Borrowing from a Bigtech Platform

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Abstract

We model competition between banks and a bigtech platform that lend to a merchant with private information and subject to moral hazard. By controlling access to a valuable marketplace for the merchant, the platform enforces partial loan repayments, thus alleviating financing frictions, reducing the risk of strategic default, and contributing to welfare positively. Credit markets become partially segmented, with the platform targeting merchants of low and medium perceived credit quality. However, conditional on observables, the platform lends to better borrowers than banks because bad borrowers self-select into bank loans to avoid the platform's enforcement, causing negative welfare effects in equilibrium.

Keywords: Bigtech, platform, enforcement, adverse selection, moral hazard, advantageous screening, 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 of non-mortgage credit extended by fintech firms (Cornelli et al., 2021).[2]

Unlike other lenders, bigtech firms provide a marketplace for merchants. Moreover, they typically implement revenue-based repayment plans, whereby borrowing merchants pledge a percentage of their sales on the marketplace as loan repayment.[3] Despite the growing relevance of bigtech platforms in credit markets, there is no theoretical framework to understand their unique lending model. In this paper, we provide a model to explain these patterns.

We make three main contributions. First, we identify a key advantage bigtech lenders possess over other lenders: control of a marketplace. By simply controlling access to a source of revenues for a borrower, the platform can enforce partial loan repayment, alleviate financing frictions, and even reduce the risk of strategic default. Second, we assess the welfare consequences of the platform entering the credit market and show the change in welfare is ambiguous and determined by two counteracting forces. On the one hand, the platform and banks offer loan contracts with a different level of enforcement, which screen borrowers in favor of the platform and at the expense of banks, causing a negative welfare effect in equilibrium. On the other hand, the platform can reduce default probabilities through better enforcement and increase output, leading to a positive welfare effect. The net effect depends on the borrower's characteristics and on the difference between the platform and banks' cost of capital. Third, we show a platform with superior enforcement power does not necessarily benefit from possessing also superior information about the borrower. Because of bank's equilibrium reaction, the option to acquire

[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.

information may lower the surplus the platform can extract from banks or borrowers through better enforcement.

We study a model in which a merchant possesses private information about her cash flows and is subject to moral hazard. The merchant needs to borrow capital to produce over two periods and she is privately informed about whether her future sales will be high or low.[4] The merchant could borrow from the platform or from competitive banks. The merchant is also subject to two forms of moral hazard. First, after obtaining financing, the merchant may choose not to sell on the platform's marketplace, and sell instead in an alternative venue. Second, the merchant is subject to limited commitment. In particular, after the first period, she has the option to default on the loan balance, forfeit production in the second period, and abscond with the net revenues from the first period. In equilibrium, a merchant with low revenue optimally chooses to default on banks because future revenues are insufficient to motivate her to repay the loan balance and continue production. Lenders have a common prior about the merchant's future revenues and we refer to it as the merchant's credit quality. Because of the merchant's limited commitment and the asymmetric information between the borrower and lenders, the equilibrium is characterized by financing frictions.

Because the platform's marketplace provides a *valuable* source of revenues for a merchant, the platform exploits its control over the marketplace to alleviate financing frictions and to gain an advantage when competing with banks. Whereas banks offer standard one-period loan contracts, the platform also charges higher transaction fees on borrowing merchants when they sell on the marketplace before the loan due date. The platform deducts the proceeds of these additional fees from the loan balance. We call these additional fees *repayment fees*. Because a merchant may sell on alternative venues after obtaining financing from the platform, repayment fees are bounded by the value the merchant obtains from selling on the platform. Hence, the platform charges higher repayment fees to merchants who benefit more from using the platform compared to their outside option. The platform thus implements a revenue-based repayment plan, consistent with industry practice. Banks cannot implement similar revenue-based repayment plans because they do not add value to the merchant's revenues.

Compared to banks, the platform possesses two advantages that help it alleviate financing frictions and lend to merchants. First, a platform internalizes the transaction fees merchant pay on the marketplace. Second, more importantly, the platform enforces

[4] In practice, the platform's potential borrowers are typically small businesses, for which uncertain cash flows represent an important source of credit risk. Even though a merchant may not know her future cash flows with certainty, she may still have more information about them than the external creditors.

loan repayment more effectively than banks by charging repayment fees. By using repayment fees, the platform alleviates financing frictions in a direct and an indirect way. Specifically, the platform obtains partial repayment from a merchant, even if the latter intends to default when the loan balance is due. Thus, part of the merchant's income is directly pledged to the platform. Furthermore, by charging repayment fees, the platform indirectly improves the merchant's ex-post incentives to repay the loan and continue production. In fact, after paying the fees, the merchant is left with a smaller loan balance and the platform faces a lower risk of strategic default. Because the platform charges higher repayment fees on merchants that benefit more from participating in the marketplace, even a merchant of low credit quality may still obtain financing from the platform provided her outside option is particularly unattractive.

When the platform lends in competition with banks, it acquires a third advantage because merchants of different types self-select into different loan contracts. As mentioned before, while the platform imposes repayment fees in its loan contracts, banks cannot. As a result, a borrower faces a menu of two contracts: a contract with repayment fees and high enforcement offered by the platform, and a contract with no repayment fees and low enforcement offered by banks. This is a screening menu of contracts. The low-revenue merchant always prefers the low-enforcement contract offered by banks to minimize pledgeable income ahead of her default. The low-revenue merchant thus self-select into the contract offered by banks. The high-revenue merchant is indifferent to the level of enforcement in a contract and selects the contract with the lowest interest rate.[5] In equilibrium, the platform benefits from *advantageous screening*, whereas banks suffer from *adverse screening*. Whereas internalization of transaction fees and enforcement alleviates financing frictions, which tend to increase welfare, the platform's advantageous screening is associated with negative welfare effects if the platform's cost of capital exceeds the banks'.

Our model provides a series of predictions and welfare implications. First, the model predicts credit markets become partially segmented when the platform competes with banks. Banks remain the only lenders to merchants of high credit quality, to whom they offer rates below or equal to the platform's cost of capital. The platform becomes the only lender to merchants of low credit quality, provided they value access to the marketplace sufficiently highly. The platform and banks compete for merchants of intermediate credit quality.

[5]The platform could offer the same menu of screening contracts. However, such menu is not optimal. Because low-revenue merchants would self-select into a low-enforcement, the platform would benefit from pooling the two types into an high-enforcement contract with high repayment fees.

Second, because of the platform's advantageous screening, we obtain nuanced predictions on the quality of the platform's borrowers compared to bank borrowers. Although the platform seems to specialize in merchants with lower perceived credit quality based on observable characteristics, the platform actually lends to a better pool of borrowers than banks once we condition on such observable characteristics. According to the model, borrowers who are likely to default in the future prefer to borrow from banks to avoid pledging income to the platform through repayment fees.

Third, when the platform enters the credit market, it generates heterogeneous welfare effects depending on the credit quality of the merchant and the value the platform provides to her. By enforcing repayments better than banks and by internalizing transaction fees, the platform profitably extends credit to merchants of low credit quality who value access to the marketplace sufficiently highly. If these merchants are not financed by banks, the platform improves the expected welfare by lending. However, when the platform directly competes with banks for a merchant, the expected welfare declines if the platform's cost of capital sufficiently exceeds the banks'. Because of adverse screening, banks lend more conservatively in equilibrium. Compared to an equilibrium where banks are the only lender, the merchant may be rationed with a higher probability and the project may be financed at a higher cost of capital.

Finally, we provide an extension of the model where the platform may acquire superior information about the borrower's future revenues at a cost, although infinitesimally small.[6] Importantly, we obtain the same results and predictions identified in the baseline model, thus highlighting that enforcement represents a crucial element in assessing the equilibrium implications of bigtech lenders in the market. Furthermore, we find that the platform uses superior information to either screen out bad borrowers or to customize interest rate offers in order to maximize the surplus it extracts from the merchant. In the first case, after observing a negative signal about the merchant's revenues, the platform denies credit and banks suffer from a winner's curse. In the second case, after observing a negative signal, the platform offers a low rate to the merchant to discourage strategic default, thus lowering credit risk and improving welfare. The platform offers higher rates after observing a positive signal to extract more surplus from a merchant with low risk of strategic default. Banks respond by extending more credit to compete more aggressively

[6]Existing literature shows bigtech platforms may also possess information advantage over banks (Frost et al., 2019) because, for example, platforms may use alternative data and methodologies to assess the borrower's future revenues and, hence, default risk. Because we focus on a platform lending to merchants, we consider only information about the merchant. 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.

for a share of the surplus the platform extracts.

Because of the equilibrium reaction of banks, the option to acquire information does not always benefit the platform. This result is in contrast to the standard credit-competition literature in which the informed lender benefits from a superior screening technology when competing with other lenders (Hauswald and Marquez, 2003; He et al., 2023). Our results differ because, in our model, the platform possesses better enforcement power compared to banks. When the platform can also acquire superior information, competing banks adjust their lending strategy in response. As a result, the platform may obtain lower profits from its superior enforcement power. If banks reduce lending because of the winner's curse, the platform collects smaller rents from advantageous screening in equilibrium. If banks increase lending to compete for the surplus the platform extracts, the platform faces more fierce competition in the credit market. We identify conditions under which banks' equilibrium reaction causes the platform's profits to decline when it has the option to acquire information. We, therefore, highlight that private information may lower the rents the platform extracts through enforcement because of competitors' equilibrium reaction.

2 RELATED LITERATURE

So far, researchers have identified three advantages fintech and bigtech lenders possess over banks: superior information (Buchak et al., 2018; He et al., 2023; Huang, 2021a; Philippon, 2019; Di Maggio and Yao, 2021; Hu and Zryumov, 2022), less stringent regulation (Beaumont et al., 2021; Buchak et al., 2018; Gopal and Schnabl, 2022), and convenience (Fuster et al., 2019). Among those, our work is closely related to the recent literature on payment platforms making loans because of their information advantages (Parlour et al., 2020; Ghosh et al., 2021). However, we focus on a fourth advantage, which is specific to bigtech platforms. According to our model, the bigtech platform's advantage can be primarily attributed to its control over a marketplace. Therefore, we establish a complementarity between lending and operating a product market. Recent work has studied how payment platforms make loans, again focusing on the

The platform's advantage is thus similar to the advantage of warehouse banks (Donaldson et al., 2018) and trade creditors (Biais and Gollier, 1997; Burkart and Ellingsen, 2004; Petersen and Rajan, 1997). In particular, we micro-found the platform's ability to enforce repayment from a borrowing merchant as a function of the value that the platform provides to the merchant. We analyze how lenders differential enforcement power affects equilibrium outcomes for merchants with different credit risk. Unlike previous contributions, we focus specifically on bigtech firms that, by simply controlling access to a marketplace or a payment ecosystem, obtain a crucial advantage as a lender, even without superior information.

Related, Huang (2021a) and Boualam and Yoo (2022) assume fintech lenders can seize an exogenous fraction of the borrower's cash flow, and focus on other aspects of this market. Huang (2021a) analyzes competition under a private-value setting, where lenders may be differentially informed. We study competition under a common-value setting, where lenders have different enforcement power. Boualam and Yoo (2022) study whether banks and the fintech emerge as competitors or partners in equilibrium. Relative to Boualam and Yoo (2022), we consider credit risk and information asymmetry between lenders and borrowers, while focusing on the competition among different lenders. Finally, compared to these existing literature, we identify a new channel whereby the platform could lower equilibrium welfare when competing with banks because of its ability to enforce repayments.

Our model builds upon the credit market competition literature (Broecker, 1990). Instead of focusing on lenders who are differentially informed (Hauswald and Marquez, 2003; He et al., 2023; Goldstein et al., 2022), our competing lenders have different degrees of enforcement power. The welfare effects of the platform's better enforcement resemble the effects of a winner's curse among bidders in a common-value auction (Milgrom and Weber, 1982; Engelbrecht-Wiggans et al., 1983; Hausch, 1987; Kagel and Levin, 1999). However, the underlying mechanism is very different. Whereas a winner's curse originates from asymmetric information among bidders, advantageous screening originates because the platform and banks offer contracts that, in equilibrium, screen good and bad borrowers. Banks are then adversely affected by this equilibrium screening.

More broadly, our research is also related to the theoretical literature on two-sided markets and lending with limited commitment. In particular, although we take fees as given,[7] our research highlights that a platform profits not only from designing a two-sided market (Weyl, 2010; Armstrong, 2006; Rochet and Tirole, 2002; Jullien et al., 2021), but also from financing the activity of market users. In contemporaneous work, Bouvard et al. (2022) find that a platform can use credit contracts to indirectly discriminate platform participants with different wealth. Huang (2021b) analyzes the synergy between consumer lending and e-commerce. Similar to the limited-commitment literature (Alvarez and Jermann, 2000; Kehoe and Levine, 1993; Kocherlakota, 1996; Ligon et al., 2002), in our model the borrower is motivated to (partially) repay the loan to maintain access to

[7] According to our conversations with practitioners, transaction fees and loan terms are typically set by different divisions within a bigtech firm.

a valuable market which, in our case, is the platform's marketplace instead of the credit market.

The empirical literature studying lending by bigtech and fintech firms is expanding rapidly. Liu et al. (2022) find evidence of advantageous selection for bigtech lenders, whereas Frost et al. (2019), Hau et al. (2019), and Ouyang (2022) provide evidence that bigtech firms expand credit access, consistent with our model that bigtechs are able to reach borrowers who are under-served by traditional banks. Other authors focus on fintech firms lending strategies to consumers (Di Maggio and Yao, 2021; Balyuk, 2022), and the substitutability (Buchak et al., 2018; Eça et al., 2022; Gopal and Schnabl, 2022) or complementarity (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. Agarwal et al. (2021) and Di Maggio and Yao (2021) analyze fintech firms using alternative data to expand credits. Berg et al. (2020) show the alternative footprint data complements the traditional credit bureau information for predicting defaults. Finally, Dai et al. (2023) find fintech lenders can increase repayment likelihood on delinquent loans. Several recent review articles has summarized the developments and the literature on bigtech and fintech lending (Stulz, 2019; Petralia et al., 2019; Allen et al., 2020; Agarwal and Zhang, 2020; Berg et al., 2021).

3 SET-UP

We consider 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 or sell through other channels. The merchant is subject to moral hazard in the form of limited commitment. Moreover, the merchant also possesses private information about the revenues she will produce after obtaining financing.

TIMING. To model business dynamics in a tractable way, we use a model with three dates, $t \in \{0, 1, 2\}$, and two periods. Figure 1 shows the timeline of the model. At date $t = 0$, the merchant applies for financing. If the merchant obtains financing, she produces and sells goods in the first period, which is between date zero and date one. The merchant chooses whether to sell on the platform's marketplace or in an alternative venue. If she sells on the platform, she pays transaction fees over the course of the first period, when revenues are realized. At date $t = 1$, the merchant decides whether to repay the loan or

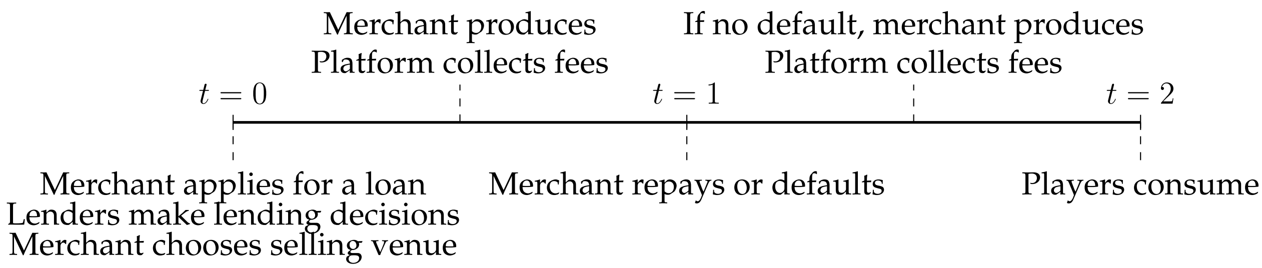


Figure 1: Timeline of the model.

default. If the merchant repays, she produces and sells in the second period, which is between date one and date two. If she defaults, she absconds with the after-fee cash flow generated in the first period and forfeits production in the second period. We normalize all players' discount rates to zero.

The merchant. The merchant requires one unit of capital at date $t = 0$ to start (or continue) her business. If the merchant obtains financing at date zero, she can generate revenues in the subsequent two periods. Revenues are either high, c_H, or low c_L, with $c_H > c_L$, and are constant over the two periods. At date zero, the merchant possesses private information about the revenues she will generate. We use $\theta \in \{H, L\}$ to denote the merchant's type, and we refer to a merchant as good (bad) if her revenues are high (low) and $\theta = H$ ($\theta = L$). The platform and banks do not know the merchant's type at date $t = 0$, and they have common prior beliefs $p := P(\theta = H)$. However, they observe revenues when they are realized over the course of the two production periods. Beliefs p measure the creditworthiness of the merchant.[8] We refer to a merchant with high p as having higher credit quality.

As a seller, the merchant may sell goods either on the platform's marketplace or on some alternative market. On the marketplace, a merchant of type θ pays a transaction fee f, thus netting $(1-f)c_\theta$. Alternatively, the merchant could sell goods outside the platform and earn revenues equal to $(1-\eta)c_\theta$ (here $\eta \leq 1$ is common knowledge among all players). We call η the merchant's *relative revenues*, because it measures the proportional increase in gross revenues for a merchant who switches from the alternative market to the platform.[9]

[8]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.

[9]By revealed preferences, merchants join marketplaces like Amazon and Doordash or payment services like Paypal because they obtain higher profits compared to alternative options. In addition, Higgins (2022) shows that using payment platforms also increases sales for local retail businesses. Dubey and Purnanandam (2023) find the adoption of digital payment platforms spurs economic growth.

A merchant with relative revenue $\eta \geq f$ sells on the platform's marketplace. Otherwise, the merchant sells on the alternative venue. We focus our analysis on the set of merchants with $\eta \geq f$.

A merchant's relative revenue η is a key dimension of heterogeneity we focus on, and it potentially varies significantly across different merchants. For example, a local small business likely benefits a lot from being listed on Amazon and having access to a national market, i.e. it has a high η. On the other hand, internationally recognized brand does not benefit as much from being listed on Amazon, hence it has a smaller η. The advantage of the platform as a lender is larger for a borrower with high relative revenue for being on the platform.

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 $R_D > 0$. If a merchant applies for a loan at a bank, the bank issues a credit decision (d_B, R_B) 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.

THE PLATFORM. The platform operates a marketplace where merchants sell goods. The platform charges a transaction fee f on the merchant's revenues to cover its operating costs. Because, in this paper, we focus on how the platform lends to merchants, we leave transaction fees as exogenous and focus on the platform's lending decisions.[10]

To lend to merchants, the platform pays a cost of capital $\bar{R} > 0$. 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.

REPAYMENT FEES. As a lender, the platform benefits from its power of controlling access to the marketplace. In particular, the platform can increase transaction fees for borrowing merchants from f to $f + f_P$, and apply the difference towards loan repayment.

[10]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 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 relatively small measure of merchants needs to borrow to operate on the platform.

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. We refer to the increased portion of the transaction fees as the repayment fees.

A platform can implement such revenue-based repayment plans because merchants value access to the marketplace. If a merchant of type θ intends to avoid repayment fees by selling outside the platform, the merchant must forfeit net revenues equal to $(\eta - f)c_\theta$. This outside option endogenously limits how much the platform can set the repayment fees for the merchants.

Unlike the platform, banks are unable to charge repayment fees, because banks cannot exclude borrowers from any source of revenue. Although banks could impose fees on incoming deposits, in normal circumstances a borrower could divert such deposits to another bank at a negligible cost.[11] Therefore, whereas the platform can charge repayment fees f_P because it controls access to a valuable marketplace, banks cannot. In our model, banks' repayment fees are therefore $f_B = 0$, consistent with empirically observed loan contracts between banks and merchants.

Hence, when lending to a merchant, the platform specifies an interest rate R_P and a revenue-based repayment fee f_P. To enforce the revenue-based repayment, the platform collects additional fees f_P when the transaction happens between date $t = 0$ and $t = 1$, thus increasing total fees from fc_θ to $(f + f_P)c_\theta$. The platform applies the additional fees $f_P c_\theta$ toward loan repayment. At date $t = 1$, the merchant owes the balance $R_P - f_P c_\theta$ to the platform. Because revenue-based repayments are collected at the time of the transaction, a merchant cannot abscond with them. A merchant can, however, default on the remaining balance.

MORAL HAZARD AND INCENTIVE COMPATIBILITY. As a borrower, the merchant is subject to moral hazard in the form of limited commitment. In particular, at date $t = 1$, after revenues are realized, the merchant decides whether to repay the loan and continue production in the second period, or default on the loan and cease production.

Suppose that, at date $t = 0$, the merchant of type θ borrowed from lender J at rate R_J and with repayment fees f_J. By date $t = 1$, she has accumulated net revenues $(1-f-f_J)c_\theta$ and she owes balance $R_J - f_J c_\theta$ to the lender. The merchant then decides whether to repay the balance and continue production in the second period, or default, cease future production, and abscond with the revenues she accumulated by date $t = 1$. The merchant chooses to repay the loan if future net revenues, $(1 - f)c_\theta$, exceed the balance due, $R_J -$

[11] In practice, there might be some non-zero cost when switching banks. However, what is important for our mechanism is that this cost is much smaller than the cost of migrating off the platform.

$f_J c_\theta$; that is, when

$$(1 - f + f_J)c_\theta \geq R_J. \tag{1}$$

Equation (1) is an incentive-compatibility condition which ensures a borrower of type θ will not default. This condition imposes an upper bound on the interest rate R_J. The upper bound increases with the repayment fees f_J. In other words, the repayment fee f_J not only directly increases the amount that the lender can recover, it also indirectly increases the amount repaid by reducing the borrower's incentive to default. We thus make the following remark.

REMARK 1. By using repayment fees, a lender improves the merchant's ex-post incentives to repay the loan balance.

The repayment fee forces the merchant to prepay the loan when transactions take place in the first period. As a result, the merchant has a lower loan balance at date $t = 1$, and hence, stronger incentives to repay and continue production in the second period. As discussed above, a platform can charge positive repayments fees on a merchant who values the platform's marketplace; that is a merchant with $\eta > f$. Banks, on the other hand, cannot charge repayment fees because they cannot exclude a merchant from a source of revenues. Therefore, by controlling access to the marketplace, the platform will be able to improve the merchant's ex-post incentives to repay by using repayment fees.

Although repayment fees reduce ex-post incentives to default, the platform cannot increase the repayment fees without any limit. The platform faces an additional incentive-compatibility condition in setting repayment fees. In particular, fees must be sufficiently low that a merchant prefers remaining on the platform and pay the additional fees rather than selling outside the platform. This limits how high a repayment fee that the platform can set.

If condition (1) is violated when the platform is the lender ($J = P$), a merchant defaults on the remaining loan balance even after selling on the platform. Because repayment fees lower the ex-post incentive to default, the same merchant also defaults if she sells outside the platform in the first period. In this case, an incentive-compatibility condition on f_P imposes that the cost of selling on the platform, $(f + f_P)c_\theta$, does not exceed the cost of selling outside the platform, ηc_θ. That is, revenue-based repayment fees must satisfy

$$f_P \leq \eta - f. \tag{2}$$

If condition (1) is satisfied, a merchant may still default after selling outside the platform if $(1 - f)c_\theta < R_J$. In this case, an incentive-compatibility condition imposes that the net revenues from staying on the platform and not defaulting, $2(1-f)c_\theta - R_P$, should exceed the net revenues of leaving the platform and defaulting, $(1-\eta)c_\theta$; that is, $(1-2f+\eta)c_g \leq R_P$. However, this condition is redundant once we impose condition (1) and (2).

One important feature of bank lending is that banks often lend against physical collateral. Other papers have focused on this dimension of difference between bank lending and fintech lending (Huang, 2021a; Boualam and Yoo, 2022). We focus on small businesses at the startup stage that often lack collateral. In other words, we assume the borrowers do not have any collateral. This is also the type of businesses for whom the limited commitment problem is the most severe.

Throughout the rest of the paper, we focus on parameter values satisfying Assumption 1 to ensure the model's outcomes are not trivial.

ASSUMPTION 1. *We impose the following restrictions on parameter values:*

$$2c_H > \bar{R} \geq R_D > c_L \tag{3}$$

$$(1-f)c_H > R_D, \quad \eta \geq f \tag{4}$$

To begin with, we assume the platform has no advantage over banks in terms of cost of capital; that is, $\bar{R} \geq R_D$. With this assumption, we emphasize that a platform can profitably compete with banks even if its cost of capital is equal to or larger than banks' cost of capital. Next, we assume a good merchant generates enough value over two periods to exceed the cost of capital of the platform. That is, $2c_H > \bar{R}$. Without this assumption, the platform, and possibly banks, would not lend in equilibrium.

For the financing frictions to be relevant in equilibrium, we assume bad merchants always default when they borrow from banks, even if financed at the banks' cost of capital; that is, $R_D > c_L$. Because R_D is the lowest rate banks could possibly offer and $f_B = 0$, condition (1) is always violated in equilibrium when banks are the lenders ($J = B$) and banks ration credit in equilibrium when the perceived credit quality of the merchant is sufficiently low.

Moreover, we assume a good merchant is sufficiently profitable that she chooses not to default if banks lend at their cost of capital; that is, $(1-f)c_H > R_D$. Thanks to this assumption, high-revenue merchants choose not to default when banks are able to offer sufficiently low rates.

Finally, we focus on merchants who join the platform in equilibrium; that is, $\eta \geq f$. As a lender, the platform can compete with banks only for merchants satisfying this condition. Otherwise, the merchants obtain no value by selling on the platform's marketplace and, in equilibrium, they borrow exclusively from banks. Formally, for a merchant with

$\eta < f$, condition (2) becomes $f_P = 0$ and, hence, a platform would be unable to charge repayment fees, just like a bank.

