need to be compared to case B from section 2 when $p + (1-p)\eta + \beta \leq \bar{R}$.

We start by considering $p + (1-p)\eta + \beta > \bar{R}$ and we thus compare with case A. In case A, the platform's profits are

$$L_P(R_D/p, m_B^*, G_B^*; p) = R_D - m_B^* p\bar{R} + (1-m_B^*)[(1-p)(\eta - f) - \bar{R}] + f + \beta.$$

Comparing this expression with (A.13) and recalling that $m_B^{I*} = m_B^*$ for these cases, we therefore see that equilibrium profits increase by $(1-\psi)(1-m_B^{I*})(\bar{R} - \eta - \beta) - c$.

Next, we consider $p + (1-p)\eta + \beta \leq \bar{R}$ and we thus compare with case B. In case B, $L_P(R_D/p, m_B^*, G_B^*; p)$, where m_B^* is given by (13). In case I.B, the platform profits as in (A.13) where m_B^{I*} is given by the right-hand side of (10) when $\min\{R_D/p - (\eta - f), 0\} = 0$. We then compare m_B^* and m_B^{I*}. In particular, $m_B^{I*} \geq m_B^*$ if an only if

$$(R_D/p - \bar{R})(p + (1-p)\eta + \beta - \bar{R}) \geq 0.$$

This condition holds we are considering $p + (1-p)\eta + \beta \leq \bar{R}$ and $p \leq R_D/\bar{R}$. We therefore have

$$\begin{aligned}[\psi L_P(R_D/p, m_B^{I*}, G_B^*; p^h) &+ (1-\psi) m_B^{I*}(f+\beta) - c] - L_P(R_D/p, m_B^*, G_B^*; p) \\ &= -(m_B^{I*} - m_B^*)[(1-p)(\eta - f - \bar{R})] + (1-\psi)(1-m_B^{I*})(\bar{R} - \eta - \beta) - c \\ &\geq (1-\psi)(1-m_B^{I*})(\bar{R} - \eta - \beta) - c\end{aligned}$$

where the last inequality follows because $m_B^{I*} - m_B^* \geq 0$ and $\eta \leq \bar{R} - \beta \leq \bar{R} + f$. Therefore, even when $p + (1-p)\eta + \beta \leq \bar{R}$, the platform's profits increase at least by $(1-\psi)(1-m_B^{I*})(\bar{R} - \eta - \beta) - c$.