We make no other parametric assumption. In particular, we impose no restriction on the relative value of $2c_L$ and $\bar{R}$ or R_D. For example, if $2c_L < R_D$, it is socially inefficient to finance a bad merchant at the bank's cost of capital, even if the merchant produces and sells for two periods. On the other hand, if $2c_L > \bar{R}$, a merchant would improve social welfare if she produced for two periods, even if she borrowed from the platform.

In this paper, we characterize the equilibrium in the credit market under arbitrary combinations of parameters satisfying conditions in Assumption 1. We focus on the two dimensions of heterogeneity: merchant's credit quality p and relative revenue η. As we show ahead, the nature of the equilibrium and its welfare properties vary based on the parameters values.

3.1 Benchmark Models: One Type of Lender

We start by considering when only the banks or only the platform operates as lenders. With no competition between banks and the platform, we illustrate the relative advantages and disadvantages of borrowing from either type of lender.

3.1.1 Banks as the Only Lenders

Suppose the platform does not offer loans. Banks can profitably lend to the merchant only if good merchants are willing to accept their loan offers and not default at date $t = 1$, that is, when $R_B \leq (1 - f)c_H$. Otherwise, all merchants would default on the entire loan. Given a credit decision (d_B, R_B), a bank's profits are

$$d_B\{p\mathbb{I}[R_B \leq (1 - f)c_H]R_B - R_D\}.$$

Because banks are competitive, they earn zero profits in equilibrium. Hence, they agree to lend if $p \geq \frac{R_D}{(1-f)c_H}$ and they charge the break-even rate

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

If instead, $p < \frac{R_D}{(1-f)c_H}$, banks refuse to lend, because the break-even rate exceeds $(1 - f)c_H$ and even good merchants would default. We, therefore, highlight the following remark.

Remark 2. When banks are the only lenders, only merchants with credit quality $p \geq$

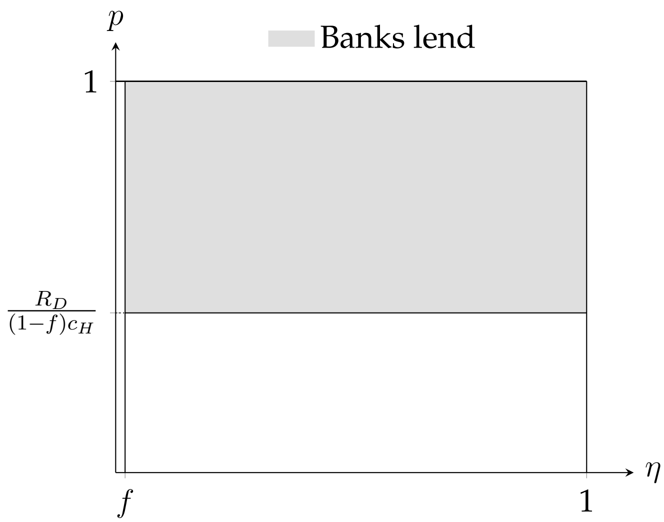


Figure 2: Equilibrium with banks as the only lenders. The shaded area indicates the set of merchants (different combinations of relative revenues η and credit quality p) that banks extend credits to.

$\frac{R_D}{(1-f)c_H}$ receive funding. In particular, banks' lending decisions are 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. As we will discuss in section 3.2, banks ration credit excessively compared to the second-best allocation, causing welfare losses. Figure 2 provides an illustration of the equilibrium when banks are the only type of lenders.

3.1.2 Platform as the Only Lender

If the platform is a monopolistic lender, it chooses the revenue-based repayment f_P and issues a credit decision (d_P, R_P) to maximize its profit. By capping rates at $R_P \leq (1 - f + f_P)c_\theta$, the platform makes sure a merchant of type θ will not default. In particular, if $R_P \leq (1 - f + f_P)c_L$, both types of merchants repay their loan at $t = 1$ and continue production in the second period. If instead $R_P \in ((1 - f + f_P)c_L, (1 - f + f_P)c_H]$, only the good merchant repays at $t = 1$ and continues production in the second period. Therefore, the platform maximizes

$$\max_{f_P, R_P, d_P \in \{0,1\}} \begin{cases} d_P\{R_p - \bar{R} + 2[pc_H + (1-p)c_L]f\} & \text{if } R_P \leq (1 - f + f_P)c_L \\ d_P\{pR_P + (1-p)f_P c_L - \bar{R} + [2pc_H + (1-p)c_L]f\} & \text{if } R_P > (1 - f + f_P)c_L \end{cases} \tag{5}$$

s.t. (2) and $R_P \leq (1 - f + f_P)c_H$

The incentive-compatibility constraint on the repayment fee f_P in (2) always binds. In fact, the objective function in problem (5) is weakly increasing in f_P.

Moreover, with no competition from banks, the platform chooses the interest rate on the loan to maximize the expected surplus it extracts from the merchant. In particular, the platform increases the interest rate until either the high-revenue merchant or the low-revenue merchant is indifferent between repaying the loan or defaulting strategically. That is, the incentive-compatibility condition (1) binds for one type of merchant. As a result, the platform sets its interest rate either to $(1-2f+\eta)c_L$ or to $(1-2f+\eta)c_H$. If (1) binds for $\theta = L$ and the rate is $(1-2f+\eta)c_L$, both types repay the loan in full and the platform extracts surplus $(1-2f+\eta)c_L$ from both types in addition to transaction fees. If (1) binds for $\theta = H$ and the rate is $(1-2f+\eta)c_H$, only the high-revenue merchant repays the loan and the platform extracts surplus $(1-2f+\eta)c_H$ from this merchant. However, the platform can extract only repayment fees $(\eta - f)c_L$ as surplus from the low-revenue merchant. We describe the platform's lending behavior in Lemma 1.

LEMMA 1. *When the platform is the only lender, a merchant receives funding if and only if*

$$\max\{p(1+\eta)c_H + (1-p)\eta c_L, (1+\eta)c_L + 2p(c_H - c_L)f\} - \bar{R} \geq 0. \tag{6}$$

The monopolistic platform sets rate $R_P = (1-2f+\eta)c_H$ if

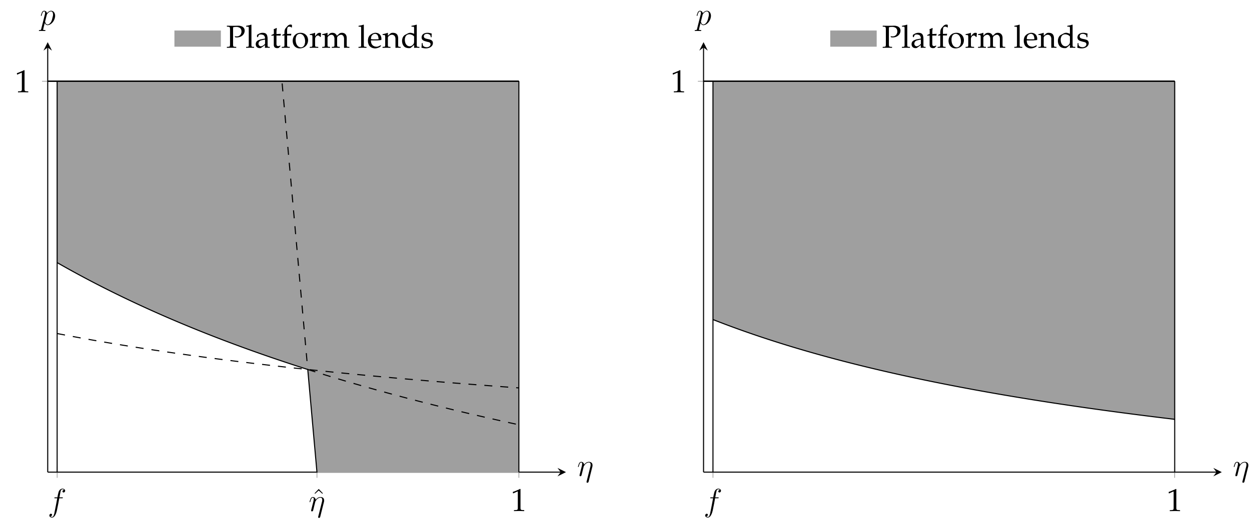
$$p \geq \frac{c_L}{(1-2f+\eta)(c_H - c_L) + c_L}, \tag{7}$$

and it sets rate $R_P = (1-2f+\eta)c_L$ otherwise. In particular, if it is efficient to finance bad merchants with the platform's capital, that is, if $2c_L > \bar{R}$, then there exists $\hat{\eta} \in (f, 1)$ such that the platform lends regardless of credit quality for $\eta \geq \hat{\eta}$.

Lemma 1 is crucial to understanding the platform's unique behavior and advantage as a lender. Whereas banks account only for the merchant's perceived quality in their credit decision, the platform evaluates also the merchant's relative revenue η when deciding whether to lend or not. Everything else equal, a merchant who benefits more from selling on the platform (that is, a merchant with higher η) is more profitable to lend to. In fact, when $2c_L > \bar{R}$ and η is large enough ($\eta \geq \hat{\eta}$), the platform lends to any merchant, regardless of her credit quality.

Furthermore, conditional on lending, the platform lends at a low interest rate, $R_P = (1-2f+\eta)c_L$, when the merchant's credit quality is relatively low and condition (7) is not satisfied. In this case, neither the good type nor the bad type merchants default on their remaining loan balances. As a result, the platform is able to reduce default risks conditional on observables and increase total output.

As we will discuss in Section 3.2.2, the platform's control over the marketplace is cru-



(a) $2c_L > \bar{R}$

(b) $2c_L < \bar{R}$

Figure 3: Equilibrium with the platform as a monopolistic lender. Figure 3(a) illustrates when the parameter values are such that it is efficient even to lend to bad merchants. In figure 3(b) illustrates the case when it is inefficient to lend to bad merchants. The shaded area indicates the set of merchants (with different combinations of relative revenues η and credit quality p) that receive funding the platform.

cial for these results. Figure 3 provides an illustration of the equilibrium when the platform is the only lender.

3.2 Discussion of the Benchmark Models

Before analyzing the equilibrium when banks compete with the platform, we discuss the sources of inefficient credit allocation in the model. We then highlight how the platform is able to partially alleviate these inefficiencies thanks to its control over a valuable marketplace.

3.2.1 Financing Frictions and Credit Rationing

We first study which financing frictions cause inefficient allocations of credit when banks are the only type of creditors. These observations will be useful in understanding how the platform gains an advantage over banks thanks to its control of the marketplace.

To disentangle the role of each of the model's components, we start from the full information benchmark with full income pledgeability. We then add asymmetric information about the merchant's type, limited commitment, and moral hazard. Finally, we introduce transaction fees which further restrict pledgeable income to banks.

Suppose banks are the only lenders. In the Pareto-efficient allocation of resources with full information, banks should finance good merchants because $2c_H > R_D$ by Assumption 1. Moreover, if $2c_L > R_D$, they should finance also bad merchants. After introducing asymmetric information, banks cannot condition credit on the merchant's type. Therefore, banks would lend if and only if

$$2(pc_H + (1-p)c_L) \geq R_D. \tag{8}$$

In Appendix B, we show a social planner would lend to merchants satisfying condition (8) in the second-best allocation, when there are information asymmetry and limited enforcement.

If $2c_L \geq R_D$, welfare does not decline because of asymmetric information, because all merchants would still receive financing. If, instead, $2c_L < R_D$, lenders allocate capital inefficiently because of asymmetric information: bad merchants satisfying condition (8) would receive financing when they should not, whereas good merchants failing to satisfy condition (8) do not receive financing when they should.

Next, we add limited commitment and the incentive-compatibility condition (1) with $f = f_B = 0$. In this situation, each type of merchant can at most pledge their first-period income to banks. Moreover, under Assumption (1), a bad merchant chooses to default when borrowing from banks in equilibrium.[12] Hence, the set of merchants receiving financing is reduced to those satisfying $pc_H \geq R_D$. If $2c_L \geq R_D$, welfare declines after introducing limited commitment because the set of merchants who are rationed expands. In expectation, welfare declines also when $2c_L < R_D$. In this case, when parameters satisfy condition (8) and credit is rationed, the expected welfare loss from not financing good merchants exceeds the expected welfare gain from avoiding bad merchants.

Finally, the transaction fee $f > 0$ charged by the platform further decreases the cash flow that merchants can pledge to banks. As a result, the set of merchants receiving funding reduces to those with $(1-f)c_H \geq R_D$, and the expected welfare is smaller than the case without the transaction fee.

3.2.2 THE PLATFORM'S ADVANTAGE

The platform as a creditor is subject to similar financing frictions as banks: the platform does not possess better information about the merchant's type, and merchants may still default on their loans from the platform. However, the platform possesses two key advantages over banks: enforcement of early repayment and internalization of the transaction fees.

[12] Default is an ex-post welfare loss, even if $2c_L < R_D$. By defaulting, a merchant forfeits future production opportunities after the capital investment was made.

ENFORCEMENT. Unlike banks, the platform controls access to a valuable source of revenues for merchants. It thus can implement a revenue-based repayment plan by charging repayment fees $f_P = \eta - f$. Thanks to repayment fees, the platform is able to better enforce loan contracts.

In particular, repayment fees force merchants to credibly pledge part of their revenues to the platform. This effect operates through a direct channel and an indirect channel. The direct channel is straightforward: even when a merchant defaults, the platform is able to collect a partial repayment equal to $f_P c_L$. This partial loan repayment reduces the cost of financing frictions for the platform and allows the platform to lend to a broader set of merchants.

The indirect channel is that the repayment fees improve the merchant's ex-post incentives to repay and continue production, as mentioned in Remark 1. By enforcing early repayment of the loan, the platform partially alleviates the limited-commitment problem. As a result, for a given merchant, he is more likely to repay his loan in full when borrowing from the platform. In other words, the platform can reduce default risk for a given type of borrower. This allows the borrowers to continue production in future periods and increases welfare.

Both the direct and indirect channels operate via the repayment fee f_P. Since the repayment fee f_P is limited by the merchant's relative revenue for being on the platform (η), the advantage of the platform as a creditor is particularly strong among merchants that have large relative revenue (large η).

INTERNALIZATION. Because the platform controls access to the marketplace, it internalizes the transaction fees f merchants pay. As the platform's objective function (5) indicates, the platform accounts for the transaction fees the merchant generates over the course of the two production periods. Banks, on the other hand, can at most collect revenues $(1 - f)c_\theta$ from a merchant of type θ. Because the platform internalizes transaction fees, the platform has the potential to improve social welfare and expand credit compared to banks.[13]

Because of better enforcement and internalization, the platform is able to expand credit and improve welfare compared to banks. Consider the case when $2c_L > \bar{R}$ and it is efficient to lend to bad merchants. According to Lemma 1, if η is sufficiently large, a

[13]More broadly, a platform may internalize also the network externalities a marginal merchant generates on buyers on the platform. At the margin, such network effects could be introduced in the same way we introduce transaction fees f in our model (Weyl, 2010; Jullien et al., 2021). However, to micro-fund network effects, one would need to explicitly model the market-design problem of the platform. To streamline our model and focus on the implications of the platform's enforcement on the credit market, we abstract from network effects and leave them for future work.

merchant receives financing regardless of her credit quality p. Moreover, for small p, no merchant will default. For these merchants, the platform unambiguously improves social welfare compared to banks, which avoid lending to any merchants of low credit quality.

4 Equilibrium with Competition

We now study the equilibrium and welfare implications when the platform competes with banks in the credit market. The merchant may receive credit offers from several banks and the platform. Unlike Section 3.1, where lenders use pure strategies, here the equilibrium is characterized by mixed strategies in the region where banks and the platform are competing directly. We start by specifying the structure of the model at date $t = 0$ in more details when the merchant applies for financing and lenders compete.

4.1 Competition between the Platform and Banks

Consider date $t = 0$. First, competitive banks announce their lending mechanisms and commit to them. A lending mechanism specifies the probability the bank offers a loan, $m_B = P(d_B = 1)$, and the distribution of the interest rate R_B offered conditional on extending a loan, $F_B(R) := P(R_B \leq R)$. The merchant then chooses the bank offering the best mechanism for the merchant.[14] We label this bank as the merchant's preferred bank.

The platform also selects a lending mechanism in order to compete with the merchant's preferred bank. The platform's lending mechanism specifies the platform's lending probability $m_P = P(d_P = 1)$, and the distribution of rates $F_P(R) := P(R_P \leq R)$ the platform offers, conditional on lending. The platform also charges repayment fees f_P such that the merchant prefers to operate on the platform, i.e. satisfying condition (2). The merchant simultaneously applies for a loan from her preferred bank and the platform. The bank and the platform, therefore, issue their lending decisions, (d_B, R_B) and (d_P, R_P), at the same time.

Merchant's strategy If only one lender grants credit, the merchant borrows from that lender regardless of the merchant's type. If neither lender extends credit, the merchant does not produce goods and generates zero value. If both lenders offer credit, the merchant will choose her best option. However, good and bad merchants face different incentives to repay the loan and may, therefore, choose differently.

[14] We assume the merchant suffers a non-pecuniary cost when applying to multiple banks. Typically, when multiple banks pull the credit report of the borrower, the perceived credit quality of the borrower will be negatively affected in the future.

In equilibrium, a good merchant who receives offers from both lenders chooses the offer with the lowest rate. If a good merchant borrows from a bank at a rate greater than $(1-f)c_H$, she will default at date $t=1$. Therefore, banks will never offer rates above $(1-f)c_H$ and hence, $F_B((1-f)c_H)=1$. Moreover, without loss of generality, we set $F_B(R_D)=0$, because banks cannot lend below their cost of capital without experiencing losses. If a good merchant borrows from the platform with repayment fees f_P, she will default if the platform's rate exceeds $(1-f+f_P)c_H$. Because repayment fees are bounded above by $(\eta-f)$ (see condition (2)), a platform never offers rates above $(1-2f+\eta)c_H$. Hence, we have $F_P((1-2f+\eta)c_H)=1$. Given these upper limits on the interest rates offered by banks and by the platform, a good merchant who receives offers from both lenders chooses the offer with the lower rate.[15]

Whereas a good merchant always chooses the lender offering the lowest rate, a bad merchant takes into account the option value to default. If $c_L(1-f)$ exceeds $2(1-f)c_L-R$, where R is the interest rate on the loan, a bad merchant prefers to default rather than keep producing. Therefore, when both lenders offer rates above $(1-f)c_L$, the bad merchant always defaults. Because the platform charges repayment fees, the option value of defaulting is lower if the loan is from the platform. Hence, in this case, the bad merchant always chooses to borrow from the bank and defaults in order to avoid the repayment fees on the platform.

PLATFORM'S PROFIT Because the borrower's choice and default decision depend on the interest rate offered, we need to consider three different regions of interest rates when analyzing the platform's profit. When the platform offers very low interest rates, i.e. $R \leq (1-f)c_L$, both types of merchants would produce and pay transaction fees for two periods. Furthermore, both types of merchants will borrow from the platform and not default.[16] The platform's profit of lending at rate R is given by

$$l_P^-(R, m_B, G_B; p) \coloneqq R - \bar{R} + 2[pc_H + (1-p)c_L]f,$$

[15]In what follows, we assume the good merchant selects the platform if both lenders offer the same rate. This assumption is without loss of generality. In fact, if the merchant's choice were endogenously determined in case of indifference, in equilibrium we would observe the same outcome. Therefore, to streamline the model and the exposition, we directly assume the good merchant borrows from the platform if indifferent between the two offers.

[16]Because $R_D > (1-f)c_L$, banks never offer rates below $(1-f)c_L$ in equilibrium.

where we explicitly denote the dependence of the platform's profits on the merchant's credit quality p. This scenario could only be profitable for the platform if

$$(1-f)c_L \geq \bar{R} - 2[pc_H + (1-p)c_L]f.$$

In other words, the platform could lend below its cost of capital and still make profit if the transaction fee f is high enough.

In the second scenario, when the platform offers an intermediate interest rate, i.e. $R \in ((1-f)c_L, (1-2f+\eta)c_L]$, a bad merchant who borrows from the platform will repay the balance and continue production in the second period. However, if a bank also makes an offer, the bad borrower prefers to borrow from the bank and default after one period. In this case, the platform's expected profit at lending rate R is

$$l_P^0(R, m_B, G_B; p) := m_B p G_B(R)(R-\bar{R}) + (1-m_B)[R-\bar{R}+(1-p)c_L f] + [2pc_H + (1-p)c_L]f,$$

where

$$G_B(R) := P(R_B \geq R) = 1 - \lim_{\varepsilon \to 0^+} F_B(R-\varepsilon).$$

With probability m_B, a bank lends and only good borrowers accept the platform's offer, provided $R_B \geq R$. The good merchant produces and pays transaction fees for two periods. If the merchant is bad, she borrows from banks and defaults, thus paying the transaction fee only in the first period. With probability $(1-m_B)$, the bank denies credit and thus, the merchant necessarily borrows from the platform. Because $R \leq (1-2f+\eta)c_L$, the rate is sufficiently low that both types of borrowers repay the loan balance. In this case, both borrowers produce and pay transaction fees for two periods.

Finally, if the platform lends at a high rate, i.e. $R \in ((1-2f+\eta)c_L, (1-2f+\eta)c_H]$, the rate is so high that a bad merchant defaults even when she borrows from the platform. Hence, the platform's expected profit is

$$l_P^1(R, m_B, G_B; p) := m_B p G_B(R)(R-\bar{R}) + (1-m_B)[pR + (1-p)(\eta - f)c_L - \bar{R}] + [2pc_H + (1-p)c_L]f.$$

Similar to the previous case, with probability m_B a bank lends and the platform attracts only good borrowers provided that $R_B \geq R$. With probability $(1-m_B)$, the bank denies credit. In this case, the good merchant fully repays the loan, but the bad merchant pays only the repayment fees $f_P c_L$ and defaults on the balance. Regardless of the lender, the platform also collects revenues from transaction fees f in both periods from good merchants and for one period from bad merchants.

To summarize, conditional on lending at rate $R \leq (1-2f+\eta)c_H$, the expected profits of the platform are

$$L_P(R, m_B, G_B; p) \coloneqq \begin{cases} l_P^-(R, m_B, G_B; p) & \text{if } R \leq (1-f)c_L \\ l_P^0(R, m_B, G_B; p) & \text{if } R \in ((1-f)c_L, (1-2f+\eta)c_L] \\ l_P^1(R, m_B, G_B; p) & \text{if } R > (1-2f+\eta)c_L. \end{cases} \tag{9}$$

Unlike Section 3.1, 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 transaction fees if a bank lends to the merchant, which happens with probability m_B. Hence, the payoff of a platform that does not lend is $m_B[2pc_H + (1-p)c_L]f$ instead of zero.

BANK'S PROFIT On the bank side, conditional on lending at rate $R \in [R_D, (1-f)c_H]$, a bank obtains the following expected profits:

$$L_B(R, m_P, G_P; p) \coloneqq m_P[pG_P(R)(R-R_D) - (1-p)G_P((1-f)c_L)R_D] + (1-m_P)(pR-R_D), \tag{10}$$

where

$$G_P(R) \coloneqq P(R_P > R) = 1 - F_P(R).$$

If the platform offers a loan, with probability p the merchant is good and borrows from the bank only if $R_P > R$. With probability $1-p$, the merchant is bad and she borrows from the bank whenever the platform's rate exceeds $(1-f)c_L$. If the platform does not offer a loan (with probability $(1-m_P)$), the merchant necessarily borrows from the bank. Whenever a bad merchant borrows from the bank, she defaults at date $t=1$. A bank that decides not to lend earns its outside option, which is equal to zero.

Let $\Delta([0, X])$ be the set of non-decreasing, right-continuous functions satisfying $F(x) = 0$ for all $x < 0$ and $F(x) = 1$ for all $x \geq X$ for any $F \in \Delta([0, X])$. We define 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 $F_P^* \in \Delta([0, (1-2f+\eta)c_H])$ and $F_B^* \in \Delta([0, (1-f)c_H])$ with supports $\mathcal{R}_P^*$ and $\mathcal{R}_B^*$ and with $G_B^*(R) \coloneqq 1 - \lim_{\varepsilon \to 0^+} F_B^*(R-\varepsilon)$ and $G_P^*(R) \coloneqq 1 - F_P^*(R)$, such that:*

1. *The platform and competitive banks set rates optimally:*

$$\mathcal{R}_P^* = \arg \max_{R \leq (1-2f+\eta)c_H} L_P(R, m_B^*, G_B^*; p)$$

$$\mathcal{R}_B^* = \arg \max_{R \in [R_D, (1-f)c_H]} L_B(R, m_P^*, G_P^*; p)$$
$$s.t.\ L_B(R, m_P^*, G_P^*; p) \leq 0.$$

2. *Lenders extend credit optimally:*

$$m_P^* \in \arg \max_{m_P \in [0,1]} \{m_P L_P(R, m_B^*, G_B^*; p) + (1 - m_P) m_B^* [2pc_H + (1-p)c_L] f\} \quad \forall R \in \mathcal{R}_P^*$$
$$m_B^* \in \arg \max_{m_B \in [0,1]} m_B L_B(R, m_P^*, G_P^*; p) \quad \forall R \in \mathcal{R}_B^*.$$

3. *Banks are competitive in the lending market; that is, no lending mechanism* (F_B, m_B) *exists such that* $\int_0^{(1-f)c_H} L_B(R, m_P^*, G_P^*; p)\, dF_B(R) > 0$ *and* $U(1, m_P^*, F_B, F_P^*) > U(m_B^*, m_P^*, F_B^*, F_P^*)$.

According to part 1, lenders select their rates in the set of best responses. Competitive banks offer rates so that, at best, they break even. According to part 2, lenders decide whether to lend or not optimally when comparing profits from lending activity with their outside option. Combining parts 1 and 2, we also have that banks earn zero profits in equilibrium. That is,

$$m_B^* L_B(R_B, m_P^*, G_P^*; p) = 0 \quad \forall R_B \in \mathcal{R}_B^*. \tag{11}$$

Part 3 of the definition specifies that banks offer competitive terms to merchants. In particular, a bank cannot deviate from the equilibrium mechanism and obtain a strictly positive profit while also increasing the good merchant's utility. This condition ensures banks offer the best terms for a good merchant that are compatible with the other equilibrium conditions.

Next, we provide a first characterization of the platform's interest-rate strategy. In particular, we show a platform never offers a rate equal to or below $(1-f)c_L$. Therefore, the first case in equation (9) is not part of any equilibrium.

LEMMA 2. *For any* $m_B \in [0,1]$ *and* $R \leq (1-f)c_L$, $L_P(R, m_B, G_B; p) < L_P((1 - 2f + \eta)c_L, m_B, G_B; p)$. *Therefore,* $[0, (1-f)c_L] \cap \mathcal{R}_P^* = \emptyset$.

Thanks to Lemma 2, from now we focus on equilibria in which $R_P > (1-f)c_L$. Thus, the bad merchant always prefers borrowing from banks and defaulting rather than borrowing from the platform.

4.2 Market Segmentation and Advantageous Screening

We begin by exploring some general features of the equilibrium. Lemma 3 establishes that, in equilibrium, the market will be partially segmented based on the merchant's credit quality. Merchants of high credit quality borrow exclusively from banks, whereas merchants of low credit quality borrow exclusively from the platform.

Lemma 3 (Partial Segmentation)**.** *If $p < \frac{R_D}{(1-f)c_H}$, banks do not lend to the merchant, but if condition* (6) *holds, the platform lends as in Lemma 1. If $p \geq \frac{R_D}{\bar{R}}$, the merchant borrows exclusively from banks that offer loans with probability 1 at rate $\frac{R_D}{p}$.*

If the merchant's credit quality is low, i.e. $p < \frac{R_D}{(1-f)c_H}$, all banks refuse to lend to the merchant because the credit risk is too high, similar to Remark 2. Thus, the platform remains the only lender as long as condition (6) is satisfied. If the merchant's credit quality is very high, i.e. $p \geq \frac{R_D}{\bar{R}}$, the platform cannot profitably compete with banks because banks are able to offer very low interest rates to these borrowers. When banks offer loans at their most competitive rate $\frac{R_D}{p}$, the platform could attract good borrowers by matching or undercutting the banks' interest rate. However, if $p \geq \frac{R_D}{\bar{R}}$, the platform's cost of capital is equal to or exceeds the banks' competitive rate. Thus, the platform has no incentives to compete with banks for borrowers of high credit quality.

Markets are only partially segmented because, as we show in Lemma 4, the platform and banks compete for borrowers of intermediate credit quality, $p \in \left[\frac{R_D}{(1-f)c_H}, R_D/\bar{R}\right)$.

Lemma 4 (Mixed Strategies)**.** *If $p \in \left[\frac{R_D}{(1-f)c_H}, R_D/\bar{R}\right)$, banks offer loans with probability $m_B^* \in (0,1)$ and the platform offers loans with probability $m_P^* \in (0,1]$. Moreover, the platform offers rates ranging between $\min \mathcal{R}_P^* \leq R_D/p$ and $\max \mathcal{R}_P^* \geq (1-f)c_H$. In particular, $\min \mathcal{R}_P^*$ coincides either with R_D/p or with $(1-2f+\eta)c_L$. Banks offer rates up to $\sup \mathcal{R}_B^* = (1-f)c_H$.*

The platform and banks compete for borrowers of intermediate credit quality, and any equilibrium in this region is characterized by mixed strategies. Because of competition, the platform lowers interest rates below its monopolistic rate $(1-2f+\eta)c_H$ with strictly positive probability.[17] At the same time, compared with the bank-only benchmark model, banks increase their rates up to their monopolistic rate $(1-f)c_H$. Moreover, banks also deny credit with positive probability $1 - m_B^* > 0$.

[17]In the proof of Lemma 4, we show that

$$p(1+\eta)c_H + (1-p)\eta c_L > (1+\eta)c_L + 2p(c_H - c_L)f$$

when $p \geq \frac{R_D}{(1-f)c_H}$. For these parameters, if the platform were a monopolistic lender, it would lend at a rate equal to $(1-2f+\eta)c_H$ or not lend at all.

Banks ration credit and increase rates because they suffer from a worse adverse selection problem compared with the benchmark model where the banks are the only type of lenders. Whereas a good borrower prefers the lender offering the lowest rate, a bad borrower prefers banks in order to avoid the increased fees on the platform.

By implementing revenue-based repayments through increased fees, the platform thus benefits from a form of *advantageous screening*, whereby bad borrowers self-exclude from borrowing from the platform when the bank credit is available. Banks, on the other hand, suffer from *adverse screening*, worsening the adverse-selection problem.

Interestingly, according to Lemma 3, the platform tends to lend to merchants of lower credit quality p. That is, based on public information, the platform provides credit to merchants with worse credit credentials. However, once we condition on public information about the merchant's credit quality, the platform's borrowers reveal themselves to be of higher quality than banks' borrowers, on average. We, therefore, summarize the equilibrium prediction of the platform's advantageous screening in the following remark.

REMARK 3. The platform lends to merchants with worse *observable* credit quality than banks. However, conditional on observable characteristics, the platform lends to a better pool of borrowers because of advantageous screening.

Furthermore, because of advantageous screening, a platform competing with banks lends to a wider set of merchants than a monopolistic platform. Compared with the benchmark model where the platform is the only lender, the platform now extends credit to a merchant even if condition (6) is not satisfied (provided $p \geq \frac{R_D}{(1-f)c_H}$). In this case, the platform profits from advantageous screening at the expense of banks. We further characterize the platform behavior in Lemma 5.

LEMMA 5 (The Platform's Strategy)**.** *Consider a merchant characterized by* $p \in \left[\frac{R_D}{(1-f)c_H}, \frac{R_D}{\bar{R}}\right)$*. If* $p(1+\eta)c_H + (1-p)\eta c_L > \bar{R}$*, the platform lends with probability* $m_P^* = 1$ *and the highest rate it offers is* $\max \mathcal{R}_P^* = (1-2f+\eta)c_H$*. If* $p(1+\eta)c_H + (1-p)\eta c_L \leq \bar{R}$*, the platform is indifferent between offering a loan or not. Moreover, if* $\bar{R} > (1-2f+\eta)c_L$*, the platform's lowest rate is* $\min \mathcal{R}_P^* = R_D/p > (1-2f+\eta)c_L$*. If* $\bar{R} \leq (1-2f+\eta)c_L$ *and* $R_D/p \leq (1-2f+\eta)c_L$*,* $\min \mathcal{R}_P^* = R_D/p$*.*

Lemma 5 shows that in the region where the platform can profitably lend as the only lender, i.e. $p(1+\eta)c_H+(1-p)\eta c_L > \bar{R}$, the platform will continue lending with probability 1 when it faces competition from the banks. However, in the region where the platform cannot profitably lend as the only lender, i.e. $p(1+\eta)c_H + (1-p)\eta c_L \leq \bar{R}$, the platform will now lend when there are also banks making loans. In particular, if $p \in \left[\frac{R_D}{(1-f)c_H}, \frac{R_D}{\bar{R}}\right)$, then the platform collects rents from lending because of advantageous screening, at the expense of banks: the presence of banks increases the quality of the platform's borrower pool endogenously. In equilibrium, the rents are enough to leave the platform indifferent between lending and not lending.

Next, we fully characterize the equilibrium in the region where the banks and the platform compete, i.e. $p \in \left[\frac{R_D}{(1-f)c_H}, \frac{R_D}{\bar{R}}\right)$. Based on Lemma 4 and Lemma 5, we distinguish three cases, with the second one including two sub-cases:

A: $p(1+\eta)c_H + (1-p)\eta c_L > \bar{R} > (1-2f+\eta)c_L$, and $p \in \left[\frac{R_D}{(1-f)c_H}, \frac{R_D}{\bar{R}}\right)$;

B: $\bar{R} \leq (1-2f+\eta)c_L$ and $p \in \left[\frac{R_D}{(1-f)c_H}, \frac{R_D}{\bar{R}}\right)$

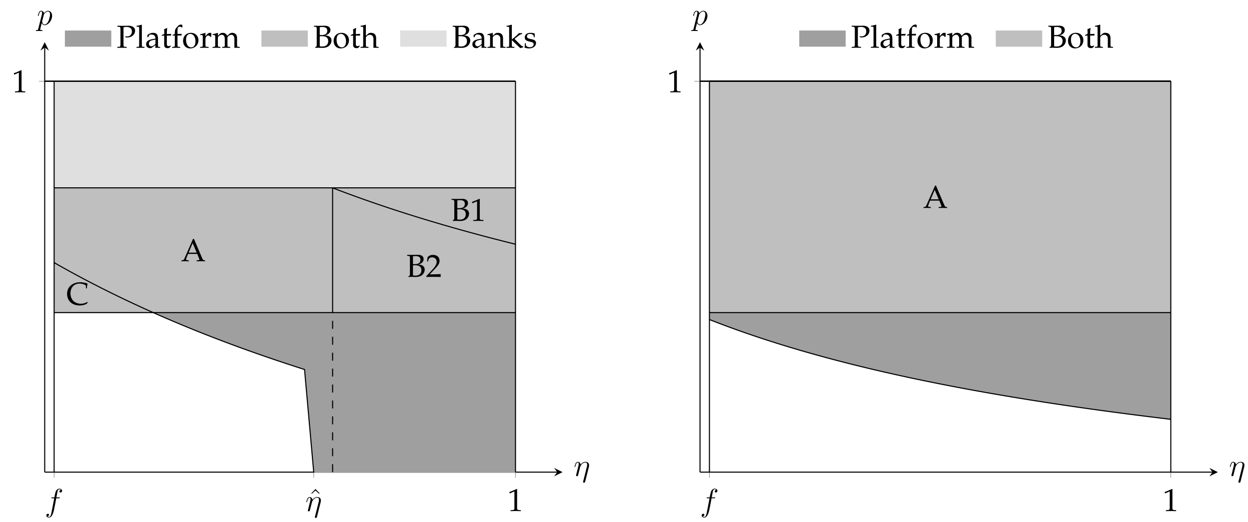
- B1: Like case B, but restricted to $p \geq \frac{R_D}{(1-2f+\eta)c_L}$;
- B2: Like case B, but restricted to $p < \frac{R_D}{(1-2f+\eta)c_L}$;

C: $p(1+\eta)c_H + (1-p)\eta c_L \leq \bar{R}$ and $p \in \left[\frac{R_D}{(1-f)c_H}, \frac{R_D}{\bar{R}}\right)$.

Figure 4 provides a graphical illustration of the possible cases for different values of relative revenues η and credit quality p. Although the graphical illustration in the (η, p) space may vary depending on the parameters (the four cases may not always co-exist for all the parameter values), cases A, B1, B2, and C cover all possible combinations of parameters satisfying Assumption 1, and $p \in \left[\frac{R_D}{(1-f)c_H}, \frac{R_D}{\bar{R}}\right)$ (the region where both types of lenders offer loans with positive probability).[18] In particular, we note that case C implies $\bar{R} > R_D$ and, hence, the platform's cost of capital exceeds the banks'. Case B requires $\bar{R} < 2(1-f)c_L \leq 2c_L$ and, hence, it is efficient to finance bad merchants if they produce for two periods.

Next, we characterize the equilibrium for each case in detail and analyze the welfare implication of the platform offering credits. A challenge in characterizing the equilibrium is that the platform's profit function is not continuous in the interest rate offered. The discontinuity originates from the bad merchant's decision to default strategically when the interest rate exceeds $(1-2f+\eta)c_L$.

[18] By the observation in footnote 17, case B implies $\bar{R} < p(1+\eta)c_H + (1-p)\eta c_L$, whereas case C implies $\bar{R} > (1-2f+\eta)c_L$.



(a) $2c_L > \bar{R} > R_D$

(b) $2c_L < \bar{R} = R_D$

Figure 4: Equilibrium with competition. The figure illustrates when the platform, banks, or both lend to a merchant for different combinations of relative revenues η and credit quality p. In figure 4(a), it is efficient to lend to a bad merchant and the platform's cost of capital exceeds the banks'. In figure 4(b), it is inefficient to lend to a bad merchant and the platform's cost of capital is equal to the banks'.

4.3 Equilibrium with competition

We fully characterize the equilibrium with competition between banks and the platform. We consider cases A, B, and C separately.

Case A. The merchants in this region have relatively high credit quality and relative revenue, hence the platform optimally lends with probability $m_P^* = 1$. In other words, there is no credit rationing and all the merchants receive credits. Compared with the platform-only benchmark, competition from banks forces the platform to offer lower rates. However, the monopolistic rate $(1 - 2f + \eta)c_H$ remains a best response for the platform.

Moreover, the platform never offers a contract that enforces full repayment from bad merchants, because the merchant's relative revenues η are too low compared to its cost of capital. The platform could either offer a high rate, in which case the bad type of merchants will default, but the platform can earn high profit from the good type of merchants, or the platform could offer a low rate, in which case both types of merchants repay. In this region, to enforce full repayment, the platform needs to offer a very low rate, and that is not profit maximizing given the mix of good and bad merchants.

Banks suffer from adverse screening in equilibrium, and they thus deny credit with positive probability $1 - m_B^* \in (0, 1)$. They also offer rates up to their monopolistic rate

$(1-f)c_H$. The following proposition fully characterizes the equilibrium in this case.

On the merchant's side, a good merchant never defaults and a bad merchant always defaults on their remaining balances, regardless of who the lender is.

PROPOSITION 1. *Assume parameters satisfy case A. The equilibrium is characterized as follows:*

1. *The platform extends credit with probability $m_P^* = 1$ and, conditional on making an offer, it chooses a rate from $\mathcal{R}_P^* = [R_D/p, (1-f)c_H] \cup \{(1-2f+\eta)c_H\}$ so that $P(R_P > R) = G_P^*(R)$, where $G_P^*(\cdot)$ is characterized by* (A.7) *in Appendix A.*

2. *Banks extend credit with probability $m_B^* \in (0,1)$, where the expression is given by* (A.5) *in Appendix A. Conditional on making an offer, they choose a rate from the support $\mathcal{R}_B^* = [R_D/p, (1-f)c_H]$ so that $P(R_B \geq R) = G_B^*(R)$, where the expression for $G_P^*(\cdot)$ is given by* (A.6) *in Appendix A.*

Compared with the benchmark model where banks are the only type of lender, the merchant still receives credit offers from at least one lender, but now she pays borrowing costs strictly exceeding R_D/p.

Furthermore, banks now lend at their monopolistic rate $(1-f)c_H$ with positive probability. By lending at the monopolistic rate, banks obtain profits when the platform denies credit to merchants or offers a higher rate. They use these profits to cover the losses they experience from adverse screening in equilibrium.

CASE B. Merchants in this region have even higher credit quality and relative revenue, compared to those in case A. Similar to case A, the platform optimally lends with probability $m_P^* = 1$, and all merchants receive credits. However, unlike in case A, the platform may now offer a contract that induces full repayment from even the bad merchants; that is, a contract with $R_P \leq (1-2f+\eta)c_L$. As before, the platform could either offer a high rate, in which case the bad merchants default, but it earns high profit from the good merchants, or the platform could offer a low rate, in which case both types of merchants repay. The relative revenue η in this region is high enough such that both strategies could be profit maximizing.

In particular, in case B1 when $R_D/p \leq (1-2f+\eta)c_L$, the lowest interest rate that could be offered by banks is below $(1-2f+\eta)c_L$. In order to compete, the platform also offers rates lower than $(1-2f+\eta)c_L$ (this is formally shown in Lemma 4). When the interest rate is lower than $(1-2f+\eta)c_L$, the bad type of merchants will also repay in full if they borrow from the platform (however, the bad type of borrowers only borrow from the platform when banks deny them credits). Similar to what happens in the platform-only benchmark model, the platform reduces the default probability of bad merchants and increases output. In this case, social welfare may increase because the bad borrower produces for two periods instead of one. The following proposition describes the equilibrium in case B1.

PROPOSITION 2. *Assume parameters satisfy case B1 and define*

$$T := \min\{(1-2f+\eta)c_L, (1-f)c_H\}$$
$$U := \min\left\{(1-2f+\eta)c_L + \frac{(1-p)c_L[(1-2f+\eta)c_L - \bar{R}]}{p(1-2f+\eta)c_H - (1-p)c_L - p\bar{R}}, (1-f)c_H\right\}.$$

The equilibrium is characterized as follows.

1. *The platform extends credit with probability $m_P^* = 1$ and, conditional on making an offer, it offers rates in $\mathcal{R}_P^* = [R_D/p, T] \cup [U, (1-f)c_H] \setminus \{(1-f)c_H\} \cup \{(1-2f+\eta)c_H\}$ so that $P(R_P > R) = G_P^*(R)$, where the expression for $G_P^*(R)$ is given by* (A.11) *in Appendix A.*
2. *Banks extend credit with probability $m_B^* \in (0,1)$, where its exact expression is given by* (A.8) *in Appendix A. Conditional on making an offer, they choose a rate from the support $\mathcal{R}_B^* = [R_D/p, T) \cup [U, (1-f)c_H]$ so that $P(R_B \geq R) = G_B^*(R)$, where $G_B^*(R)$ is characterized by* (A.13) *in Appendix A.*

Notice that in equilibrium, the platform's optimal interest rate strategy $\mathcal{R}_P^*$ may consist two disconnected regions. The reason is because the platform's objective function is discontinuous in its interest rate around $R_P = (1-2f+\eta)c_L$. By moving from a rate equal to $(1-2f+\eta)c_L$ to marginally higher rate equal to $(1-2f+\eta)c_L + \varepsilon$ for a very small positive ε, the bad type of merchants switches from repaying the loan in full to defaulting on the remaining balances. Hence, the platform's profits change discontinuously and decline by at least

$$(1-m_B^*)(1-p)c_L - \varepsilon G_B^*((1-2f+\eta)c_L).$$

As a result, the platform only offers interest rates above $(1-2f+\eta)c_L$ if such rates are sufficiently high to justify the decline in profits due to worse enforcement. The lowest of such rates, if they exist, is $U \in ((1-2f+\eta)c_L, (1-f)c_H)$ such that, by offering interest rate U, the platform's profit is equal to its profit when offering $(1-2f+\eta)c_L$. That is,

$$l_P^1(U, m_B^*, G_B^*; p) = l_P^0((1-2f+\eta)c_L, m_B^*, G_B^*; p).$$

Furthermore, if the parameter values are such that $(1-2f+\eta)c_L < (1-f)c_H$, the platform offers rate $(1-2f+\eta)c_L$ with strictly positive probability

$$P(R_P = (1-2f+\eta)c_L) = (1-p)\frac{R_D}{p}\left(\frac{U-(1-2f+\eta)c_L}{[((1-2f+\eta)c_L)-R_D](U-R_D)}\right) > 0,$$

and banks are thus deterred from offering rates in $((1-2f+\eta)c_L, U)$.

In case B2, when $R_D/p > (1-2f+\eta)c_L$, the lowest interest rate could be offered by banks is above $(1-2f+\eta)c_L$, so the platform does not necessarily need to offer contracts below $(1-2f+\eta)c_L$, which induce full repayment from bad merchants. However, if R_D/p is not too much higher than $(1-2f+\eta)c_L$, the platform may still choose to undercut banks by offering a rate exactly equal to $(1-2f+\eta)c_L$, which is lower than R_D/p, with positive probability. This could be profit maximizing because the bad merchants will repay in full when they borrow from the platform. The following proposition describes the equilibrium in this case.

PROPOSITION 3. *Assume parameters satisfy case B2, if*

$$R_D/p \geq (1-2f+\eta)c_L \frac{(1-2f+\eta)c_H - \bar{R} - \frac{1-p}{p}c_L\frac{\bar{R}}{(1-2f+\eta)c_L}}{(1-2f+\eta)c_H - \bar{R} - \frac{1-p}{p}c_L} \tag{12}$$

the equilibrium is the same as in case A and it is described by Proposition 1. Otherwise, define

$$V := \min\left\{(1-f)c_H, (1-2f+\eta)c_L \frac{(1-2f+\eta)c_H - \bar{R} - \frac{1-p}{p}c_L\frac{\bar{R}}{(1-2f+\eta)c_L}}{(1-2f+\eta)c_H - \bar{R} - \frac{1-p}{p}c_L}\right\}.$$

the equilibrium is characterized as follows.

1. *The platform extends credit with probability $m_P^* = 1$ and, conditional on making an offer, it offers a rate from the support $\mathcal{R}_P^* = [V, (1-f)c_H] \cup \{(1-2f+\eta)c_L, (1-2f+\eta)c_H\}$ so that $P(R_P > R) = G_P^*(R)$, where $G_P^*(R)$ is given by* (A.17) *in Appendix A.*

2. *Banks extend credit with probability $m_B^* \in (0,1)$, where the expression for m_B^* is given by* (A.15). *Conditional on making an offer, they choose a rate from the support $\mathcal{R}_B^* = [V, (1-f)c_H]$ so that, if $V \in (R_D/p, (1-f)c_H)$, $P(R_B \geq R) = G_B^*(R)$, where $G_B^*(R)$ is given by* (A.16) *in Appendix A. If, instead, $V = (1-f)c_H$, then $P(R_B = (1-f)c_H) = 1$.*

To understand the platform's equilibrium strategy, let R^V be the lowest rate in $[R_D/p, (1-2f+\eta)c_H]$ such that by offering rate R^V, the platform is earning as high profit as when offering rate $(1-2f+\eta)c_L$

$$l_P^1(R^V, m_B^*, G_B^*; p) \geq l_P^0((1-2f+\eta)c_L, m_B^*, G_B^*; p).$$

Since $R^V > (1-2f+\eta)c_L$, the platform receives lower profits from the good merchants when it offers the lower interest rate $(1-2f+\eta)c_L$. However, at such a rate, it induces full repayment from the bad merchants. The rate R^V corresponds to the rate at which the two forces are exactly equal to each other.

If $R_D/p \geq R^V$, this means the lowest possible rate offered by banks is relatively high compared to the rate at which the platform is willing to undercut. Hence then the platform prefers to match banks' rates rather than undercut banks and set $(1-2f+\eta)c_L$. This is the case when condition (12) is satisfied. The equilibrium is then the same as in case A.

If instead $R^V \in (R_D/p, (1-f)c_H]$, this means the platform can earn higher profit by undercutting the banks and offering rate $(1-2f+\eta)c_L$ (compared to matching the banks rate R_D/p). Hence the platform offers the lower rate $(1-2f+\eta)c_L$ with positive probability

$$P(R_P = (1-2f+\eta)c_L) = 1 - \frac{(1-p)R_D/p}{V - R_D} > 0,$$

and banks are thus deterred from offering rates in $((1-2f+\eta)c_L, V]$.

Finally, if $R^V > (1-f)c_H$ exists, the platform always prefers to undercut banks rather than compete with them. We thus set $V = (1-f)c_H$. In this case, the platform offers only contracts with a rate equal to either $(1-2f+\eta)c_L$ or $(1-2f+\eta)c_H$, each with positive probability.

CASE C. We now consider parameters satisfying case C. Merchants in case C have low credit quality and also low relative revenue. With these parameters, the platform is unwilling to lend to the merchant when it is the only lender in the market. However, as shown in Lemma 5, the platform is now indifferent between lending and not lending in equilibrium. Due to the effect of advantageous screening in equilibrium, the platform is able to extract rents from banks to cover its cost of capital.

PROPOSITION 4 (Equilibrium in Case C)**.** *Assume parameters satisfy case C. The equilibrium is characterized as follows.*

1. *If $p(1+\eta)c_H + (1-p)\eta c_L < \bar{R}$, the platform extends credit with probability $m_P^* \in (0,1)$, with the exact expression given by* (A.20) *in Appendix A. Conditional on making an offer, it chooses a rate from the support $\mathcal{R}_P^* = [R_D/p, (1-f)c_H]$ so that $P(R_P > R) = G_P^*(R)$, where G_P^* is given by* (A.21) *in Appendix A.*

If $p(1+\eta)c_H+(1-p)\eta c_L = \bar{R}$, there are multiple equilibria indexed by $Q \in \left[0, \frac{(1-p)R_D/p}{(1-f)c_H-R_D}\right]$ whereby the platform extends credit with probability $m_P^* \in (0,1]$, with the exact expression given by (A.22) *in Appendix A. Conditional on making an offer, it chooses a rate from the support $\mathcal{R}_P^* = [R_D/p, (1-f)c_H] \cup \{(1-2f+\eta)c_H\}$ so that $P(R_P > R) = G_P^*(R)$, where $G_P^*(R)$ is given by* (A.23) *in Appendix A.*

2. *Banks extend credit with probability $m_B^* \in (0,1)$, where m_B^* is given by* (A.18) *in Appendix A. Conditional on making an offer, they choose a rate from the support $\mathcal{R}_B^* = [R_D/p, (1-f)c_H]$ so that $P(R_B \geq R) = G_B^*(R)$, where $G_B^*(R)$ is given by* (A.19) *in Appendix A.*

If $p(1+\eta)c_H + (1-p)\eta c_L < \bar{R}$, the merchant is rationed with positive 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 screening at the expense of banks. Therefore, the platform never offers its monopolistic rate $(1-2f+\eta)c_H$ because it is higher than what banks would offer and the platform is unable to extract any rents from banks at that rate.

If $p(1+\eta)c_H + (1-p)\eta c_L = \bar{R}$, multiple equilibria exist and they are indexed by Q. In the knife-edge equilibrium with $Q = \frac{(1-p)R_D/p}{(1-f)c_H-R_D}$, the merchant is not rationed, but she is rationed in all the other equilibria with smaller values of Q. We obtain multiple equilibria because the platform is indifferent between lending at the monopolistic rate $(1-2f+\eta)c_H$ and not lending. Therefore, a continuum combinations of $Q = P(R_P = (1-2f+\eta)c_H)$ and $m_P^* = P(d_P = 1)$ satisfy the equilibrium conditions.

4.4 Enforcement and Competition

In our model, banks are fully competitive and earn zero profits, hence the benefit of the platform entering the credit market is not to increase competition. Moreover, the platform's cost of capital is weakly larger than banks, so the platform cannot compete on costs. As discussed in the literature review, other research in fintech assumes fintech lenders enter the credit market because of superior information, regulatory advantage, or consumers' taste. The platform from our model does not benefit from any of these advantages. So, why does the bigtech platform enter the credit market and compete with banks?

Similar to the benchmark model in Section 3.1.2, the platform enters the credit market because it can alleviate financing frictions by enforcing partial repayments with fees. In addition, it also internalizes transaction fees. Thanks to these two advantages, the platform has the potential to compete with banks and to improve social welfare because more income can be credibly pledged to the platform than to banks.

However, when the platform directly competes with banks, it lends also for a third reason: advantageous screening, which is particularly stark in case C. As a monopolist, the platform would not lend when parameters satisfy case C. However, when the banks are present, the platform will offer credits. Whereas internalization and better enforcement were insufficient to justify lending in case C, the additional rents accruing from equilibrium screening convince the platform to lend in competition with banks.

With advantageous screening, the platform earns higher profits when banks lend more because the platform can extract larger rents from them. In fact, in case C, the platform's expected profits when lending are given by

$$m_B^*[2pc_H + (1-p)c_L]f$$

In equilibrium, the platform's lending profits increase with the probability that banks offer a loan. In contrast, in case A and B, the competition from banks decreases the platform's equilibrium profit, i.e. the platform's profit is decreasing in the bank's lending probability m_B. This is because fiercer competition from banks decreases how much surplus the platform can extract from the borrowers. The difference in how banks and the platform interact across different regions is crucial for understanding the role of information advantage in Section 5.

Unlike better enforcement and internalization, advantageous screening could lower equilibrium welfare. Because the platform extracts rents from banks, banks lend more conservatively by denying credit with higher probability and by offering higher interest rates, as Lemma 4 shows. The equilibrium effects of the platform's advantageous screening are similar to the effect of a winner's curse on banks. Whereas a winner's curse originates from asymmetric information among lenders or bidders (Milgrom and Weber, 1982; Engelbrecht-Wiggans et al., 1983; Hausch, 1987; Kagel and Levin, 1999), in our model, advantageous screening originates from the platform's superior ability to enforce repayments from a bad merchant. If the bad merchant prefers defaulting to repaying the loan, she chooses to borrow from banks when possible. We formally explore the welfare implications of the platform on credit markets in the next section.

4.5 Welfare

We now evaluate how welfare changes when the platform enters the credit market in competition with banks. Whereas lenders always improve welfare by providing credit to a good merchant, denying credit to a bad merchant is efficient if $2c_L < R_D$. To properly evaluate the welfare effect of the platform in the credit market, we assess the expected welfare based on public information about the merchant, thus not conditioning on the merchant's type. We then compare the expected welfare when the platform and banks compete to the expected welfare when banks are the only type of lenders.

Changes in expected welfare are determined by the combination of the positive effects of the platform's better enforcement and internalization on the one hand, and the negative effects of the platform's advantageous screening on the other.

If $p < \frac{R_D}{(1-f)c_H}$, the platform does not compete with banks and, therefore, there is no advantageous screening. If condition (6) is satisfied and the platform lends, then the expected welfare increases because more cash flow is credibly pledged to the lender. In this case, social welfare strictly increases and it is at least as large as

$$2pc_H + (1-p)c_L - \bar{R} \geq 0,$$

where the inequality follow from condition (6) and it is strict when $\eta < 1$. Welfare is even larger if $p < \frac{c_L}{(1-2f+\eta)(c_H-c_L)+c_L}$, in which case the equilibrium interest rate is such that even the bad merchant does not default and produces for two periods. The platform lowers default probability for the bad merchant and increase welfare even more.

If $p \geq \frac{R_D}{(1-f)c_H}$, expected welfare is $2c_H + c_L - R_D$ when banks are the only lenders. In the region where $p \geq R_D/\bar{R}$, the expected welfare does not change when the platform enters the credit market because the merchant would keep borrowing exclusively from banks.

In the intermediate region with $p \in \left[\frac{R_D}{(1-f)c_H}, R_D/\bar{R}\right)$, when the platform enters the credit market, the change in the expected welfare is given by

$$\begin{aligned}\Delta W(\bar{R}) = & -\underbrace{(1-m_B^*)(1-m_P^*)[2pc_H + (1-p)c_L - R_D]}_{\text{credit rationing}} \\ & \underbrace{- m_P^*\left[(1-m_B^*) + m_B^* p\int_{R_D/p}^{1-2f+\eta} G_B^*(R)dF_P^*(R)\right](\bar{R}-R_D)}_{\text{higher cost of capital}} \\ & + \underbrace{(1-m_B^*)m_P^*(1-p)F_P^*((1-2f+\eta)c_L)c_L}_{\text{lower default risk}},\end{aligned} \tag{13}$$

The change in welfare depends on three components. First, welfare declines when credit is rationed in equilibrium. Without a platform, banks always lend to merchants with $p \in \left[\frac{R_D}{(1-f)c_H}, R_D/\bar{R}\right)$ but, with competition from the platform, lenders may ration credit with positive probability. Second, welfare declines if $\bar{R} > R_D$ because merchants are financed at a higher cost of capital. This happens when the platform offers credit and banks do not, or when the merchant is good the platform offers a lower rate than banks. Third, welfare increases when the platform offers contracts satisfying the incentive-compatibility condition (1) for $\theta = L$ and a bad merchant does not default when borrowing from the platform. This happens when banks do not lend and the platform offers a rate equal to or below $(1 - 2f + \eta)c_L$.

The following corollary establishes how welfare changes when the platform enters the credit 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 $p \geq R_D/\bar{R}$, expected welfare remains unchanged.*

2. *For merchants of low credit quality with $p < \frac{R_D}{(1-f)c_H}$, expected welfare increases if* (6) *is satisfied. Otherwise, expected welfare remains unchanged.*

3. *For merchants of intermediate credit quality with parameters satisfying case A, expected welfare declines if $\bar{R} > R_D$. Otherwise, expected welfare remains unchanged.*

4. *For merchants of intermediate credit quality with parameters satisfying B, the change in expected welfare depends on the platform's cost of capital. In particular, there exists $\bar{R}^M \in [R_D, R_D/p)$ such that welfare increases if $\bar{R} < \bar{R}^M$, welfare remains unchanged if $\bar{R} = \bar{R}^M$, and it declines if $\bar{R} > \bar{R}^M$.*

5. *For merchants of intermediate credit quality with parameters satisfying case C, expected welfare declines.*

In case A, $m_P^* = 1$ and $F_P^*((1 - 2f + \eta)c_L) = 0$. Hence, the first and third effects in (13) are zero. The change in welfare depends entirely on the difference between the platform's and the bank's cost of capital. In particular, the expected welfare does not change if the two lenders have the same cost of capital and the expected welfare declines if the platform's cost of capital exceeds the bank's.

In case B, $m_P^* = 1$ and, hence, credit is not rationed. As shown in Propositions 2 and 3, it is possible that $F_P^*((1 - 2f + \eta)c_L) > 0$. In this case, with positive probability, the bad merchant borrows from the platform and produces for two periods. Welfare depends on the trade-off between the positive effects of the platform's better enforcement on credit risk and the negative effects of equilibrium screening on the cost of capital. If $\bar{R}$ is sufficiently close to R_D, the positive effect of better enforcement dominates, and expected welfare increases. If $\bar{R}$ is sufficiently high, the negative effects of equilibrium screening prevail over the benefits of enforcement, and welfare declines.

Finally, in case C, we have $F_P^*((1-2f+\eta)c_L) = 0$, i.e. enforcement and credit risk do not improve when the platform enters the credit market. In addition, merchants are rationed with positive probability under competition, and the platform's cost of capital strictly exceeds the banks'. Hence, for these parameters, social welfare declines unambiguously.

5 INFORMATION ACQUISITION

Bigtech platforms may obtain an advantage over banks because they possess superior information. For example, a platform may observe the past history of transactions of the merchant or of similar merchants and infer useful information about a borrower's future sales. In this section, we consider an extension of the model where the platform 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. The effects discussed in Section 4 remain. Moreover, for certain types of merchants, the platform uses the additional information to customize interest rates offered, which further increases repayment incentives and decreases default risk. We also find that the ability to acquire information may actually hurt the platform's profit in certain regions. We briefly describe the setting and the implications here. We leave the details regarding the equilibrium to Appendix C.

5.1 INFORMATION-ACQUISITION TECHNOLOGY

By paying a cost $c > 0$, the platform acquires a private signal s that is informative about the borrower's type θ. Similar to He et al. (2023), we assume the platform may observe either a high or a low signal, i.e., $s \in \{h, l\}$. 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,

$$P(s = l|\theta = H) = 0 \text{ and } P(s = l|\theta = L) > 0.$$

Let

$$\psi := p + (1-p)P(s = h|\theta = L)$$

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

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

be the platform's posterior belief about the probability that the merchant generates high revenue after observing a high signal. When the platform observes a low signal, its posterior belief is $p^l := P(\theta = H|s = l) = 0$.

The platform chooses whether to acquire the signal or not at a cost $c > 0$. We study the equilibrium in the limit where $c \to 0$. 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. As a result, banks will lend more conservatively when the platform acquires information in equilibrium.

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.

5.2 INFORMATION ACQUISITION AND COMPETITION

Like in Section 4, the equilibrium features mixed strategies in the credit decisions of the lenders. The formal definition of the equilibrium is in Definition C.1 of Appendix C.

Several results we obtained in Section 4 are extended to this framework. First, Lemma C.3 establishes the same results as Lemma 3, showing that the market is partially segmented in the same way as in Section 4. Second, according to Lemma C.4, banks deny credit with positive probability and offer rates up to $(1 - f)c_H$, as in Section 4. Moreover, the uninformed platform and the optimistic platform combined offer rates that span a set similar to the one in Lemma 4. However, the uninformed and optimistic platform may offer rates over different supports. Importantly, the platform still benefits from advantageous screening in equilibrium, and Remark 3 applies also to this extension of the model.

Next, we discuss the implications of the option to acquire information when the platform and banks directly compete for merchants of intermediate quality $p \in \left[\frac{R_D}{(1-f)c_H}, \frac{R_D}{\bar{R}}\right)$. As we discuss ahead, social welfare and the platform's profits may change in non-trivial ways because of the banks' equilibrium reaction to the platform's information-acquisition strategy.[19] Based on the results in Appendix C, we distinguish three main cases, which are analogous to those we studied in Section 4.

CASE I.A: $p^h(1+\eta)c_H + (1-p^h)\eta c_L > \bar{R} > (1-2f+\eta)c_L$, $p \in \left[\frac{R_D}{(1-f)c_H}, \frac{R_D}{\bar{R}}\right)$ In this case, the platform earns positive profits as a monopolist and always acquires information. However, depending on the platform's cost of capital, the platform either uses the information to screen out bad borrowers or to adjust interest rates and maximize the surplus it extracts from the borrower. When the platform's cost of capital $\bar{R}$ exceeds $(1+\eta)c_L$, the platform denies credit upon receiving a low signal. When $\bar{R} \leq (1+\eta)c_L$ and the platform observes a low signal, it lends at interest rate $R_P = (1-2f+\eta)c_L$, thus satisfying the incentive-compatibility condition (1) for $\theta = L$.

In the latter case, the platform charges higher rates after observing good signals in order to extract more rents from merchants with a low perceived risk of strategic default. The platform charges lower rates after observing bad signals to discourage strategic default from low-revenue merchants. Because the platform reduces the risk of strategic default, welfare increases.

The banks' lending probability and distribution of rate offers are identical to those of case A in Section 4, when the platform has no option to acquire information. Moreover, the optimistic platform offers interest rates from the same distribution as the uninformed platform in case A of Section 4.

CASE I.B: $\bar{R} \leq (1-2f+\eta)c_L$, $p \in \left[\frac{R_D}{(1-f)c_H}, \frac{R_D}{\bar{R}}\right)$ In this case, the merchant's relative revenues are sufficiently high that the platform is always willing to lend, regardless of its posterior p^i. The platform acquires information with positive probability. When it does acquire information, it always uses the information to customize interest rates and maximize the surplus it extracts. In particular, a pessimistic platform offers interest rates satisfying the incentive-compatibility condition (1) for $\theta = L$, thus ensuring a bad merchant always repays in full and improving welfare.

[19]When $p \geq R_D/\bar{R}$, neither welfare nor the platform's profits change with the option to acquire information because banks remain the only lenders. When $p < \frac{R_D}{(1-f)c_H}$, both welfare and the platform's profits increase with the option to acquire information provided the platform lends. In this case, information alleviates financing frictions between the borrower and the platform, which is the only lender for this merchant.

Interestingly, when the platform can acquire information, banks lend with higher probability compared to the analogous case B from section 4.[20] With better information, the platform raises the interest rate charged to the good merchants to extract more surplus, which increases the chance that a bank lends to a good merchant. As a result, banks lend more aggressively to compete with the platform.

CASE I.C: $p^h(1+\eta)c_H + (1-p^h)\eta c_L \leq \bar{R}$, $p \in \left[\frac{R_D}{(1-f)c_H}, \frac{R_D}{\bar{R}}\right)$ In this case, the platform acquires information with positive probability and lends only when it receives high signal. Upon receiving a high signal, the platform lends with probability 1 and offers rates with the same distribution as described in Proposition 4 of section 4. The platform remains uninformed with positive probability and, in this case, it denies credit. Overall, the platform denies credit with higher probability compared to the baseline model, because it can better screen out bad merchants.

If the platform were the only lender for a merchant in case I.C, it would deny credit even after observing a high signal. However, similar to case C in Section 4, the platform benefits from advantageous screening when competing with banks. The platform, therefore, lends with positive probability in equilibrium to extract advantageous-screening rents.

In Case I.C, banks lend with lower probability when the platform has the ability to acquire superior information compared to Case C from Section 4.[21] Because the platform denies credit after observing a low signal, banks suffer from winner's curse when the platform possesses superior information. As both the platform and banks scale back lending, credit is rationed more frequently compared to case C in Section 4.

THE VALUE OF INFORMATION AND WELFARE. Usually, better information increases the informed lender's profit in equilibrium (Hauswald and Marquez, 2003; He et al., 2020). Perhaps surprisingly, in our setting, the ability to acquire superior information does not always increase the platform's profit. In our model, because of bank's equilibrium reaction to the platform information-acquisition strategy, the option to acquire information may lower the profits the platform obtains because of its superior enforcement power.

In case I.B, because of the platform's enforcement power, the pessimistic platform offers lower rates than an optimistic platform to incentivize full repayment and avoid

[20]Case I.B in the superior information case does not overlap exactly with Case B in the common information case. The comparison here applies only to the over-lapping region.

[21]Case I.C in the superior information case does not overlap exactly with Case C in the common information case. The comparison here applies to the overlapping region.

strategic default. An optimistic platform offers higher rates to extract more surplus from the borrowers. As a result, banks expand lending and compete more aggressively for the good merchant, which leads to lower profit for the platform.

In case I.C, the platform lends solely to extract advantageous-screening rents at the expense of banks. When the platform acquires superior information and denies credit to bad borrowers, banks suffer from winner's curse and lend more conservatively. As a result, the platform extracts less rents in equilibrium, and its profits decline.

Finally, the welfare effect of having better information is also ambiguous. On the one hand, welfare may decline because less informed lenders reduce credit in response to their winner's curse, as in He et al. (2020). On the other hand, better information allows the platform to customize interest rates and discourage a bad merchant from defaulting, thus increasing welfare. The latter effect is unique to our setting because of the platform's better enforcement power, and it serves to alleviate financial frictions.

6 CONCLUSIONS

We study the equilibrium and welfare implications of a bigtech platform entering the credit market and competing with banks. The unique feature of the platform is that it is the monopolistic provider of a valuable marketplace. Because of its control to the marketplace, a platform can implement revenue based repayment plans and better enforce loan repayments. For high-risk borrowers, the platform can incentivize full loan repayment even though the same borrowers would default if they borrowed from banks. As a result, the platform can lend to small businesses of high credit risk, who are traditionally denied credits by banks. When borrowing from the platform, these high-risk merchants are more likely to remain in business and continue production. For such merchants, the platform generally increases welfare.

We also find that when the platform competes directly with banks, the platform benefits from advantageous screening — conditional on the observable characteristics, the platform attracts a better pool of borrowers compared to the banks. As a result, banks scale back lending and increase interest rates. Banks do so to cover the losses they incur when the platform extracts advantageous-screening rents from them. Our theory predicts that the platform lends to a worse pool of borrowers based on observable characteristic than banks. But conditional on observables, the platform lends to a better pool of borrowers than banks. Because banks are adversely affected by equilibrium screening, they lend more conservatively. Social welfare may thus decline when the platform enters the credit market and competes with banks for merchants of intermediate credit quality.

To study the interaction effect between enforcement power and information advantage, we extend the baseline model allowing the platform to acquire superior information about the borrowers at a small cost. We find that conditional on having better enforcement power, additional information advantage does not always increase the platform's profit. Depending on whether the platform uses the information to screen out bad merchants or to tailor interest rates to incentivize full repayment, banks may either decrease or increase lending in response.

There are many other features unique to platforms making loans. For example, there might be synergies between lending and platform's marketplace business through network effects. It would also be interesting to explore how credit decisions feed back to platform's optimal fee design for different users. We leave those interesting questions for future research.

References

Agarwal, S., Alok, S., Ghosh, P., and Gupta, S. (2021). Financial Inclusion and Alternate Credit Scoring: Role of Big Data and Machine Learning in Fintech. *Working Paper*.

Agarwal, S. and Zhang, J. (2020). FinTech, Lending and Payment Innovation: A Review. *Asia-Pacific Journal of Financial Studies*, 49(3):353–367.

Allen, F., Gu, X., and Jagtiani, J. (2020). A Survey of Fintech Research and Policy Discussion. *Federal Reserve Bank of Philadelphia Working Papers*.

Alvarez, F. and Jermann, U. J. (2000). Efficiency, Equilibrium, and Asset Pricing with Risk of Default. *Econometrica*, 68(4):775–797.

Armstrong, M. (2006). Competition in two-sided markets. *The RAND Journal of Economics*, 37(3):668–691.

Balyuk, T. (2022). FinTech Lending and Bank Credit Access for Consumers. *Management Science*, 69(1):555–575.

Beaumont, P., Tang, H., and Vansteenberghe, E. (2021). The Role of FinTech in Small Business Lending.

Berg, T., Burg, V., Gombovi´c, A. G., and Puri, M. (2020). On the Rise of FinTechs: Credit Scoring Using Digital Footprints. *The Review of Financial Studies*, 33(7):2845–2897.

Berg, T., Fuster, A., Puri, M., and Lending, F. (2021). Fintech Lending. *NBER Working Paper*.

Biais, B. and Gollier, C. (1997). Trade Credit and Credit Rationing. *The Review of Financial Studies*, 10(4):903–937.

Boualam, Y. and Yoo, P. (2022). Fintech Disruption, Banks, and Credit Dis-Intermediation: When Do Foes Become Friends?

Bouvard, M., Casamatta, C., and Xiong, R. (2022). Lending and monitoring: Big Tech vs Banks.

Broecker, T. (1990). Credit-Worthiness Tests and Interbank Competition. *Econometrica*, 58(2):429.

Buchak, G., Matvos, G., Piskorski, T., and Seru, A. (2018). Fintech, regulatory arbitrage, and the rise of shadow banks. *Journal of Financial Economics*, 130(3):453–483.

Burkart, M. and Ellingsen, T. (2004). In-Kind Finance: A Theory of Trade Credit. *American Economic Review*, 94(3):569–590.

Cornelli, G., Frost, J., Gambacorta, L., Rau, R., Wardrop, R., and Ziegler, T. (2021). Fintech and Big Tech Credit: What Explains the Rise of Digital Lending? *CESifo Forum*, 2.

Dai, L., Han, J., Shi, J., and Zhang, B. (2023). Digital Footprints as Collateral for Debt Collection. *SSRN Electronic Journal*.

Di Maggio, M. and Yao, V. (2021). Fintech Borrowers: Lax Screening or Cream-Skimming? *Review of Financial Studies*, 34(10):4565–4618.

Donaldson, J. R., Piacentino, G., and Thakor, A. (2018). Warehouse banking. *Journal of Financial Economics*, 129(2):250–267.

Dubey, T. S. and Purnanandam, A. (2023). Can Cashless Payments Spur Economic Growth? *Working Paper*.

Eça, A., Ferreira, M. A., Prado, M. P., and Rizzo, A. E. (2022). The Real Effects of FinTech Lending on SMEs: Evidence from Loan Applications.

Engelbrecht-Wiggans, R., Milgrom, P. R., and Weber, R. J. (1983). Competitive bidding and proprietary information. *Journal of Mathematical Economics*, 11(2):161–169.

Frost, J., Gambacorta, L., Huang, Y., Shin, H. S., and Zbinden, P. (2019). BigTech and the changing structure of financial intermediation.

Fuster, A., Plosser, M., Schnabl, P., and Vickery, J. (2019). Role of Technology in Mortgage Lending. *The Review of Financial Studies*, 32(5):1854–1899.

Ghosh, P., Vallee, B., and Zeng, Y. (2021). FinTech Lending and Cashless Payments.

Goldstein, I., Huang, C., and Yang, L. (2022). Open Banking under Maturity Transformation.

Gopal, M. and Schnabl, P. (2022). The Rise of Finance Companies and FinTech Lenders in Small Business Lending. *Review of Financial Studies*, 35(11):4859–4901.

Hau, H., Huang, Y., Shan, H., and Sheng, Z. (2019). How FinTech Enters China's Credit Market. *AEA Papers and Proceedings*, 109:60–64.

Hausch, D. B. (1987). An Asymmetric Common-Value Auction Model. *RAND Journal of Economics*, 18(4):611–621.

Hauswald, R. and Marquez, R. (2003). Information Technology and Financial Services Competition. *The Review of Financial Studies*, 16(3):921–948.

He, Z., Huang, J., and Zhou, J. (2020). Open Banking: Credit Market Competition When Borrowers Own the Data.

He, Z., Huang, J., and Zhou, J. (2023). Open banking: Credit market competition when borrowers own the data. *Journal of Financial Economics*, 147(2):449–474.

Higgins, S. (2022). Financial Technology Adoption: Network Externalities of Cashless Payments in Mexico. *Working Paper*.

Hu, Y. and Zryumov, P. (2022). Lending Competition and Funding Collaboration.

Huang, J. (2021a). Fintech Expansion.

Huang, J. (2021b). The Economics of Consumer Credit on an E-Commerce Platform. *SSRN Electronic Journal*.

Jullien, B., Pavan, A., and Rysman, M. (2021). Two-sided Markets, Pricing, and Network Effects. In B.V., E., editor, *Handbook of Industrial Organization*, volume 4, pages 485 – 592.

Kagel, J. H. and Levin, D. (1999). Common Value Auctions with Insider Information. *Econometrica*, 67(5):1219–1238.

Kehoe, T. J. and Levine, D. K. (1993). Debt-Constrained Asset Markets. *Review of Economic Studies*, 60(4):865–888.

Kirpalani, R. and Philippon, T. (2020). Data Sharing and Market Power with Two-Sided Platforms.

Kocherlakota, N. R. (1996). Implications of Efficient Risk Sharing without Commitment. *Review of Economic Studies*, 63(4):595–609.

Ligon, E., Thomas, J. P., and Worrall, T. (2002). Informal Insurance Arrangements with

Limited Commitment: Theory and Evidence from Village Economies. *Review of Economic Studies*, 69(1):209–244.

Liu, L., Lu, G., and Xiong, W. (2022). The Big Tech Lending Model. *NBER Working Paper Series*.

Milgrom, P. R. and Weber, R. J. (1982). A Theory of Auctions and Competitive Bidding. *Econometrica*, 50(5):1089–1122.

Ouyang, S. (2022). Cashless Payment and Financial Inclusion.

Parlour, C. A., Rajan, U., and Zhu, H. (2020). When FinTech Competes for Payment Flows.

Petersen, M. A. and Rajan, R. G. (1997). Trade Credit: Theories and Evidence. *Review of Financial Studies*, 10(3):661–691.

Petralia, K., Philippon, T., Rice, T., and Véron, N. (2019). Banking Disrupted? Financial Intermediation in an Era of Transformational Technology. *Geneva Reports on the World Economy, ICBM*.

Philippon, T. (2019). On Fintech and Financial Inclusion.

Rochet, J.-C. and Tirole, J. (2002). Cooperation among Competitors: Some Economics of Payment Card Associations. *RAND Journal of Economics*, 33(4):549–570.

Stulz, R. M. (2019). FinTech, BigTech, and the Future of Banks. *Journal of Applied Corporate Finance*, 31(4):86–97.

Weyl, E. G. (2010). A Price Theory of Multi-sided Platforms. *American Economic Review*, 100(4):1642–72.

A Proofs for the Main Model

A.1 Proof of Lemma 1

From the optimization problem (5), we have that the platform offers loans either at rate $(1-2f+\eta)c_H$ or at rate $(1-2f+\eta)c_L$. Hence, its optimized profits are given by

$$\max\{p(1+\eta)c_H + (1-p)\eta c_L, (1+\eta)c_L + 2p(c_H - c_L)f\} - \bar{R}.$$

The platform lends only if profits are non-negative, yielding condition (6).

In setting its interest rate, the platform prefers to offer rate $(1-2f+\eta)c_H$ if

$$p(1+\eta)c_H + (1-p)\eta c_L \geq (1+\eta)c_L + 2p(c_H - c_L)f,$$

which can be rearranged to become (7). Otherwise, the platform optimally offers a rate equal to $(1-2f+\eta)c_L$.

To conclude the proof, assume $2c_L > \bar{R}$. Let

$$\hat{\eta} := \frac{\bar{R}}{c_L} - 1.$$

Note $\hat{\eta} < 1$ because $2c_L > \bar{R}$. Note also $\eta > f$ because $\bar{R} \geq R_D > (1-f)c_L$. Then, for any $\eta \geq \hat{\eta}$ we have

$$(1+\eta)c_L + 2p(c_H - c_L)f - \bar{R} \geq 0,$$

for all $p \in [0,1]$. Therefore, if $\eta \geq \hat{\eta}$, (6) holds and the platform lends for any $p \in [0,1]$. □

A.2 Auxiliary Lemmas

We now introduce some lemmas which will be useful in characterizing the equilibrium with competition.

Lemma A.1. *$m_B^* > 0$ if and only if $p \geq \frac{R_D}{(1-f)c_H}$.*

Proof. First, we show $m_B^* > 0$ if $p \geq \frac{R_D}{(1-f)c_H}$. By way of contradiction, suppose $m_B^* = 0$. Then $\mathcal{R}_P^* = \{(1-2f+\eta)c_H\}$ and $G_P^*(R) = \mathbb{I}(R < (1-2f+\eta)c_H)$. Then, for any $m_P^* \in [0,1]$ and $\varepsilon \in (0, (1-f)c_H - R_D/p)$, $L_B(R_D/p + \varepsilon, m_P^*, G_P^*; p) > 0$, contradicting that $m_B^* = 0$ is the bank's equilibrium strategy.

Second, we show $m_B^* = 0$ if $p < \frac{R_D}{(1-f)c_H}$. When $p < \frac{R_D}{(1-f)c_H}$, for any $R \leq (1-f)c_H$ we have

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

and, by (11), $m_B^* = 0$. □

LEMMA A.2. *If $m_B^* \in (0,1)$, then $\sup \mathcal{R}_B^* = (1-f)c_H$.*

Proof. We proceed by contradiction and assume $\tilde{R} := \sup \mathcal{R}_B^* < (1-f)c_H$. Because $m_B^* \in (0,1)$, by Lemma A.1, we have $p \geq \frac{R_D}{(1-f)c_H}$, which also implies (7). Hence, $L_P(R, m_B^*, G_B^*; p) < L_P((1-2f+\eta)c_H, m_B^*, G_B^*; p)$ for any $R \in (\tilde{R}, (1-2f+\eta)c_H)$. Therefore, an $\varepsilon > 0$ exists such that $L_B(\tilde{R}+\varepsilon, m_P^*, G_P^*; p) > L_B(\tilde{R}, m_P^*, G_P^*; p)$.

Hence, for a small enough ε, a lending mechanism (m_B, F_B) with $m_B = 1$ and with domain $\mathcal{R}_B^* \cup \{\tilde{R}+\varepsilon\}$ exists such that $\int_0^{\hat{R}+\varepsilon} L_B(R, m_P^*, G_P^*; p)dF(R) > 0$ and $U(1, m_P^*, F_B, F_P^*) > U(m_B^*, m_P^*, F_B^*, F_P^*)$, contradicting the assumption that $\mathcal{R}_B^*$ is the domain of the equilibrium lending mechanism offered by banks. $\square$

LEMMA A.3. $\inf \mathcal{R}_P^* \in \mathcal{R}_P^*$ *and* $\inf \mathcal{R}_B^* \in \mathcal{R}_B^*$.

Proof. Define $\underline{R}_P := \inf \mathcal{R}_P^*$ and $\underline{R}_B := \inf \mathcal{R}_B^*$ and consider lender $J \in \{P, B\}$ and lender $I \in \{P, B\}$ with $J \neq I$.

If $\underline{R}_J \notin \mathcal{R}_J^*$, then a sequence $(R_n)_{n=0}^{\infty}$ exists such that $R_n > \underline{R}_J$ and $R_n \in \mathcal{R}_J^*$ for all n and $R_n \to \underline{R}_J$ as $n \to \infty$. We, therefore, must have $L_J(\underline{R}_J, m_I^*, G_I^*; p) < \lim_{n\to\infty} L_J(R_n, m_I^*, G_I^*; p)$ which, in turn, implies $G_I^*(\underline{R}_J) < \lim_{n\to\infty} G_I^*(R_n)$. This result, however, contradicts that G_I^* is a weakly decreasing function. Therefore, $\underline{R}_J \in \mathcal{R}_J^*$. $\square$

LEMMA A.4. *Assume $m_P^* > 0$ and $m_B^* > 0$. Then $\min \mathcal{R}_P^* \leq R_D/p$. Moreover, $\min \mathcal{R}_P^* = R_D/p$ or $\min \mathcal{R}_P^* = (1-2f+\eta)c_L$. Also, if $\min \mathcal{R}_P^* \neq (1-2f+\eta)c_L$, then $\min \mathcal{R}_B^* = R_D/p$.*

Proof. Define $\underline{R}_P := \min \mathcal{R}_P^*$ and $\underline{R}_B := \min \mathcal{R}_B^*$. First, we establish $\underline{R}_P \leq R_D/p$. We proceed by contradiction and assume $\underline{R}_P > R_D/p$. By competition between banks, we thus have $m_B^* = 1$ and $\mathcal{R}_B^* = \{R_D/p\}$. In this case, if $R_D/p < (1-2f+\eta)c_L$, the platform's best response is R_D/p. If instead $R_D/p \geq (1-2f+\eta)c_L$, the platform's best response could be either R_D/p or $(1-2f+\eta)c_L$. In both cases, $\underline{R} \leq R_D/p$, contradicting $\underline{R}_P > R_D/p$.

Having established $\underline{R}_P \leq R_D/p$, we now prove $\underline{R}_P = R_D/p$ or $\underline{R} = (1-2f+\eta)c_L$. If $R_D/p \leq (1-2f+\eta)c_L$, then $L_P(R, m_B^*, G_B^*; p) < L_P(R_D/p, m_B^*, G_B^*; p)$ for any $R < R_D/p$, implying $\underline{R}_P = R_D/p$. If instead $R_D/p > (1-2f+\eta)c_L$, $L_P(R, m_B^*, G_B^*; p) < L_P((1-2f+\eta)c_L, m_B^*, G_B^*; p)$ for any $R < (1-2f+\eta)c_L$ and $L_P(R', m_B^*, G_B^*; p) < L_P(R_D/p, m_B^*, G_B^*; p)$ for any $R' \in ((1-2f+\eta)c_L, R_D/p)$, implying $\underline{R} = R_D/p$ or $\underline{R} = (1-2f+\eta)c_L$.

To prove the last part of the lemma, consider $\underline{R}_P = R_D/p \neq (1-2f+\eta)c_L$. We proceed by contradiction and assume $\underline{R}_B > R_D/p$. Because $\underline{R}_P \neq (1-2f+\eta)c_L$, an $\varepsilon > 0$ exists such that $L_P(R_D/p+\varepsilon, m_B^*, G_B^*; p) > L_P(R_D/p, m_B^*, G_B^*; p)$, contradicting $R_D/p \in \mathcal{R}_P^*$. Hence, if $\underline{R}_P = R_D/p \neq (1-2f+\eta)c_L$, the $\underline{R}_B = R_D/p$. $\square$

LEMMA A.5. *If $m_B^* > 0$ and $\bar{R} > (1-2f+\eta)c_L$, then $(1-2f+\eta)c_L \notin \mathcal{R}_P^*$.*

Proof. Note that $L_P((1-2f+\eta)c_H, m_B^*, G_B^*; p) \leq L_P((1-2f+\eta)c_L, m_B^*, G_B^*; p)$ if and only if

$$(1-m_B^*)[p(1+\eta)c_H + (1-p)\eta c_L] \leq m_B^* p[(1-2f+\eta)c_L - \bar{R}] + (1-m_B^*)[(1+\eta)c_L + 2p(c_H - c_L)f]$$

From the proof of Lemma 1, we have that $p(1+\eta)c_H+(1-p)\eta c_L > (1+\eta)c_L+2p(c_H-c_L)f$ if an only if

$$p > \frac{c_L}{(1-2f+\eta)(c_H-c_L)+c_L}. \tag{A.1}$$

Note that $R_D > c_L$ and $(1-f)c_H < (1-2f+\eta)(c_H-c_L)+c_L$. Hence, because we are considering $p \geq \frac{R_D}{(1-f)c_H}$, inequality (A.1) is satisfied. We must thus have $L_P((1-2f+\eta)c_H, m_B^*, G_B^*; p) > L_P((1-2f+\eta)c_L, m_B^*, G_B^*; p)$ whenever $(1-2f+\eta)c_L - \bar{R} < 0$. □

Lemma A.6. *If* $m_P^* > 0$ *and* $m_B^* \in (0,1)$, *then* $\max \mathcal{R}_P^* \in \{(1-f)c_H, (1-2f+\eta)c_H\}$. *Furthermore, if* $m_P^* = 1$, *then* $\max \mathcal{R}_P^* = (1-2f+\eta)c_H$.

Proof. First, note $\sup \mathcal{R}_P^* \in \mathcal{R}_P^*$ by the left-continuity of $G_B^*(\cdot)$ and the platform's objective function $L_P(\cdot, m_B, G_B; p)$. Hence, $\sup \mathcal{R}_P^* = \max \mathcal{R}_P^*$. Also note that $L_P(R, m_B^*, G_B^*; p) < L_P((1-2f+\eta)c_H, m_B^*, G_B^*; p)$ for $R \in ((1-f)c_H, (1-2f+\eta)c_H)$ because $m_B^* \in (0,1)$. Therefore, $((1-f)c_H, (1-2f+\eta)c_H) \cap \mathcal{R}_P^* = \emptyset$. Finally, by Lemma A.2, $\sup \mathcal{R}_B^* = (1-f)c_H$.

To prove the first part of the lemma, we proceed by contradiction and assume $R^M := \max \mathcal{R}_P^* < (1-f)c_H$. In this case, $G_P^*(R) = 0$ for all $R \geq R^M$, along with $\sup \mathcal{R}_B^* = (1-f)c_H$, implies that $(1-f)c_H \in \mathcal{R}_B^*$ and $R \notin \mathcal{R}_B^*$ for all $R \in (R^M, (1-f)c_H)$. Otherwise, an $R' \geq R^M$ with $R' \in \mathcal{R}_B^*$ would exist such that $L_B(R', m_P^*, G_P^*; p) \neq 0$, contradicting the definition of equilibrium. Moreover, $L_B((1-f)c_H, m_P^*, G_P^*; p) = 0$ and $R^M < (1-f)c_H$ imply $m_P^* \in (0,1)$.

If $R^M > (1-2f+\eta)c_L$ or if $R^M < (1-f)c_H \leq (1-2f+\eta)c_L$ then $L_P((1-f)c_H, m_B^*, G_B^*; p) > L(R^M, m_B^*, G_B^*; p)$, contradicting $R^M := \max \mathcal{R}_P^*$. It remains to consider $R^M \leq (1-2f+\eta)c_L < (1-f)c_H$. In this case, by Lemma A.4 we have $\min \mathcal{R}_P^* = R_D/p \leq (1-2f+\eta)c_L$. Moreover, we have $\bar{R} < R_D/p$. Therefore, $L_P(R_D/p, m_B^*, G_B^*; p) > m_B^*[2pc_H + (1-p)c_L]f$. But this implies $m_P^* = 1$, which contradicts $L_B((1-f)c_H, m_P^*, G_P^*; p) = 0$. Hence, $\max \mathcal{R}_P^* \in \{(1-f)c_H, (1-2f+\eta)c_H\}$

To prove the second part of the lemma for $m_P^* = 1$, we proceed again by contradiction and assume $\mathcal{R}_P^* = (1-f)c_H$. In this case, $L_B((1-f)c_H, 1, G_P^*; p) < 0$. Therefore, $G_B^*((1-f)c_H) = 0$. But then, $L_P((1-2f+\eta)c_H, m_B^*, G_B^*; p) > L_P((1-f)c_H, m_B^*, G_B^*; p)$, contradicting $\mathcal{R}_P^* = (1-f)c_H$. Thus, if $m_P^* = 1$ and $m_B^* \in (0,1)$, then $\max \mathcal{R}_P^* = (1-2f+\eta)c_H$. □

Lemma A.7. *Suppose* $m_B^* \in (0,1)$ *and* $m_P^* > 0$. *If* $R_1 \in \mathcal{R}_B^*$ *and* $R_2 \in \mathcal{R}_B^*$ *are such that* $R_1 < R_2 \leq (1-2f+\eta)c_L$ *or* $(1-2f+\eta)c_L < R_1 < R_2$, *then we must have* $[R_1, R_2] \subseteq \mathcal{R}_B^* \cap \mathcal{R}_P^*$.

Proof. Assume, by contradiction, that an $R^k \in (R_1, R_2)$ exists such that $R^k \notin \mathcal{R}_B^*$. By the right-continuity of $G_P^*(\cdot)$ and $L_B(\cdot, m_P^*, G_P^*; p)$, we have that an $\varepsilon > 0$ exists such that $L_B(R, m_P^*, G_P^*; p) < 0$ for all $R \in (R^k, R^k+\varepsilon)$. Let $R_1' := \sup\{R\colon R \in \mathcal{R}_B^* \text{ and } R < R^k\}$. Hence, $L_B(R, m_P^*, G_P^*; p) < 0$ for all $R \in (R_1', R^k+\varepsilon)$, thus implying

$$G_P^*(R) < \frac{(1-m_P^*)(R_D-pR)}{m_P^* p(R-R_D)} + \frac{(1-p)R_D}{p(R-R_D)} \leq \frac{(1-m_P^*)(R_D-pR_1')}{m_P^* p(R_1'-R_D)} + \frac{(1-p)R_D}{p(R_1'-R_D)}. \tag{A.2}$$

Because $R \notin \mathcal{R}_B^*$ for all $R \in (R_1', R^k+\varepsilon)$, we must have $R \notin \mathcal{R}_P^*$ for any $R \in (R_1', R^k+\varepsilon)$.

If $R'_1 \in \mathcal{R}^*_B$, then the last term in (A.2) coincides with $G^*_P(R'_1)$ and therefore $G^*_P(R) < G^*_P(R'_1)$ for any $R \in (R'_1, R^k + \varepsilon)$. But this implies that there exists $R' \in (R'_1, R)$ such that $R' \in \mathcal{R}^*_P$, contradicting the previous result that $R' \notin \mathcal{R}^*_P$ for any $R' \in (R'_1, R^k + \varepsilon)$. If instead, $R'_1 \notin \mathcal{R}^*_B$, then we must have $\lim_{R \to R'^-_1} G^*_P(R) > G^*_P(R'_1)$, which implies $R'_1 \in \mathcal{R}^*_P$. However, if $R'_1 \notin \mathcal{R}^*_B$, $L_P(R^k + \varepsilon, m^*_B, G^*_B; p) > L_P(R'_1, m^*_B, G^*_B; p)$, generating a contradiction.

Hence, $[R_1, R_2] \subseteq \mathcal{R}^*_B$. In particular, $L_B(R, m^*_P, G^*_P; p) = 0$ for all $R \in [R_1, R_2]$, which implies

$$G^*_P(R) = \frac{(1 - m^*_P)(R_D - pR)}{m^*_P p(R - R_D)} + \frac{(1 - p)R_D}{p(R - R_D)}$$

is strictly decreasing for $R \in [R_1, R_2]$.

Suppose now, by way of contradiction, an $R^y \in [R_1, R_2]$ exists such that $R \notin \mathcal{R}^*_P$. By the left-continuity of $G^*_B(\cdot)$ and $L_P(\cdot, m^*_B, G^*_B; p)$, we have that an $\varepsilon > 0$ exists such that $R \notin \mathcal{R}^*_P$ for all $R \in (R^y - \varepsilon, R^y)$. However, this observation implies $G^*_P(R)$ is constant in $(R^y - \varepsilon, R^y)$, contradicting the previous result. Hence, we also obtain $[R_1, R_2] \subseteq \mathcal{R}^*_P$. □

A.3 Proof of Lemma 2

First, note $L_P(R, m_B, G_B; p) < L_P((1 - f)c_L, m_B, G_B; p)$ for any $R < (1 - f)c_L$, and hence $[0, (1 - f)c_L) \cap \mathcal{R}^*_P = \emptyset$. To prove the lemma, it suffices to show that $L_P((1 - f)c_L, m_B, G_B; p) < L_P((1 - 2f + \eta)c_L, m_B, G_B; p)$. We proceed by contradiction and assume

$$L_P((1 - f)c_L, m_B, G_B; p) \geq L_P((1 - 2f + \eta)c_L, m_B, G_B; p).$$

After some manipulations, this inequality implies

$$(\eta - f)c_L - m_B(1 - p)[(1 - f + \eta)c_L - \bar{R}] \leq 0.$$

Because $\eta \geq f$, then $(1 - f + \eta)c_L - \bar{R} \geq 0$. This observation further implies that the same inequality holds for $m_B = 1$ and $p = 0$, which is equivalent to

$$\bar{R} - c_L \leq 0.$$

However, $\bar{R} > c_L$ by Assumption 1.

Hence, this result contradicts the hypothesis that $L_P((1 - f)c_L, m_B, G_B; p) \geq L_P((1 - f)c_L, m_B, G_B; p)$. We therefore conclude that $L_P(R, m_B, G_B; p) < L_P((1 - f)c_L, m_B, G_B; p)$ for any any $m_B \in [0, 1]$ and $R \leq (1 - f)c_L$. □

A.4 Proof of Lemma 3

When $p < \frac{R_D}{(1-f)c_H}$, Lemma A.1 implies $m_B^* = 0$. The platform is thus a monopolistic lender for a merchant provided (6) is satisfied, and the results of Lemma 1 apply.

For the rest of the proof, we thus focus on $p \geq R_D/\bar{R}$. By Lemma A.1, banks lend with positive probability $m_B^* > 0$. We want to show that $m_B^* = 1$, $\mathcal{R}_B^* = \{R_D/p\}$, and $m_P^*(1 - G_P^*(R_D/p)) = 0$. Together, these conditions imply merchants borrow exclusively from banks when $p \geq R_D/\bar{R}$

As a preliminary observation, notice that, if $m_P^* > 0$, $R_D/p \in \mathcal{R}_P^*$. In fact, if $\bar{R} > (1-2f+\eta)c_L$, by Lemma A.5, $(1-2f+\eta)c_L \notin \mathcal{R}_P^*$. If instead $\bar{R} \leq (1-2f+\eta)c_L$, we have $R_D/p \leq \bar{R} \leq (1-2f+\eta)c_L$. By Lemmas A.4 and A.3, we thus have $R_D/p \in \mathcal{R}_P^*$ in both cases.

Suppose, by way of contradiction, $m_B^* \in (0,1)$. Which, in turn, implies $m_P^* > 0$ and $\underline{R}_P \leq R_D/p$, otherwise competitive banks would offer rate R_D/p with probability one and $m_B^* = 1$. It also implies $\sup \mathcal{R}_B^* = (1-f)c_H$ by Lemma A.2.

First, we exclude $m_P^* = 1$. By the previous observation, $R_D/p = \mathcal{R}_P^*$. We must therefore have $L_P(R_D/p, m_B^*, G_B^*; p) \geq L_P((1-2f+\eta)c_H, m_B^*, G_B^*; p^i)$, which implies

$$\begin{aligned} m_B^* \{ & p((1-2f+\eta)c_H - \bar{R}) - I(R_D/p)(1-p)[R_D/p - (\eta-2f)c_L] \\ & \geq p((1-2f+\eta)c_H - R_D/p) - I(R_D/p)(1-p)[R_D/p - (\eta-2f)c_L]. \end{aligned} \tag{A.3}$$

Notice we have $(1-2f+\eta)c_H \geq R_D/p$ when $p \geq \frac{R_D}{(1-f)c_H}$ and $\eta \geq f$ and $(1-2f+\eta)c_H - \bar{R} \leq (1-2f+\eta)c_H - R_D/p$ because we are considering $\bar{R} \geq R_D/p$. Finally, we also have $p((1-2f+\eta)c_H - R_D/p) - I(R_D/p)(1-p)[R_D/p - (\eta-2f)c_L]$ because either $R_D/p > (1-2f+\eta)c_L$, or $R_D/p \leq (1-2f+\eta)c_L$, along with $p \geq \frac{R_D}{(1-f)c_H}$, implies $p((1-2f+\eta)c_H - R_D/p) - I(R_D/p)(1-p)[R_D/p - (\eta-2f)c_L] > 0$. Therefore, if $p((1-2f+\eta)c_H - \bar{R}) - I(R_D/p)(1-p^i)[R_D/p - (\eta-2f)c_L] \leq 0$, the inequality (A.3) is a contradiction. If $p((1-2f+\eta)c_H - \bar{R}) - I(R_D/p)(1-p)[R_D/p - (\eta-2f)c_L] > 0$, the inequality (A.3) implies $m_B^* \geq 1$, which contradicts $m_B^* \in (0,1)$. Therefore, when $p \geq R_D/\bar{R}$, $m_B^* = 1$.

Next, we show $m_P^*(1 - G_P^*(R_D/p)) = 0$. Assume, by way of contradiction, $m_P^*(1 - G_P^*(R_D/p)) > 0$. By our previous result in the proof, if $m_P^* > 0$, then $R_D/p \in \mathcal{R}_P^*$. Consider, $p > R_D/\bar{R}$. Because $m_B^* = 1$, the platform's profits from lending are thus $L_P(R_D/p, 1, G_B^*; p) < [2pc_H + (1-p)c_L]f$, and hence $m_P^* = 0$, contradicting $m_P^*(1 - G_P^*(R_D/p)) = 0$.

Consider now $p = R_D/\bar{R}$, then $L_P(R_D/p, 1, G_B^*; p) = [2pc_H + (1-p)c_L]f$ and, moreover, $L_P(R, 1, G_B^*; p) \leq L_P(R_D/p, 1, G_B^*; p)$ for any $R > R_D/p$, thus implying $G_B^*(R) \leq 0$. Hence, banks offer rate R_D/p with probability one, and, for this to be the banks' best response, we must have $m_P^*(1 - G_P^*(R_D/p)) = 0$. □

A.5 Proof of Lemma 4

We prove $m_P^* > 0$. Suppose $m_P^* = 0$, then competitive banks would set $\mathcal{R}_B^* = \{R_D/p\}$ and $m_B^* = 1$. For a small enough $\varepsilon > 0$, $L_P(R_D/p - \varepsilon, 1, G_B^*; p) > [p2c_H + (1-p)c_L]f$, which contradicts $m_P^* = 0$. Hence $m_P^* > 0$.

By Lemma A.1, we have $m_B^* > 0$. We now prove $m_B^* \in (0,1)$. We proceed by contradiction and assume $m_B^* = 1$. In this case, $L_P(R, 1, G_B^*; p) = [2pc_H + (1-p)c_L]f < L_P(R_D/p, 1, G_B^*; p)$ for any R such that $G_B^*(R) = 0$. Hence, $m_P^* = 1$ but $R \notin \mathcal{R}_P^*$ if $G_B^*(R) = 0$.

Let $\tilde{R} = \sup \mathcal{R}_B^* \leq (1-f)c_H$. If $\tilde{R} \in \mathcal{R}_B^*$, $L_B(\tilde{R}, 1, G_P^*; p) = 0$ implies $G_P^*(\tilde{R}) > 0$ and an $R > \tilde{R}$ exists with $R \in \mathcal{R}_P^*$. If instead $\tilde{R} \notin \mathcal{R}_B^*$, then $\lim_{R \to \tilde{R}^-} G_P^*(R) > 0$, implying an $R \geq \tilde{R}$ exists with $R \in \mathcal{R}_P^*$. In either case, $G_B^*(R) = 0$, thus contradicting the previous result.

Because $m_B^* \in (0,1)$, Lemma A.2 implies $\sup \mathcal{R}_B^* = (1-f)c_H$, Moreover, by Lemmas A.3 and A.4, we have that $\min \mathcal{R}_P^* \leq R_D/p$ and $\min \mathcal{R}_P^* \in \{(1-2f+\eta)c_L, R_D/p\}$. The result that $\max \mathcal{R}_P^* \in \{(1-f)c_H, (1-2f+\eta)c_H\}$ follows from Lemma A.6. □

A.6 Proof of Lemma 5

Throughout the proof, recall that $m_B^* \in (0,1)$ and $m_P^* > 0$ by Lemma 4. In particular, an R exists such that $L_P(R, m_B^*, G_B^*; p) \geq m_B^*[2pc_H + (1-p)c_L]f$.

We first consider a merchant with $p(1+\eta)c_H + (1-p)\eta c_L > \bar{R}$. To establish our claim, it is sufficient to note

$$L_P((1-2f+\eta)c_H, m_B^*, G_B^*; p) > m_B^*[p2c_H + (1-p)c_L]f$$

because $m_B^* \in (0,1)$ and $p(1+\eta)c_H + (1-p)\eta c_L > \bar{R}$. Therefore, $m_P^* = 1$.

Next, we consider $p(1+\eta)c_H + (1-p)\eta c_L \leq \bar{R}$. Because (7) holds as a strict inequality when $p \geq \frac{R_D}{(1-f)c_H}$, we also have $R_D/p \geq \bar{R} > (1-2f+\eta)c_L$. By Lemmas A.3, A.4, and A.5, we thus have $\min \mathcal{R}_B^* \geq R_D/p > (1-2f+\eta)c_L$.

We proceed by contradiction and assume that $\max_R L_P(R, m_B^*, G_B^*; p) > m_B^*[p2c_H + (1-p)c_L]f$. In this case $m_P^* = 1$. Moreover, by Lemma 4 we have $R^M := \max \mathcal{R}_P^* \in \{(1-f)c_H, (1-2f+\eta)c_H\}$ and, by the previous result, $R^M \geq \min \mathcal{R}_P^* > (1-2f+\eta)c_L$.

If $R^M = (1-2f+\eta)c_H$, then $L_P(R^M, m_B^*, G_B^*; p) \leq m_B^*[p2c_H + (1-p)c_L]f$, generating a contradiction. We thus consider $R^M = (1-f)c_H$. In this case, because $\sup \mathcal{R}_B^* = (1-f)c_H$

and $m_P^* = 1$, we must have $\lim_{R\to(1-f)c_H^-} G_P^*(R) > 0$ and $G_P^*((1-f)c_H) = 0$. Therefore, $(1-f)c_H \notin \mathcal{R}_B^*$ and $G_B^*((1-f)c_H) = 0$. Hence, $L_P(R^M, m_B^*, G_B^*; p) < L_P((1-2f+\eta)c_H, m_B^*, G_B^*; p) \leq m_B^*[p2c_H + (1-p)c_L]f$, where the first inequality follows from $(1-2f+\eta)c_L < R^M < (1-2f+\eta)c_H$. But this result also generates a contradiction. We therefore obtain $\max_R L_P(R, m_B^*, G_B^*; p) = m_B^*[p2c_H + (1-p)c_L]f$.

When $\bar{R} > (1-2f+\eta)c_L$, Lemma A.5 implies $\min \mathcal{R}_P^* \neq (1-2f+\eta)c_L$. Therefore, by Lemmas A.3 and A.4, we obtain $\min \mathcal{R}_P^* = R_D/p > (1-2f+\eta)c_L$, where the inequality follows because $\bar{R} > (1-2f+\eta)c_L$ and $p \leq R_D/\bar{R}$.

Finally, when $R_D/p \leq (1-2f+\eta)c_L$, Lemmas A.3 and A.4 imply $\min \mathcal{R}_P^* = R_D/p \leq (1-2f+\eta)c_L$. □

When the platform and the banks are in competition, the expected profit of a good merchant facing lending mechanisms (m_B, F_B) and (m_P, F_P) is thus

$$\begin{aligned} U(m_B, m_P, F_B, F_P) :=& [1-(1-m_B)(1-m_P)]2(1-f)c_H \\ & - m_B(1-m_P)\int_0^{(1-f)c_H} R\, dF_B(R) - (1-m_B)m_P \int_0^{(1-2f+\eta)c_H} R\, dF_P(R) \\ & - m_B m_P \int_0^{(1-2f+\eta)c_H}\int_0^{(1-f)c_H} \min\{R, R'\}\, dF_B(R)\, dF_P(R'). \end{aligned} \tag{A.4}$$

A.7 Proof of Proposition 1

By Lemma 4, $m_B^* \in (0,1)$. Moreover, by Lemma 5, $m_P^* = 1$, $\min \mathcal{R}_P^* = R_D/p$, and $\max \mathcal{R}_P^* = (1-2f+\eta)c_H$. Hence, $L_P(R_D/p, m_B^*, G_B^*; p) = L_P((1-2f+\eta)c_H, m_B^*, G_B^*; p)$, from which we obtain that m_B^* is given by

$$m_B^* = \frac{(1-2f+\eta)c_H - R_D/p}{(1-2f+\eta)c_H - \bar{R}} \in (0,1) \tag{A.5}$$

Because $\min \mathcal{R}_P^* = R_D/p \geq \bar{R} > (1-2f+\eta)c_L$, Lemma A.4 implies $\min \mathcal{R}_B^* = R_D/p > (1-2f+\eta)c_L$. Moreover, $\sup \mathcal{R}_B^* = (1-f)c_H$ by Lemma 4. Hence, Lemma A.7 implies all rates in $[R_D, (1-f)c_H)$ are best responses for both the platform and banks. From $L_P(R, m_B^*, G_B^*; p) = L_P((1-2f+\eta)c_H, m_B^*, G_B^*; p)$ for $R \in [R_D, (1-f)c_H)$, we obtain the expression for G_B* in after using (A.5)

$$G_B^*(R) = \frac{R_D/p - \bar{R}}{(R-\bar{R})}\frac{(1-2f+\eta)c_H - R}{(1-2f+\eta)c_H - R_D/p}. \tag{A.6}$$

Note that $\lim_{R\to(1-f)c_H^-} G_B^*(R) > 0$, hence $(1-f)c_H \in \mathcal{R}_B^*$.

From $L_B(R,1,G_P^*;p)=0$ for $[R_D,(1-f)c_H]$ we finally obtain the expression for G_P^*

$$G_P^*(R)=\frac{(1-p)R_D/p}{R-R_D} \quad \text{for } R\in[R_D/p,(1-f)c_H]. \tag{A.7}$$

□

A.8 Proof of Proposition 2

Lemmas 4 and 5 imply $m_B^*\in(0,1)$ and $m_P^*=1$, respectively. By Lemma 5, $\min \mathcal{R}_P^*=R_D/p$ and $\max \mathcal{R}_P^*=(1-2f+\eta)c_H$. Also, Lemma A.4 implies $\min \mathcal{R}_B^*=R_D/p$. Therefore, $l_P^0(R_D/p,m_B^*,G_B^*;p)=l_P^1((1-2f+\eta)c_H,m_B^*,G_B^*;p)$, from which we obtain the expression for m_B^* in (A.8).

$$m_B^*=\frac{p(1-2f+\eta)c_H+(1-p)(\eta-2f)c_L-R_D/p}{p(1-2f+\eta)c_H+(1-p)(\eta-2f)c_L-R_D/p+R_D-p\bar{R}}\in(0,1) \tag{A.8}$$

Let $T:=\min\{(1-2f+\eta)c_L,(1-f)c_H\}$. If $T=(1-f)c_H$, Lemmas A.2 and A.7 imply all rates in $[R_D,(1-f)c_H)$ are best responses for both the platform and banks. From $l_P^0(R,m_B^*,G_B^*;p)=l_P^1((1-2f+\eta)c_H,m_B^*,G_B^*;p)$ for $R\in[R_D,(1-f)c_H)$, we obtain G_B^* is given by

$$G_B^*(R)=\frac{R_D/p-\bar{R}}{(R-\bar{R})}\frac{p(1-2f+\eta)c_H+(1-p)(\eta-2f)c_L-R}{p(1-2f+\eta)c_H+(1-p)(\eta-2f)c_L-R_D/p} \quad \text{for } R\in[R_D/p,T] \tag{A.9}$$

In particular, $\lim_{R\to(1-f)c_H^-}G_B^*(R)>0$, hence $(1-f)c_H\in\mathcal{R}_B^*$. Using $L_B(R,1,G_P^*;p)=0$ for $R\in[R_D,(1-f)c_H]$, we obtain G_P^* is given by the following equation for $R\in[R_D/p,T]$,

$$G_P^*(R)=\frac{(1-p)R_D/p}{R-R_D} \tag{A.10}$$

We focus the rest of the proof on $T=(1-2f+\eta)c_L<(1-f)c_H$. We want to show that any rate in $[R_D/p,(1-2f+\eta)c_L)$ is a best response for both the platform and banks. It is sufficient to show that $(1-2f+\eta)c_L=\sup\{\mathcal{R}_B^*\cap[R_D/p,(1-2f+\eta)c_L]\}$. Lemma A.7 will then imply $[R_D/p,(1-2f+\eta)c_L)$ is a set of best responses for lenders. We proceed by contradiction and assume $\tilde{R}':=\sup\{\mathcal{R}_B^*\cap[R_D/p,(1-2f+\eta)c_L]\}<(1-2f+\eta)c_L$. Hence, $l_P^0(R,m_B^*,G_B^*;p)<l_P^0((1-2f+\eta)c_L,m_B^*,G_B^*;p)$ for any $R\in(\tilde{R}',(1-2f+\eta)c_L)$. Therefore, an $\varepsilon>0$ exists such that $L_B(\tilde{R}'+\varepsilon,m_P^*,G_P^*;p)>0=L_B((1-f)c+H,m_P^*,G_P^*;p)$, where $\tilde{R}'+\varepsilon<(1-f)c_H$.

Therefore, for a small enough ε, a lending mechanism (m_B,F_B) with $m_B=1$ and with domain $[R_D/p,\tilde{R}'+\varepsilon]$ exists such that $\int_0^{\hat{R}'+\varepsilon}L_B(R,m_P^*,G_P^*;p)dF(R)>0$ and

$U(1, m_P^*, F_B, F_P^*) > U(m_B^*, m_P^*, F_B^*, F_P^*)$, contradicting the assumption that $\mathcal{R}_B^*$ is the domain of the equilibrium lending mechanism offered by banks. Hence, $(1-2f+\eta)c_L = \sup \mathcal{R}_B^* \cap [R_D/p, (1-2f+\eta)c_L]$ and any rate in $[R_D/p, (1-2f+\eta)c_L)$ is a best response for the lenders.

Hence, from $l_P^0(R, m_B^*, G_B^*; p) = l_P^1((1-2f+\eta)c_H, m_B^*, G_B^*; p)$ for $R \in [R_D, T)$, we obtain G_B^* is the same as (A.9). From $L_B(R, 1, G_P^*; p) = 0$ for $[R_D/p, T)$, we obtain G_P^* is given by (A.10) for $R \in [R_D/p, T)$ as well. To summarize

$$G_P^*(R) = \frac{(1-p)R_D/p}{R - R_D} \quad \text{for } R \in [R_D/p, T] \cup [U, (1-f)c_H]. \tag{A.11}$$

Let $U := \min\{\mathcal{R_B}^* \cap ((1-2f+\eta)c_L, (1-f)c_H]\}$. Note that such a U exists because $\sup \mathcal{R}_B^* = (1-f)c_H > (1-2f+\eta)c_L$ and because of a reasoning analogous to that in Lemma A.3. By Lemmas A.2 and A.7, if $U < (1-f)c_H$, $[U, (1-f)c_H)$ is a set of best responses for lenders. Because $l_P^0((1-2f+\eta)c_L, m_B^*, G_B^*; p) > \lim_{R \to (1-2f+\eta)c_L^+} l_P^1(R, m_B^*, G_B^*; p)$, a $\delta > 0$ exists such that $U \geq (1-2f+\eta)c_L + \delta$. The same result holds immediately if $U = (1-f)c_H$.

Also note $l_P^1(U, m_B^*, G_B^*; p) > l_P^1(R, m_B^*, G_B^*; p)$ for all $R \in ((1-2+\eta)c_L, U)$. Hence, from $L_B(U, 1, G_P^*; p) = 0$ and $U \geq (1-2f+\eta)c_L + \delta$, we obtain

$$P(R_P = (1-2f+\eta)c_L) = \lim_{R \to (1-2f+\eta)c_L^-} G_P^*(R) - G_P^*(U) > 0,$$

thus implying $(1-2f+\eta)c_L \in \mathcal{R}_P^*$ and that the platform offers rate $(1-2f+\eta)c_L$ with positive probability.

Because of this latest result, $G_P^*(U) < \lim_{R \to (1-2f+\eta)c_L^-} G_P^*(R)$, thus implying $L_B((1-2f+\eta), 1, G_P^*; p) < \lim_{R \to (1-2f+\eta)c_L^-} L_B(R, 1, G_P^*; p) = 0$. Hence, $(1-2f+\eta)c_L \notin \mathcal{R}_B^*$. Therefore, $G_B^*((1-2f+\eta)c_L) = G_B^*(U)$.

Let R^U be such that

$$\begin{aligned} m_B^* p G_B^*((1-2f+\eta)c_L)(R^U - \bar{R}) + (1-m_B^*)[pR^U + (1-p)(\eta-f)c_L - \bar{R}] + [2pc_H + (1-p)c_L]f \\ = l_P^0((1-2f+\eta)c_L, m_B^*, G_B^*; p), \end{aligned}$$

from which we obtain

$$R^U := (1-2f+\eta)c_L + \frac{(1-p)c_L[(1-2f+\eta)c_L - \bar{R}]}{p(1-2f+\eta)c_H - (1-p)c_L - p\bar{R}} \geq (1-2f+\eta)c_L$$

after substituting for m_B^*. We thus set $U := \min\{R^U, (1-f)c_H\}$.

If $R^U \in ((1-2f+\eta)c_L, (1-f)c_H)$, then $U = R^U$, and Lemma A.7 implies $[U, (1-f)c_H)$

is a set of best responses for lenders. From $l_P^1(R, m_B^*, G_B^*; p) = l_P^1((1-2f+\eta)c_H, m_B^*, G_B^*; p)$ for $R \in [U, (1-f)c_H)$, we obtain the expression for G_B^* in (A.12).

$$G_B^*(R) = \frac{R_D/p - \bar{R}}{(R - \bar{R})} \frac{p(1-2f+\eta)c_H - pR}{p(1-2f+\eta)c_H + (1-p)(\eta-2f)c_L - R_D/p} \quad \text{for } R \in [U, (1-f)c_H]. \tag{A.12}$$

Note that $\lim_{R\to(1-f)c_H^-} G_B^*(R) > 0$, hence $(1-f)c_H \in \mathcal{R}_B^*$. From $L_B(R, 1, G_P^*; p) = 0$ for $[R_D, (1-f)c_H]$ we obtain G_P^* same as in (A.10) for $R \in [U, (1-f)c_H]$.

If $R^U \geq (1-f)c_H$, then $U = (1-f)c_H$. Banks offer rate $(1-f)c_H$ with probability $G_B^*((1-2f+\eta)c_L)$ using the expression for $G_B^*(R)$ in (A.9). From $L_B((1-f)c_H, 1, G_P^*; p) = 0$, we obtain $P(R_P = (1-2f+\eta)c_H) = G_P^*(U)$ as given in (A.11). In particular, the platform offers rates in $\mathcal{R}_P^* = [R_D/p, (1-2f+\eta)c_L] \cup \{(1-2f+\eta)c_H\}$.

To summarize,

$$G_B^*(R) = \begin{cases} \frac{R_D/p-\bar{R}}{(R-\bar{R})} \frac{p(1-2f+\eta)c_H+(1-p)(\eta-2f)c_L-R}{p(1-2f+\eta)c_H+(1-p)(\eta-2f)c_L-R_D/p} & \text{for } R \in [R_D/p, T] \\ \frac{R_D/p-\bar{R}}{(R-\bar{R})} \frac{p(1-2f+\eta)c_H-pR}{p(1-2f+\eta)c_H+(1-p)(\eta-2f)c_L-R_D/p} & \text{for } R \in [U, (1-f)c_H] \quad \text{if } U < (1-f)c_H \end{cases} \tag{A.13}$$

□

A.9 Proof of Proposition 3

By Lemmas 4 and 5, we have, $m_B^* \in (0,1)$, $m_P^* = 1$ and $\max \mathcal{R}_P^* = (1-2f+\eta)c_H$.

Let $V' := \min \mathcal{R}_B^*$. Note that such a V' exists because $\sup \mathcal{R}_B^* = (1-f)c_H > (1-2f+\eta)c_L$ and because of a reasoning analogous to that in Lemma A.3. Note also that $V' \geq R_D/p > (1-2f+\eta)c_L$. By Lemmas A.2 an A.7, if $V' < (1-f)c_H$, $[V', (1-f)c_H)$ is a set of best responses for lenders. Because $l_P^0((1-2f+\eta)c_L, m_B^*, G_B^*; p) > \lim_{R\to(1-2f+\eta)c_L^+} l_P^1(R, m_B^*, G_B^*; p)$, a $\delta > 0$ exists such that $V' \geq (1-2f+\eta)c_L + \delta$. The same result holds immediately if $V' = (1-f)c_H$.

Because $L_B(V', 1, G_P^*; p) = 0$ and because $l_P^1(R, m_B^*, G_B^*; p) < l_P^1(V', m_B^*, G_B^*; p)$ for all $R \in ((1-2f+\eta)c_L, V')$, we have

$$P(R_P = (1-2f+\eta)c_L) = \frac{V' - R_D/p}{V' - R_D}. \tag{A.14}$$

In particular, if $V' > R_D/p$, we must have $P(R_P = (1-2f+\eta)c_L) > 0$ and hence, $(1-2f+\eta)c_L \in \mathcal{R}_P^*$.

Because $\max \mathcal{R}_P^* = (1-2f+\eta)c_H$, we must have $L_P((1-2f+\eta)c_H, m_B^*, G_B^*; p) \geq$

$L_P((1-2f+\eta)c_L, m_B^*, G_B^*; p)$, which implies

$$m_B^* \leq \frac{p(1-2f+\eta)(c_H-c_L)-(1-p)c_L}{p(1-2f+\eta)c_H-(1-p)c_L-p\bar{R}}.$$

If $V' > R_D/p$, this expression holds as an equality.

Moreover, from $L_P((1-2f+\eta)c_H, m_B^*, G_B^*; p) \geq L_P(V', m_B^*, G_B^*; p)$, we obtain

$$m_B^* \leq \tilde{m}_B(V') := \frac{(1-2f+\eta)c_H - V'}{(1-2f+\eta)c_H-\bar{R}}.$$

By Lemma A.7, if $V' < (1-f)c_H$, this expression holds as an equality.

Let R^V be defined so that

$$\tilde{m}_B(R^V) = \frac{p(1-2f+\eta)(c_H-c_L)-(1-p)c_L}{p(1-2f+\eta)c_H-(1-p)c_L-p\bar{R}},$$

which implies

$$R^V = (1-2f+\eta)c_L \frac{(1-2f+\eta)c_H - \bar{R} - \frac{1-p}{p}c_L\frac{\bar{R}}{(1-2f+\eta)c_L}}{(1-2f+\eta)c_H-\bar{R}-\frac{1-p}{p}c_L} > (1-2f+\eta)c_L.$$

The rate V' is thus determined as $V' := \min\{(1-f)c_H, \max\{R_D/p, R^V\}\}$.

If $V' = R_D/p$, then $\min \mathcal{R}_P^* = \min \mathcal{R}_B^* = R_D/p$ and the equilibrium is as described in Proposition 1.

If $V' \in (R_D/p, (1-f)c_H)$, then by Lemma A.7, all rates in $[V', (1-f)c_H)$ are best responses for the lenders. Moreover, the platform offer rate $(1-2f+\eta)c_L$ with positive probability given by (A.14). In particular,

$$P(R_P > (1-2f+\eta)c_L) = 1 - P(R_P > (1-2f+\eta)c_L) = \frac{(1-p)R_D/p}{V'-R_D},$$

For ease of exposition, define $V \equiv V'$ in this case. From $L_P((1-2f+\eta)c_L, m_B^*, G_B^*; p) = L_P((1-2f+\eta)c_H, m_B^*, G_B^*; p)$ we obtain m_B^*

$$m_B^* = \frac{p(1-2f+\eta)(c_H-c_L)-(1-p)c_L}{p(1-2f+\eta)c_H-(1-p)c_L-p\bar{R}} \in (0,1) \tag{A.15}$$

From $L_P(R, m_B^*, G_B^*; p) = L_P((1-2f+\eta)c_H, m_B^*, G_B^*; p)$ for $R \in [V, (1-f)c_H)$ we obtain the expression for G_B^*

$$G_B^*(R) = \frac{p(1-2f+\eta)c_L - p\bar{R}}{p(1-2f+\eta)(c_H - c_L) - (1-p)c_L} \frac{(1-2f+\eta)c_H - R}{R - \bar{R}} \quad \text{for } R \in [V, (1-f)c_H]; \tag{A.16}$$

This also implies $P(R_B = (1-f)c_H) > 0$ and, hence, $(1-f)c_H \in \mathcal{R}_B^*$. From $L_B(R, 1, G_B^*; p) = 0$ for $R \in [V, (1-f)c_H]$ we instead obtain G_P^* is given by

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

Hence, to summarize

$$G_P^*(R) = \begin{cases} \frac{(1-p)R_D/p}{V-R_D} & \text{if } R = (1-2f+\eta)c_L \\ \frac{(1-p)R_D/p}{R-R_D} & \text{if } R \in [V, (1-f)c_H]. \end{cases} \tag{A.17}$$

Finally, if $V = (1-f)c_H$, the platform offers only rates $(1-2f+\eta)c_L$ and $(1-2f+\eta)c_H$, with probabilities given by (A.17) after we use $V = (1-f)c_H$. From $L_P((1-2f+\eta)c_L, m_B^*, G_B^*; p) = L_P((1-2f+\eta)c_H, m_B^*, G_B^*; p)$ we again obtain m_B^* is as in (A.15), but now banks lend at rate $(1-f)c_H$ with probability 1. □

A.10 PROOF OF PROPOSITION 4

To begin with, we observe that, in case C, $R_D/p \geq \bar{R} > (1-2f+\eta)c_L$. Next, by Lemmas 4 and 5, the platform is indifferent between lending at rate R_D/p and not lending. Therefore, $L_P(R_D/p, m_B^*, G_B^*; p) = m_B^*[2pc_H + (1-p)c_L]f$ from which we obtain m_B^*

$$m_B^* = \frac{\bar{R} - R_D - (1-p)(\eta - f)c_L - [2pc_H + (1-p)c_L]f}{(1-p)[\bar{R} - (\eta - f)c_L] - [2pc_H + (1-p)c_L]f} \in (0,1) \tag{A.18}$$

Next, by Lemma A.4, $\min \mathcal{R}_B^* = R_D/p > (1-2f+\eta)c_L$. Furthermore, Lemma 4 implies $\sup \mathcal{R}_B^* = (1-f)c_H$. Therefore, by Lemma A.7, all rates in $[R_D, (1-f)c_H)$ are best responses for both the platform and banks.

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

$$L_P(R, m_B^*, G_B^*; p) = m_B^*[2pc_H + (1-p)c_L]f \quad \text{for all } R \in [R_D/p, (1-f)c_H).$$

We therefore solve for $G_B^*(R)$

$$G_B^*(R) = -\frac{1-m_B^*}{m_B^*} \frac{pR + (1-p)(\eta - f)c_L - \bar{R} + [2pc_H + (1-p)c_L]f}{p(R - \bar{R})}$$

for any $R \in [R_D/p, (1-f)c_H)$, after substituting for m_B^*, we obtain

$$G_B^*(R) = \frac{R_D/p - \bar{R}}{R - \bar{R}} \frac{\bar{R} - pR - (1-p)(\eta - f)c_L - [2pc_H + (1-p)c_L]f}{\bar{R} - R_D - (1-p)(\eta - f)c_L - [2pc_H + (1-p)c_L]f} \quad \forall R \in \mathcal{R}_B^*. \quad \text{(A.19)}$$

Because $G_B^*(\cdot)$ is left-continuous, $G_B^*((1-f)c_H) = \lim_{\varepsilon \to 0^+} G_B^*((1-f)c_H - \varepsilon) > 0$. Therefore, $(1-f)c_H \in \mathcal{R}_B^*$ and, in particular, $\mathcal{R}_B^* = [R_D/p, (1-f)c_H]$.

Using the left-continuity of $G_B^*(\cdot)$ again, we obtain

$$L_P((1-f)c_H, m_B^*, G_B^*; p) = \lim_{R \to (1-f)c_H^-} L_P(R, m_B^*, G_B^*; p) = m_B^*[2pc_H + (1-p)c_L]f.$$

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

To derive the platform's strategy, we first consider $p(1+\eta)c_H + (1-p)\eta c_L < \bar{R}$. In this case, $(1-2f+\eta)c_H \notin \mathcal{R}_P^*$ because

$$\begin{aligned} &L_P((1-2f+\eta)c_H, m_B^*, G_B^*; p) \\ &\quad = (1-m_B^*)[p(1+\eta)c_H + (1-p)\eta c_L - \bar{R}] + m_B^*[2pc_H + (1-p)c_L]f \\ &\quad < m_B^*[2pc_H + (1-p)c_L]f. \end{aligned}$$

Therefore, $G_P^*((1-f)c_H) = 0$. Using this result in equation 11 for $R = (1-f)c_H \in \mathcal{R}_B^*$, we obtain

$$m_P^* = 1 - \frac{(1-p)R_D}{p[(1-f)c_H - R_D]},$$

after some manipulation, we get

$$m_P^* = \frac{(1-f)c_H - R_D/p}{(1-f)c_H - R_D} \in (0,1) \quad \text{(A.20)}$$

Moreover, using equation 11 again for all $R \in \mathcal{R}_B^* = [R_D/p, (1-f)c_H]$, we have

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

after substituting for m_P^* and rearranging, we get

$$G_P^*(R) = \frac{(1-p)R_D}{p(1-f)c_H - R_D} \frac{(1-f)c_H - R}{R - R_D} \quad \forall R \in \mathcal{R}_P^*. \quad \text{(A.21)}$$

Next, we consider $p(1+\eta)c_H + (1-p)\eta c_L = \bar{R}$. Now, we cannot conclude $(1-2f+$

$\eta)c_H \notin \mathcal{R}_P^*$ because $L_P((1-2f+\eta)c_H, m_B^*, G_B^*; p) = m_B^*[2pc_H + (1-p)c_L]f$. Therefore, let $P(R_P = (1-2f+\eta)c_H) = G_P^*((1-f)c_H) = Q \in \left[0, \frac{(1-p)R_D/p}{(1-f)c_H - R_D}\right]$. Using equation 11 for $R = (1-f)c_H \in \mathcal{R}_B^*$, we get

$$m_P^* = \frac{(1-f)c_H - R_D/p}{(1-Q)[(1-f)c_H - R_D]} \in (0,1] \tag{A.22}$$

Because $Q \in \left[0, \frac{(1-p)R_D/p}{(1-f)c_H - R_D}\right]$, $m_P^* \in [0,1]$. We then use equation 11 for all $R \in \mathcal{R}_B^* = [R_D/p, (1-f)c_H]$, from which we obtain the following after substituting for the value of m_P^*

$$G_P^*(R) = \begin{cases} \frac{(1-p)R_D[(1-f)c_H - R] + Q[p(1-f)c_H - R_D](pR - R_D)}{(R-R_D)[p(1-f)c_H - R_D]} & \text{if } R \in [R_D/p, (1-f)c_H) \\ Q & \text{if } R \in [(1-f)c_H, (1-2f+\eta)c_H). \end{cases} \tag{A.23}$$

□

A.11 Proof of Corollary 1

The proof for parts 1, 2, 3, and 5 is included in the discussion that precedes Corollary 1 in section 4.5. We, therefore, prove part 5 of the corollary.

If parameters satisfy case C, $m_P^* = 1$ and $L_P(R, m_B^*, G_B^*; p) = L_P((1-2f+\eta)c_H, m_B^*, G_B^*; p)$ for all $R \in [R_D/p, (1-f)c_H]$. Hence, the function $G_B^*(\cdot)$ can be written as $G_B^*(R) = \frac{1-m_B^*}{m_B^*}\frac{A(R)}{R-\bar{R}}$, for some positive function $A(\cdot)$. Therefore, the welfare change can be written as

$$\Delta W(\bar{R}) = -(1-m_B^*)w(\bar{R}).$$

where

$$w(\bar{R}) \coloneqq (\bar{R} - R_D)\int_{R_D/p}^{1-2f+\eta}\left(\frac{A(R)}{R-\bar{R}} + 1\right)dF_P^*(R) - (1-p)F_P^*((1-2f+\eta)c_L)c_L$$

Given the parameter values considered in case A2, $\bar{R}$ may range from R_D to R_D/p. Note that $w(R_D) > 0$ because $F_P^*((1-2f+\eta)c_L) > 0$ in case A2. Moreover,

$$w(R_D/p) = \frac{1}{p}\left[(1-p)R_D\int_{R_D/p}^{1-2f+\eta}\left(\frac{A(R)}{R-R_D/p} + 1\right)dF_P^*(R) - (1-p)pF_P^*((1-2f+\eta)c_L)c_L\right] > 0$$

where the inequality follows because $R_D > c_L$ by Assumption 1 and $\int_{R_D/p}^{1-2f+\eta}\left(\frac{A(R)}{R-R_D/p} + 1\right)dF_P^*(R) > 1 > pF_P^*((1-2f+\eta)c_L)$.

The function $w(\cdot)$ is also continuous and strictly increasing, with

$$w'(\bar{R}) = \int_{R_D/p}^{1-2f+\eta} \left(\frac{A(R)(R - R_D)}{(R - \bar{R})^2} + 1 \right) dF_P^*(R) > 0.$$

By the intermediate value theorem and because $w(\cdot)$ is strictly increasing, there exists $\bar{R}^W \in (R_D, R_D/p)$ such that $\Delta W(\bar{R}) > 0$ if $\bar{R} \in (R_D, \bar{R}^W)$, $\Delta W(\bar{R}) = 0$ if $\bar{R} = \bar{R}^W$, and $\Delta W(\bar{R}) < 0$ if $\bar{R} \in (\bar{R}^W, R_D/p)$. □

B SECOND BEST

We now examine the second-best allocation for the setup discussed in Section 4. We consider a social planner who aims to maximize social welfare while facing the same frictions lenders face. Specifically, the planner lacks information about the merchant's type, and the merchant retains the option to strategically default.

The planner offers loans at rate R_S. Because the interest rate R_S represents a transfer from the merchant to the planner, the planner selects a rate that maximizes the merchant's output by discouraging default among bad merchants. Any rate that satisfies $(1 - f + f_S)c_L \geq R_S$ is optimal. Without loss of generality, we assume that the planner sets $R_S = 0$.

To finance the merchant, the planner has the option to obtain capital either from banks or the platform. Because $\bar{R} \geq R_D$, the planner will always obtain financing from the platform.

The planner lends with probability m_S to maximize social welfare:

$$\max_{m_S} m_S \left\{ 2 \left[pc_H + (1 - p)c_L \right] - R_D \right\}.$$

Hence, the planner lends if

$$p \geq \frac{R_D - 2c_L}{2(c_H - c_L)}.$$

Several observations can be made. First, since $\frac{R_D - 2c_L}{2(c_H - c_L)} < \frac{R_D}{(1-f)c_H}$, the planner extends loans to more merchants than banks do. By setting $R_S = 0$ and incentivizing production for two periods, the planner lends at a financial loss to maximize the value of the merchant's production and, consequently, social welfare. In particular, if the parameter values are such that it is efficient to finance the bad merchant, i.e. $2c_L \geq R_D$, the planner lends regardless of the value of p.

Second, in the region where the platform lends but $p < \frac{c_L}{(1-2f+\eta)(c_H - c_L) + c_L}$ (condition (7) is not satisfied), the platform implements the social planner's allocation. In such cases, the platform offers loans at rates such that even the low-type merchants repay in full, and hence are able to produce for two periods.

Finally, unlike the platform, the planner does not base lending decisions on relative revenues. The platform offers low rates and enforce full repayment only for merchants with high relative revenue. The planner, on the other hand, always chooses to motivate full repayment, even if losses are incurred on the loan itself.

C COMPETITION WITH INFORMATION ACQUISITION

We solve for the equilibrium in the credit market when the platform has the option to acquire information with the same technology described in section 5.1.

C.1 EQUILIBRIUM WITH INFORMATION ACQUISITION

Similar to Section 4, 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 $F_B(R) \coloneqq P(R_B \leq R)$. The merchant 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 whereby it lends with probability $m_{P,i} \in [0,1]$ and offers rates according to a distribution $F_{P,i} \coloneqq P(R_{P,i} \leq 0)$ for $i \in \{u,h,l\}$. Like in section 4, we define

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

The merchant simultaneously receives credit decisions from the bank and the platform. If both extend credit, a good merchant selects the offer with the lowest rate. We maintain the convention that, if rates are identical, the good merchant borrows from the platform. A bad merchant always selects the bank's offer if both lenders offer credit. The good merchant chooses the lender offering the lowest rate and her expected utility is

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

which is equal to $U(m_B, m_P^A, F_B, F_P^A)$, where U is defined as in equation (A.4) and

$$
\begin{aligned}
m_P^A &:= (1-a)m_{P,u} + a[\psi m_{P,h} + (1-\psi)m_{P,u}] \\
F_P^A(R) &:= \{(1-a)m_{P,u}F_{P,u}(R) + a[\psi m_{P,h}F_{P,h}(R) + (1-\psi)m_{P,u}F_{P,l}(R)]\}/m_P^A
\end{aligned}
$$

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 equation (9) in Section 4. 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, she 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 bank and never repays. The platform's profits are also equal to $L_B(R, m_P^a, G_P^a; p)$, where L_B is defined in equation (10), $m_P^a := (1-a)m_{P,u} + am_{P,h}$, and $G_P^a(R) := [(1-a)m_{P,u}G_{P,u}(R) + am_{P,h}G_{P,h}(R)]/m_P^a$.

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

Definition C.1 (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 $G_B^{I*}(R) := 1 - \lim_{\varepsilon\to 0^+} F_B^{I*}(R-\varepsilon)$, $G_{P,i}^{I*}(R) := 1 - F_{P,i}^{I*}(R)$, and*

$$
\begin{aligned}
m_P^{a*} &:= (1-a^{I*})m_{P,u}^{I*} + a^{I*}m_{P,h}^{I*} \\
G_P^{a*}(R) &:= [(1-a^{I*})m_{P,u}^{I*}G_{P,u}^{I*}(R) + a^{I*}m_{P,h}^{I*}G_{P,h}^{I*}(R)]/m_P^{a*} \\
m_P^{A*} &:= (1-a^{I*})m_{P,u}^{I*} + a^{I*}[\psi m_{P,h}^{I*} + (1-\psi)m_{P,l}^{I*}]
\end{aligned}
$$

$$F_P^{A*}(R) \coloneqq \{(1-a^{I*})m_{P,u}^{I*}F_{P,u}^{I*}(R) + a^{I*}[\psi m_{P,h}^{I*}F_{P,h}^{I*}(R) + (1-\psi)m_{P,l}^{I*}F_{P,l}^{I*}(R)]\}/m_P^{A*}$$

such that:

1. *The platform and competitive banks set rates optimally:*

$$\mathcal{R}_{P,i}^{*I} = \arg\max_{R\le(1-2f+\eta)c_H} L_P(R, m_B^{I*}, G_B^{I*}; p^i) \quad \textit{for } i \in \{u,h,l\}$$
$$\mathcal{R}_B^{I*} = \arg\max_{R\in[R_D,(1-f)c_H]} L_B(R, m_P^{a*}, G_P^{a*}; p)$$
$$\textit{s.t. } L_B(R, m_P^{a*}, G_P^{a*}; p) \le 0.$$

2. *Lenders extend credit optimally:*

$$m_{P,i}^{I*} \in \arg\max_{m_P\in[0,1]} \{m_P L_P(R, m_B^{I*}, G_B^{I*}; p^i) + (1-m_P)m_B^{I*}[2p^i c_H + (1-p^i)c_L]f \qquad \forall R \in \mathcal{R}_P^*$$

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

$$m_B^{I*} \in \arg\max_{m_B\in[0,1]} m_B L_B(R, m_P^{a*}, G_P^{a*}; p) \quad \forall R \in \mathcal{R}_B^*.$$

3. *The platform acquires information optimally:*

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

where

$$L_P^{I*}(m_B^{I*}, G_B^{I*}; p^i) \coloneqq m_{P,i}^{I*} L_P(R, m_B^{I*}, G_B^{I*}; p^i) + (1-m_{P,i}^{I*})m_B^{I*}[2pc_H + (1-p)c_L]f$$
$$\forall R \in \mathcal{R}^{P,i}, i \in \{u,h,l\}.$$

4. *Banks are competitive in the lending market; that is, no lending mechanism (F_B, m_B) exists such that $\int_0^{(1-f)c_H} L_B(R, m_P^{a*}, G_P^{a*}; p)\, dF_B(R) > 0$ and $U(m_B, m_P^{A*}, F_B, F_P^{A*}) > U(m_B^{I*}, m_P^{A*}, F_B^{I*}, F_P^{A*})$,.*

Similar to Section 4, competitive banks earn zero profits in equilibrium; that is,

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

Before solving for the equilibrium fully, we characterize some general properties in a series of lemmas. We first show that, if the platform acquires information in equilibrium, it lends with probability one after observing a high signal. All the proofs are in Appendix D.

LEMMA C.1 (Lending with Optimistic Beliefs). *If $a^{I*} \in (0,1]$, then $m^{I*}_{P,h} = 1$. 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 $m^{I*}_{P,h} = 1$.

To characterize the equilibrium, we first describe the platform's strategy when it is a monopolistic lender, i.e. when banks do not lend and $m^{I*}_B = 0$. The optimal strategy of the platform depends on two considerations analogous to those in Lemma 1 of Section 3.1.2. First, if

$$\max\{p^i(1+\eta)c_H + (1-p^i)\eta c_L, (1+\eta)c_L + 2p^i(c_H - c_L)f\} - \bar{R} \geq 0 \tag{C.2}$$

the platform earns profits by lending when its beliefs are equal to p^i. If this inequality if violated, the platform prefers not to lend to a merchant whose perceived quality is p^i. Second, if

$$p^i > \frac{c_L}{(1-2f+\eta)(c_H - c_L) + c_L}, \tag{C.3}$$

the platform's unique profit-maximizing rate is $(1-2f+\eta)c_H$; otherwise, the platform offers a rate equal to $(1-2f+\eta)c_L$, with indifference between the two rates in case $p^i = \frac{c_L}{(1-2f+\eta)(c_H-c_L)+c_L}$. The following lemma characterizes the equilibrium when the platform is a monopolistic lender

LEMMA C.2. *In any equilibrium with $m^*_B = 0$, the following holds.*

1. *If $\max\{p^h(1+\eta)c_H + (1-p^h)\eta c_L, (1+\eta)c_L + 2p^h(c_H - c_L)f\} - \bar{R} < 0$ the platform does not acquire information and does not lend to the merchant.*

2. *If $\max\{p^h(1+\eta)c_H + (1-p^h)\eta c_L, (1+\eta)c_L + 2p^h(c_H - c_L)f\} - \bar{R} \geq 0$ but $(1+\eta)c_L - \bar{R} < 0$ the platform acquires information with probability 1 and does not lend after observing a low signal. After observing a high signal, it lends at rate $(1-2f+\eta)c_H$ if* (C.3) *holds for $i = h$, otherwise it lends at rate $(1-2f+\eta)c_L$.*

3. *If $\max\{p^h(1+\eta)c_H + (1-p^h)\eta c_L, (1+\eta)c_L + 2p^h(c_H - c_L)f\} - \bar{R} \geq 0$, $(1+\eta)c_L - \bar{R} \geq 0$, and* (C.3) *holds for $i = h$, the platform acquires information with probability 1 and lends regardless of the signal. It lends at rate $(1-2f+\eta)c_H$ if the signal is high, whereas it lends at rate $(1-2f+\eta)c_L$ if the signal is low.*

4. *If* $\max\{p^h(1+\eta)c_H + (1-p^h)\eta c_L, (1+\eta)c_L + 2p^h(c_H - c_L)f\} - \bar{R} \geq 0$, $(1+\eta)c_L - \bar{R} \geq 0$, *and* (C.3) *does not hold for* $i = h$, *the platform does not acquire information and lends with probability one at rate* $(1 - 2f + \eta)c_L$.

Next, we observe the results in Lemmas 2 and in Section 4 hold also for an equilibrium with information acquisition. The results hold for any p, and thus apply also to an informed platform.

We also obtain a Lemma identical to Lemma 3. We state it below because its proof is different from Lemma 3 because we need to account for the platform's option to acquire information.

LEMMA C.3 (Partial Segmentation with Information Acquisition). *If* $p < \frac{R_D}{(1-f)c_H}$, *banks do not lend to the merchant, but if* (C.3) *holds as a weak inequality, the platform lends in the way described in Lemma C.2. If* $p \geq \frac{R_D}{\bar{R}}$, *the merchant borrows exclusively from banks that offer loans with probability 1 at rate* $\frac{R_D}{p}$.

Hence, 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 $p < \frac{R_D}{(1-f)c_H}$, 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 4, the platform is a monopolistic lender when $p < \frac{R_D}{(1-f)c_H}$.

We also obtain the counterpart of Lemma 4.

LEMMA C.4 (Mixed Strategies with Information Acquisition). *If* $p \in \left[\frac{R_D}{(1-f)c_H}, R_D/\bar{R}\right)$ *and* c *is sufficiently small, banks offer loans with probability* $m_B^{I*} \in (0,1)$ *and the platform acquires information with probability* $a^{I*} > 0$ *and offers loans so that* $(1-a^{I*})m_{P,u}^{I*} + a^{I*}m_{P,h}^{I*} \in (0,1]$. *Moreover, the uninformed and optimistic platform offer rates ranging between* $\min\{\mathcal{R}_{P,u}^* \cup \mathcal{R}_{P,h}^*\} \leq R_D/p$ *and* $\max\{\mathcal{R}_{P,u}^* \cup \mathcal{R}_{P,h}^*\} \geq (1-f)c_H$. *In particular,* $\min\{\mathcal{R}_{P,u}^* \cup \mathcal{R}_{P,h}^*\}$ *coincides either with* R_D/p *or with* $(1-2f+\eta)c_L$. *Banks offer rates up to* $\sup \mathcal{R}_B^{I*} = (1-f)c_H$.

Like in section 4, banks always deny credit with positive probability and offer rates up to $(1-f)c_H$ when they directly compete with the platform of merchants of intermediate credit quality. Moreover, the ex-ante set of rates offered by the platform coincides with the set identified in Lemma 4. However, the uninformed platform and the optimistic platform may offer different rates.

Lemma C.4 also indicates the platform still benefits from advantageous selection when competing with banks. In particular, the platform lends with positive probability when $p^h(1+\eta)c_H + (1-p^h)\eta c_L < \bar{R}$, but $p \in \left[\frac{R_D}{(1-f)c_H}, R_D/\bar{R}\right)$. According to Lemma C.2 the platform would not lend in this situation when $m_B^{I*} = 0$. Remark 3 thus also apply to this extension of the model.

We also obtain a result similar to those in Lemma 5 about the equilibrium strategy of the platform.

LEMMA C.5 (The Platform's Strategy with Information Acquisition). *Consider a merchant characterized by $p \in \left[\frac{R_D}{(1-f)c_H}, \frac{R_D}{\bar{R}}\right)$ and assume c is sufficiently small. If $p^h(1+\eta)c_H + (1-p^h)\eta c_L > \bar{R}$, the platform acquires information and lends so that $(1-a^{I*})m^{I*}_{P,u} + a^{I*}m^{I*}_{P,h} = 1$ and $\max \mathcal{R}^{I*}_{P,h} = (1-2f+\eta)c_H$. If $p^h(1+\eta)c_H + (1-p^h)\eta c_L \leq \bar{R}$, the platform is indifferent between acquiring information and not lending. Moreover, if $\bar{R} > (1-2f+\eta)c_L$, then $\min \mathcal{R}^*_{P,u} = \min \mathcal{R}^*_{P,h} = R_D/p > (1-2f+\eta)c_L$. If $\bar{R} \leq (1-2f+\eta)c_L$ and $R_D/p < (1-2f+\eta)c_L$, $\mathcal{R}^*_{P,h} = R_D/p$.*

We focus on the region where the banks and the platform compete for borrowers; that is borrowers with intermediate credit quality $p \in \left[\frac{R_D}{(1-f)c_H}, \frac{R_D}{\bar{R}}\right)$. Using results from Lemma C.4 and D.9, we consider cases analogous to those we had in section 4.

- A: $p^h(1+\eta)c_H + (1-p^h)\eta c_L > \bar{R} > (1-2f+\eta)c_L$, and $p \in \left[\frac{R_D}{(1-f)c_H}, \frac{R_D}{\bar{R}}\right)$;
- B: $\bar{R} \leq (1-2f+\eta)c_L$ and $p \in \left[\frac{R_D}{(1-f)c_H}, \frac{R_D}{\bar{R}}\right)$
  - B1: Like case B, but restricted to $p \geq \frac{R_D}{(1-2f+\eta)c_L}$;
  - B2: Like case B, but restricted to $p < \frac{R_D}{(1-2f+\eta)c_L}$;
- C: $p^h(1+\eta)c_H + (1-p^h)\eta c_L \leq \bar{R}$ and $p \in \left[\frac{R_D}{(1-f)c_H}, \frac{R_D}{\bar{R}}\right)$.

C.2 EQUILIBRIUM IN CASE I.A

First, we consider case I.A. If $\bar{R} > (1+\eta)c_L$, 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 potentially screening borrowers exceeds the information cost. Hence the platform always acquires information.

If instead, $\bar{R} \in ((1-2f+\eta)c_L, (1+\eta)c_L]$, the platform obtains positive profits even when lending to a bad merchant by setting a rate equal to $(1-2f+\eta)c_L$. However, because $\bar{R} > (1-2f+\eta)c_L$, an optimistic platform has no incentive to undercut banks by setting a rate equal to $(1-2f+\eta)c_L < R_D/p$.

The following proposition characterizes the equilibrium.

PROPOSITION C.1. *Consider a merchant with parameters satisfying I.A. There exists $\epsilon > 0$ such that, for any $c \in (0, \epsilon)$, the equilibrium is characterized uniquely as follows.*

1. *Banks lend as described in Proposition 1.*

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

3. *If* $\bar{R} > (1+\eta)c_L$*, a pessimistic platform offers loans with probability* $m^{I*}_{P,l} = 0$*. If* $\bar{R} \in ((1-2f+\eta)c_L, (1+\eta)c_L]$*, a pessimistic platform offers loans with probability* $m^{I*}_{P,l} = 1$ *and offers rate* $(1-2f+\eta)c_L$*.*

4. *An optimistic platform lends with probability* $m^{I*}_{P,h} = 1$ *and offers rates with the same distribution described in equation* (A.7) *of Proposition 1.*

The banks' lending probability and distribution of rate offers are identical to case A in Section 4. Moreover, the optimistic platform offers interest rates from the same distribution as the uninformed platform in case A of Section 4, when the platform had no option to acquire information. However, when $\bar{R} > (1+\eta)c_L$, the platform lends only with probability $\psi < 1$, because it refuses to lend if the merchant is revealed to be bad.

C.3 Equilibrium in Case I.B

In case I.B, the platform may profitably offer rates equal to or below $(1-2f+\eta)c_L$ because $(1-2f+\eta)c_L \geq \bar{R}$. Moreover, the platform can profitably lend after observing a low signal by offering rates equal to $(1-2f+\eta)c_L$.

In case I.B1, competitive banks do force the platform to offer rates weakly below $(1-2f+\eta)c_L$. After observing a low signal, the platform thus lends at rate $(1-2f+\eta)c_L$ to maximize the surplus extracted from a bad merchant when banks do not lend. After observing a high signal, the platform faces a trade-off: either it offers low rates to compete with banks for a borrower of high perceived quality, or it offers high rates to extract more surplus from the borrower. Because information allows the platform to customize interest rates, the platform will acquire information in equilibrium with positive probability. The next proposition characterizes the equilibrium in case I.B1.

Proposition C.2. *Assume parameters satisfy case I.B1 and define*

$$T \coloneqq \min\{(1-2f+\eta)c_L, (1-f)c_H\}$$

$$U^c \coloneqq \min\{(1-2f+\eta)c_L + \frac{(1-m^{I*}_B)(1-p^h)c_L}{p[m^{I*}_B G^{I*}_B((1-2f+\eta)c_L) + (1-m^{I*}_B)]}, (1-f)c_H\}$$

There exists $\epsilon > 0$ *such that, for any* $c \in (0,\epsilon)$*, there exists a unique equilibrium characterized by the following:*

1. *Banks extend credit with probability*

$$m^{I*}_B = \frac{p^h(1-2f+\eta)c_H + (1-p^h)(\eta-2f)c_L - R_D/p}{p^h(1-2f+\eta)c_H + (1-p^h)(\eta-2f)c_L - R_D/p + p^h R_D/p - p^h\bar{R}} \in (0,1). \tag{C.4}$$

Compared with m_B^* in Proposition 2, we have $m_B^{I*} > m_B^*$. Conditional on making an offer, they choose a rate from the support $\mathcal{R}_B^* = [R_D/p, T) \cup [U^c, (1-f)c_H]$ so that, if $(1-f)c_H < (1-2f+\eta)c_H$,

$$G_B^{I*} = \frac{R_D/p - \bar{R}}{(R-\bar{R})} \frac{p^h(1-2f+\eta)c_H + (1-p^h)(\eta-2f)c_L - R}{p^h(1-2f+\eta)c_H + (1-p^h)(\eta-2f)c_L - R_D/p} \quad \text{for } R \in [R_D/p, T]. \tag{C.5}$$

If, instead, $T = (1-2f+\eta)c_L$, G_B^{I*} coincides with equation (C.5) above for $R \in [R_D/p, R^c]$, where

$$R^c := (1-2f+\eta)c_L - \frac{c}{(1-\psi)(1-m_B^{I*})}, \tag{C.6}$$

whereas for $R \in [R_c, (1-2f+\eta)c_L]$, G_B^{I*} is given by

$$G_B^{I*}(R) = \frac{R_D/p - \bar{R}}{R-\bar{R}} + \frac{1-m_B^{I*}}{m_B^{I*}} \frac{\psi R_D/p + (1-\psi)(1-2f+\eta)c_L - R}{p(R-\bar{R})} - \frac{c}{m_B^{I*}p(R-\bar{R})}. \tag{C.7}$$

Furthermore,

$$G_B^{I*}(R) = \frac{R_D/p - \bar{R}}{(R-\bar{R})} \frac{p^h(1-2f+\eta)c_H - p^h R}{p^h(1-2f+\eta)c_H + (1-p^h)(\eta-2f)c_L - R_D/p} \quad \text{for } R \in [U^c, (1-f)c_H]. \tag{C.8}$$

2. *If $T = (1-f)c_H < (1-2f+\eta)c_L$, the platform acquires information with probability $a^{I*} = 1$. If $T = (1-2f+\eta)c_L$, the platform acquires information with probability*

$$a^{I*} = 1 - \frac{U^c - R^c}{U^c - R^D} \frac{(1-p)R_D/p}{R^c - R_D} \in (0,1). \tag{C.9}$$

3. *The pessimistic platform offers loans with probabilities $m_{P,l}^{I*} = 1$ at a rate equal to $(1-2f+\eta)c_L$.*

4. *An optimistic platform lends with probability $m_{P,h}^{I*} = 1$. If $T = (1-f)c_H < (1-2f+\eta)c_L$, offers rates in $\mathcal{R}_{P,h}^{I*} = [R_D/p, (1-f)c_H) \cup \{(1-2f+\eta)c_H\}$ so that $P(R_P > R) = G_P^{I*}(R)$, where*

$$G_{P,h}^*(R) = \frac{(1-p)R_D/p}{R-R_D} \text{for } R \in [R_D/p, (1-f)c_H]. \tag{C.10}$$

If $T = (1-2f+\eta)c_L$, the platform offers rates in $\mathcal{R}_{P,h}^{I*} = [R_D/p, R^c] \cup [U^c, (1-f)c_H] \setminus \{(1-f)c_H\} \cup \{(1-2f+\eta)c_H\}$ so that $P(R_P > R) = G_P^*(R)$, where

$$G_{P,h}^*(R) = \begin{cases} \frac{1}{a^{I*}} \frac{(1-p)R_D/p}{R-R_D} & \text{for } R \in [R_D/p, R^c] \\ \frac{1}{a^{I*}} \frac{(1-p)R_D/p}{R-R_D} & \text{for } R \in [U^c, (1-f)c_H]. \end{cases} \tag{C.11}$$

5. *If $T = (1-2f+\eta)c_L$, the uniformed platform extends credit with probability $m_{P,u}^{I*} = 1$ and*

offers rates in $\mathcal{R}^{I*}_{P,u} = [R^c, (1-2f+\eta)c_L]$*, so that*

$$G^{I*}_{P,u} = \frac{(1-p)R_D/p}{(1-a^{I*})(R-R_D)} - \frac{a^{I*}G^{I*}_{P,h}(U^c)}{1-a^{I*}} \quad \textit{for } R \in [R^c, (1-2f+\eta)c_L). \tag{C.12}$$

Competition between banks and the platform forces lenders to offer rates in $[R_D/p, T]$. If $T = (1-f)c_H < (1-2f+\eta)c_L$, the optimistic and pessimist platform offer different rates and the platform thus acquires information with positive probability. If $T = (1-2f+\eta)c_L$, the incentive to customize is limited because, if the platform always acquired information, the optimistic and pessimist platform would share a best response. Hence, in equilibrium, the platform remains uniformed with positive probability and the uninformed platform offers different rates from both the optimistic and pessimistic one.

In case I.B2, the optimal response of a pessimistic platform remains to lend at rate $(1-2f+\eta)c_L$ to maximize the surplus it extracts from a bad borrower when banks do not lend. Although the platform would like to offer high rates to extract more surplus from the merchant after observing a high signal, competition from banks force the platform to offer rates down to R_D/p, which, if close enough to $(1-2f+\eta)c_L$, may be dominated by the latter rate. The following proposition describes the equilibrium in this case.

PROPOSITION C.3. *Assume parameters satisfy case I.B2. Define*

$$V^c := \min\{(1-f)c_H, \max\{R_D/p, (1-2f+\eta)c_L \frac{(1-2f+\eta)c_H - \bar{R} - \frac{1-p^h}{p^h}c_L\frac{\bar{R}}{(1-2f+\eta)c_L}}{(1-2f+\eta)c_H - \bar{R} - \frac{1-p^h}{p^h}c_L}\}\}$$

There exists $\epsilon > 0$ *such that, for any* $c \in (0, \epsilon)$*, there exists an equilibrium characterized by the following*

1. *If* $V^c = R_D/p$*, the equilibrium is the same as in case I.A and it is described by Proposition C.1.*

2. *If* $V^c \in (R_D/p, (1-f)c_H]$*, the equilibrium is characterized as follows:*

   (a) *Banks extend credit with probability*

$$m^{I*}_B = \frac{p^h(1-2f+\eta)(c_H-c_L) - (1-p^h)c_L - c/\psi}{p^h(1-2f+\eta)c_H - (1-p^h)c_L - p^h\bar{R}} \in (0,1). \tag{C.13}$$

   Compared with m^*_B *in Proposition 3, we have* $m^{I*}_B > m^*_B$*. Conditional on making an offer, they choose a rate from the support* $\mathcal{R}^*_B = [V^c, (1-f)c_H]$ *so that, if* $V^c \in$

$(R_D/p, (1-f)c_H)$, $P(R_B \geq R) = G_B^{I*}(R)$, *where*

$$G_B^{I*}(R) = \frac{p^h(1-2f+\eta)c_L - p^h\bar{R} + c/\psi}{p^h(1-2f+\eta)(c_H-c_L) - (1-p^h)c_L}\frac{(1-2f+\eta)c_H - R}{R-\bar{R}} \quad \text{for } R \in [V^c, (1-f)c_H]; \tag{C.14}$$

if, instead, $V^c = (1-f)c_H$, $P(R_B = (1-f)c_H) = 1$.

(b) *The platform acquires information with probability*

$$a^{I*} = \frac{(1-p)R_D/p}{V^c - R_D} \in (0,1). \tag{C.15}$$

(c) *The pessimist and the uniformed platform offer loans with probabilities* $m_{P,l}^{I*} = m_{P,u}^{I*} = 1$ *at a rate equal to* $(1-2f+\eta)c_L$.

(d) *An optimistic platform lends with probability* $m_{P,h}^{I*} = 1$ *and offers rates with the same distribution described in Proposition 3 for the uniformed platform.*

When $V^c > R_D/p$, the pessimistic and uniformed platform offer rate $(1-2f+\eta)c_L$ with positive probability, thus deterring banks from offering rates below V^c. The platform thus uses information to offer customized interest rates and to extract surplus based on the default risk of the merchant.

C.4 EQUILIBRIUM IN CASE I.C

We now study a merchant whose parameters satisfy I.C. The following proposition characterizes the equilibrium and shows that the platform acquires information with probability strictly between zero and one.

PROPOSITION C.4. *Assume parameters satisfy case I.C. There exists* $\epsilon > 0$ *such that, for any* $c \in (0, \epsilon)$, *the equilibrium is characterized as follows.*

1. *The bank lends with probability* $m_B^{I*} \in (0,1)$ *given by*

$$m_B^{I*} = \frac{\bar{R} - R_D/\psi - (1-p^h)(\eta - f)c_L - [2p^h c_H + (1-p^h)c_L]f + c/\psi}{(1-p^h)\bar{R} - (1-p^h)(\eta-f)c_L - [2p^h c_H + (1-p^h)c_L]f}. \tag{C.16}$$

   and, conditional on lending, they offer rates in $\mathcal{R}_B^{I*} = [R_D/p, (1-f)c_H]$ *so that* $P(R_B \geq R) = G_B^{I*}(R)$ *where*

$$G_B^{I*}(R) = \frac{(1-m_B^{I*})[\bar{R} - p_h R - (1-p^h)(\eta-f)c_L - (2p^h c_H + (1-p^h)c_L)f] + c/\psi}{m_B^{I*}p^h(R-\bar{R})}. \tag{C.17}$$

2. *Compared to* m_B^* *in Proposition 4,* $m_B^{I*} < m_B^*$.

3. *The platform acquires information with probability* $a^{I*} \in (0,1)$ *equal to* m_P^* *from Proposition 4.*

4. *The uninformed and the pessimistic platform do not lend; that is,* $m_{P,u}^{I*} = m_{P,l}^{I*} = 0$.

5. *The optimistic platform lends with probability* $m_{P,h}^{I*} = 1$ *and offers rates with the same distribution described in Proposition 4 for the uninformed platform.*

The platform acquires information with probability a^{I*} that is equal to its lending probability in case C of Section 4. However, it denies credit at a higher probability, equal to $1 - a^{I*}\psi$. Moreover, banks offer loans with lower probability than in case C. 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.

When $p^h(1+\eta)c_H + (1-p^h)\eta c_L = \bar{R}$, multiple equilibria still exist and they are indexed by $Q \in \left[0, \frac{(1-p)R_D/p}{(1-f)c_H - R_D}\right]$ whereby $P(R_P = (1-2f+\eta)c_L) = Q$ and a^{I*} is given by the right-hand side of equation (A.22) in Proposition 4.

D Proofs for the Information Acquisition Extension

D.1 Proof of Lemma C.2

First, we consider $\max\{p^h(1+\eta)c_H + (1-p^h)\eta c_L, (1+\eta)c_L + 2p^h(c_H - c_L)f\} - \bar{R} < 0$. In this case, even after observing a high signal, the platform has no incentive to lend. Therefore, the platform does not acquire information.

Next, $\max\{p^h(1+\eta)c_H + (1-p^h)\eta c_L, (1+\eta)c_L + 2p^h(c_H - c_L)f\} - \bar{R} \geq 0$ but $(1+\eta)c_L - \bar{R} < 0$. In this case, the platform can profitably lend after observing a high signal but prefers to deny credit after a low signal. Therefore, for a sufficiently small c,

$$\begin{aligned} L_P(R, m_B^{I*}, G_B^{I*}; p^u) &= \max\{\max\{p^u(1+\eta)c_H + (1-p^u)\eta c_L, (1+\eta)c_L + 2p^u(c_H - c_L)f\} - \bar{R}, 0\} \\ &< \psi\left\{\max\{p^h(1+\eta)c_H + (1-p^h)\eta c_L, (1+\eta)c_L + 2p^h(c_H - c_L)f\} - \bar{R} \right. + (1-\psi)0 - c \\ &= \psi L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h) + (1-\psi)L_P^{I*}(m_B^{I*}, G_B^{I*}; p^l) - c, \end{aligned}$$

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

We now consider $\max\{p^h(1+\eta)c_H + (1-p^h)\eta c_L, (1+\eta)c_L + 2p^h(c_H - c_L)f\} - \bar{R} \geq 0$, $(1+\eta)c_L - \bar{R} \geq 0$, and assume (C.3) holds for $i = h$. Now, the platform optimally lends regardless of the signal it receives because $(1+\eta)c_L - \bar{R} \geq 0$. However, the optimal rate for an optimistic platform is $(1-2f+\eta)c_H$, whereas the optimal rate for a pessimistic platform is $(1-2f+\eta)c_L$. Let $R_U \in \{(1-2f+\eta)c_H, (1-2f+\eta)c_L\}$ be the optimal rate for an uninformed platform. For a small enough c we have

$$\begin{aligned}
L_P(R_U, m_B^{I*}, G_B^{I*}; p^u) &= \psi L_P(R_U, m_B^{I*}, G_B^{I*}; p^h) + (1-\psi) L_P(R_U, m_B^{I*}, G_B^{I*}; p^u) \\
&< \psi L_P((1-2f+\eta)c_H, m_B^{I*}, G_B^{I*}; p^h) + (1-\psi) L_P((1-2f+\eta)c_L, m_B^{I*}, G_B^{I*}; p^u) - c \\
&= \psi L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h) + (1-\psi) L_P^{I*}(R, m_B^{I*}, G_B^{I*}; p^u) - c,
\end{aligned}$$

and the platform thus acquires information with probability $a^{I*} = 1$.

Finally, we consider $\max\{p^h(1+\eta)c_H + (1-p^h)\eta c_L, (1+\eta)c_L + 2p^h(c_H - c_L)f\} - \bar{R} \geq 0$, $(1+\eta)c_L - \bar{R} \geq 0$, and assume (C.3) does not hold for $i = h$. In this case, the rate $(1-2f+\eta)c_L$ is optimal for the platform regardless of the information it possesses. Therefore, for any positive cost of information acquisition, c, the platform does not acquire information and lends with probability one at rate $(1-2f+\eta)c_L$. □

D.2 Auxiliary Lemmas

We now introduce some lemmas which will be useful in characterizing the equilibrium with competition. Some lemmas contain new results which are specific to a model with information acquisition. Others are extensions or modifications of lemmas derived in the main model with no information acquisition.

Lemma D.1. *Consider $p^i > 0$. If $R > (1-2f+\eta)c_L$ and $R \in \mathcal{R}^*_{P,i}$, then for any $R' < (1-2f+\eta)c_L$, we have $R' \notin \mathcal{R}^*_{P,y}$ for $p^y > p^i$. Moreover, $R \in \mathcal{R}^*_{P,y}$ for $p^y > p^i$.*

Proof. Note

$$\begin{aligned}
&L(R, m_B, G_B; p^i) \\
&\quad = m_B G_B(R)(R-\bar{R}) + (1-m_B)[p^i R + (1-p^i)(\eta - f)c_L - \bar{R}] + [2p^i c_h + (1-p^i)c_L]f \\
&\qquad\qquad + I(R)(1-m_B)(1-p^i)\{R - (\eta - f)c_L + fc_L\}
\end{aligned}$$

where $I(R) \coloneqq \mathbb{I}[R \leq (1-2f+\eta)c_L]$. Because $L(R, m_B, G_B; p^i) \geq L(R', m_B, G_B; p^i)$ for any R',

$$\begin{aligned}
&m_B[G_B(R)(R-\bar{R}) - G_B(R')(R'-\bar{R})] \\
&\geq -(1-m_B)(R-R') - (1-m_B)\frac{1-p^i}{p^i}\{I(R)(R + (2f-\eta)cL) - I(R')(R' + (2f-\eta)cL)\}
\end{aligned}$$

Now consider $L(R, m_B, G_B; p^y) - L(R', m_B, G_B; p^y)$, which is equal to

$$p^y m_B[G_B(R)(R-\bar{R}) - G_B(R')(R'-\bar{R})] + (1-m_B)(R-R')$$

$$+ (1 - m_B) 1 - p^y \{I(R)(R + (2f - \eta)cL) - I(R')(R' + (2f - \eta)cL)\}$$
$$\geq p^y (1 - m_B) \left(1 - \frac{p^y}{p^i}\right) \{I(R)(R + (2f - \eta)cL) - I(R')(R' + (2f - \eta)cL)\}$$

If $R > (1-2f+\eta)c_L$ and $R' \leq (1-2f+\eta)c_L$, then $I(R)(R+(2f-\eta)cL) - I(R')(R'+(2f-\eta)cL) < 0$. If $p^y > p^i$, then $1 - p^y/p^i < 0$. Hence $L(R, m_B, G_B; p^y) - L(R', m_B, G_B; p^y) > 0$ and R' cannot be a best response for $p^y > p^i$.

Therefore, $\mathcal{R}R^{I*}_{P,y} \subseteq ((1 - 2f + \eta)c_L, (1 - 2f + \eta)c_H]$. For $R > (1 - 2f + \eta)c_L$, we have $\arg\max_{R>(1-2f+\eta)c_L} L(R, m_B^{I*}, G_B^{I*}; p^i) = \arg\max_{R>(1-2f+\eta)c_L} L(R, m_B^{I*}, G_B^{I*}; p^y)$. Hence, $R \in \mathcal{R}^*_{P,y}$ for $p^y > p^i$.

□

Lemma D.2. *If $R \leq (1-2f+\eta)c_L$ and $R \in \mathcal{R}^*_{P,i}$, then for any $R' < R$ and $R' > (1-2f+\eta)c_L$, we have $R' \notin \mathcal{R}^*_{P,y}$ with $p^y < p^i$.*

Proof. Because $L(R, m_B, G_B; p^i) \geq L(R', m_B, G_B; p^i)$ for any R',

$$m_B[G_B(R)(R - \bar{R}) - G_B(R')(R' - \bar{R})]$$
$$\geq -(1-m_B)(R-R') - (1-m_B)\frac{1-p^i}{p^i}\{I(R)(R + (2f - \eta)cL) - I(R')(R' + (2f - \eta)cL)\},$$

where $I(R) \coloneqq \mathbb{I}[R \leq (1 - 2f + \eta)c_L]$

Now consider $L(R, m_B, G_B; p^y) - L(R', m_B, G_B; p^y)$, which is equal to

$$p^y m_B[G_B(R)(R - \bar{R}) - G_B(R')(R' - \bar{R})] + (1 - m_B)(R - R')$$
$$+ (1 - m_B) 1 - p^y \{I(R)(R + (2f - \eta)cL) - I(R')(R' + (2f - \eta)cL)\}$$
$$\geq p^y (1 - m_B) \left(1 - \frac{p^y}{p^i}\right) \{I(R)(R + (2f - \eta)cL) - I(R')(R' + (2f - \eta)cL)\}$$

If $p^y < p^i$, then $1 - p^y/p^i > 0$. If $R \leq (1 - 2f + \eta)c_L$ and $R' < R$, then $I(R)(R + (2f - \eta)cL) - I(R')(R' + (2f - \eta)cL) > 0$. If $R' > (1 - 2f + \eta)c_L$, then $I(R)(R + (2f - \eta)cL) - I(R')(R' + (2f - \eta)cL) > 0$. Hence, in either case, $L(R, m_B, G_B; p^y) - L(R', m_B, G_B; p^y) > 0$ and R' cannot be a best response for $p^y < p^i$. □

Lemma D.3. *Suppose $R \geq \bar{R}$. $L_P(R, m_B, G_B; x) - m_B^{I*}[2xc_H + (1 - x)c_L]f$ is increasing in x. Moreover, if $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^i) = m_B^{I*}[2p^i c_H + (1 - p^i)c_L]f$, then $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^y) = m_B^{I*}[2p^i c_H + (1 - p^i)c_L]f \geq \max_R L_P(R, m_B^{I*}, G_B^{I*}; p^y)$ for all $p^y < p^i$, with strict inequality if $R > \bar{R}$ and $m_B^{I*} \in (0, 1)$.*

Proof. Define $I(R) = \mathbb{I}(R \leq (1 - 2f + \eta)c_L)$. One can immediately verify

$$L_P(R, m_B, G_B; x) - m_B^{I*}[2xc_H + (1 - x)c_L]f$$
$$= m_B x G_B(R)(R - \bar{R}) + (1 - m_B)[x(R + 2c_H f) + (1 - x)\eta c_L - \bar{R}] + I(R)(1 - x)[R - (\eta - 2f)c_L]$$

is increasing in x. Using this observation, we obtain that, if $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^i) = m_B^{I*}[2p^i c_H + (1-p^i)c_L]f$ and $p^y < p^i$, then

$$\begin{aligned} 0 &= L_P^{I*}(m_B^{I*}, G_B I*; p^i) - m_B^{I*}[2p^i c_H + (1-p^i)c_L]f \\ &\geq L_P^{I*}(m_B^{I*}, G_B I*; p^y) - m_B^{I*}[2p^y c_H + (1-p^y)c_L]f \end{aligned}$$

for $p^y < p^i$. If $R > \bar{R}$ and $m_B^{I*} \in (0,1)$, the last inequality is strict. □

LEMMA D.4. *$m_B^{I*} > 0$ if and only if $p \geq \frac{R_D}{(1-f)c_H}$.*

Proof. First, we show $m_B^{I*} > 0$ if $p \geq \frac{R_D}{(1-f)c_H}$. By way of contradiction, suppose $m_B^{I*} = 0$. Then $\mathcal{R}_{P,u}^{I*} = \mathcal{R}_{P,h}^{I*} = \{(1-2f+\eta)c_H\}$ and $G_P^{a*}(R) = \mathbb{I}(R < (1-2f+\eta)c_H)$. Then, for any $m_P^{a*} \in [0,1]$ and $\varepsilon \in (0, (1-f)c_H - R_D/p)$, $L_B(R_D/p + \varepsilon, m_P^{a*}, G_P^{a*}; p) > 0$, contradicting that $m_B^{I*} = 0$ is the bank's equilibrium strategy.

Second, we show $m_B^{I*} = 0$ if $p < \frac{R_D}{(1-f)c_H}$. When $p < \frac{R_D}{(1-f)c_H}$, for any $R \leq (1-f)c_H$ we have

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

and, by (11), $m_B^{I*} = 0$. □

LEMMA D.5. *If $m_B^{I*} \in (0,1)$, then $\sup \mathcal{R}_B^{I*} = (1-f)c_H$.*

Proof. We proceed by contradiction and assume $\tilde{R} \coloneqq \sup \mathcal{R}_B^{I*} < (1-f)c_H$. Because $m_B^{I*} \in (0,1)$, by Lemma A.1, we have $p \geq \frac{R_D}{(1-f)c_H}$, which also implies (7). Hence, $L_P(R, m_B^*, G_B^*; p^i) < L_P((1-2f+\eta)c_H, m_B^*, G_B^*; p^i)$ for any $R \in (\tilde{R}, (1-2f+\eta)c_H)$ and for $i \in \{u, h\}$. Therefore, an $\varepsilon > 0$ exists such that $L_B(\tilde{R}+\varepsilon, m_P^{a*}, G_P^{a*}; p^i) > L_B(\tilde{R}, m_P^{a*}, G_P^{a*}; p^i)$ for $i \in \{u, h\}$.

Hence, for a small enough ε, a lending mechanism (m_B, F_B) with $m_B = 1$ and with domain $\mathcal{R}_B^{I*} \cup \{\tilde{R}+\varepsilon\}$ exists such that $\int_0^{\hat{R}+\varepsilon} L_B(R, m_P^{a*}, G_P^{a*}; p) dF(R) > 0$ and $U(1, m_P^{A*}, F_B, F_P^{A*}) > U(m_B^{I*}, m_P^{A*}, F_B^I, F_P^{A*})$, contradicting the assumption that $\mathcal{R}_B^{I*}$ is the domain of the equilibrium lending mechanism offered by banks. □

LEMMA D.6. *Suppose $m_B^{I*} \in (0,1)$ for all $c > 0$. Then a $\bar{m} \in (0,1)$ exists such that $m_B^{I*} \leq \bar{m}$ for any $c > 0$. That is, as $c \to 0$, $\limsup m_B^{I*} < 1$.*

Proof. We proceed by contradiction and assume a sequence $(c_n)_{n=0}^{\infty}$ with $c_n > 0$ and $c_n \to 0$ such that $m_{B,n}^{I*} \to 1$, where $m_{B,n}^{I*}$ is the equilibrium value of m_B^{I*} when $c = c_n$. In this case, for any $i \in \{u, h\}$ and for a sufficiently large N, $L_P(R, m_{B,N}^{I*}, G_B^{I*}; p^i) = (1 - m_{B,N}^{I*})[2pc_H + (1-p)c_L]f < L_P(R_D/p, 1, G_B^{I*}; p^i)$ for any R such that $G_B^{I*}(R) = 0$. Hence, $m_{P,i}^{I*} = 1$ but $R \notin \mathcal{R}_{P,i}^{I*}$ if $G_B^{I*}(R) = 0$.

By Lemma D.5, $\sup \mathcal{R}_B^{I*} = (1-f)c_H$. If $(1-f)c_H \in \mathcal{R}_B^{I*}$, $L_B((1-f)c_H, 1, G_P^{a*}; p) = 0$ implies $G_P^{a*}(\tilde{R}) > 0$ and an $R > (1-f)c_H$ exists with $R \in \mathcal{R}_{P,i}^{I*}$ for some $i \in \{u, h\}$. If instead $(1-f)c_H \notin \mathcal{R}_B^{I*}$, then $\lim_{R \to \tilde{R}^-} G_P^{a*}(R) > 0$, implying an $R \geq (1-f)c_H$ exists with $R \in \mathcal{R}_{P,i}^{I*}$ for some $i \in \{u, h\}$. In either case, $G_B^{I*}(R) = 0$, thus contradicting the previous result. □

LEMMA D.7. *$\inf \mathcal{R}_{P,i}^{I*} \in \mathcal{R}_{P,i}^{I*}$ for $i \in \{u, l, h\}$ and $\inf \mathcal{R}_B^{I*} \in \mathcal{R}_B^{I*}$.*

Proof. Define $\underline{R}_{P,i} \coloneqq \inf \mathcal{R}_{P,i}^{I*}$ and $\underline{R}_B \coloneqq \inf \mathcal{R}_B^{I*}$. If $\underline{R}_B \notin \mathcal{R}_B^{I*}$, then a sequence $(R_n)_{n=0}^{\infty}$ exists such that $R_n > \underline{R}_B$ and $R_n \in \mathcal{R}_B^{I*}$ for all n and $R_n \to \underline{R}_B$ as $n \to \infty$. We therefore must have

$$L_B(\underline{R}_B, m_P^{a*}, G_P^{a*}; p) < \lim_{n\to\infty} L_B(R_n, m_P^{a*}, G_P^{a*}; p)$$

which, in turn, implies $G_P^{a*}(\underline{R}_J) < \lim_{n\to\infty} G_P^{a*}(R_n)$. This result, however, contradicts that G_P^{a*} is a weakly decreasing function. Hence, $\underline{R}_B \in \mathcal{R}_B^{I*}$.

Similarly, if $\underline{R}_{P,i} \notin \mathcal{R}_{P,i}^{I*}$, a sequence $(R_n)_{n=0}^{\infty}$ exists such that $R_n > \underline{R}_{P,i}$ and $R_n \in \mathcal{R}_{P,i}^{I*}$ for all n and $R_n \to \underline{R}_{P,i}$ as $n \to \infty$. Using a similar reasoning to the one above, we would then conclude $G_B^{I*}(\underline{R}_J) < \lim_{n\to\infty} G_B^{I*}(R_n)$, contradicting that G_B^{I*} is a weakly decreasing function. Hence, $\underline{R}_{P,i} \in \mathcal{R}_{P,i}^{I*}$ for $i \in \{u, l, h\}$. □

LEMMA D.8. *Assume $m_P^{a*} > 0$ and $m_B^{I*} > 0$. Then $\min\{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\} \le R_D/p$. Moreover, either $\min\{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\} = R_D/p$ or $\min\{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\} = (1-2f+\eta)c_L$. Finally, if $\min\{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\} \neq (1-2f+\eta)c_L$, then $\min \mathcal{R}_B^{I*} = R_D/p$.*

Proof. Define $\underline{R}_P \coloneqq \min\{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\}$ and $\underline{R}_B \coloneqq \min \mathcal{R}_B^{I*}$. First, we establish $\underline{R}_P \le R_D/p$. We proceed by contradiction and assume $\underline{R}_P > R_D/p$. By bank competition, we thus have $m_B^{I*} = 1$ and $\mathcal{R}_B^{I*} = \{R_D/p\}$. In this case, if $R_D/p < (1-2f+\eta)c_L$, the uniformed and optimistic platform's best response is R_D/p. If instead $R_D/p \ge (1-2f+\eta)c_L$, the platform's best response could be either R_D/p or $(1-2f+\eta)c_L$. In both cases, $\underline{R} \le R_D/p$, contradicting $\underline{R}_P > R_D/p$.

Having established $\underline{R}_P \le R_D/p$, we now prove $\underline{R}_P = R_D/p$ or $\underline{R} = (1-2f+\eta)c_L$. If $R_D/p \le (1-2f+\eta)c_L$, then $L_P(R, m_B^{I*}, G_B^{I*}; p^i) < L_P(R_D/p, m_B^{I*}, G_B^{I*}; p)$ for any $R < R_D/p$ and any $i \in \{u, h\}$, implying $\underline{R}_P = R_D/p$. If instead, $R_D/p > (1-2f+\eta)c_L$, $L_P(R, m_B^{I*}, G_B^{I*}; p^i) < L_P((1-2f+\eta)c_L, m_B^{I*}, G_B^{I*}; p^i)$ for any $R < (1-2f+\eta)c_L$ and $L_P(R', m_B^{I*}, G_B^{I*}; p^i) < L_P(R_D/p, m_B^{I*}, G_B^{I*}; p^i)$ for any $R' \in ((1-2f+\eta)c_L, R_D/p)$, implying $\underline{R} = R_D/p$ or $\underline{R} = (1-2f+\eta)c_L$.

To prove the final part of the lemma, consider $\underline{R}_P = R_D/p \neq (1-2f+\eta)c_L$. We proceed by contradiction and assume $\underline{R}_B > R_D/p$. Because $\underline{R}_P \neq (1-2f+\eta)c_L$, an $\varepsilon > 0$ exists such that $L_P(R_D/p + \varepsilon, m_B^{I*}, G_B^{I*}; p^i) > L_P(R_D/p, m_B^{I*}, G_B^{I*}; p^i)$ for $i \in \{u, h\}$, contradicting $R_D/p \in \{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\}$. Hence, if $\underline{R}_P = R_D/p \neq (1-2f+\eta)c_L$, the $\underline{R}_B = R_D/p$. □

LEMMA D.9. *Assume $\min\{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\} = R_D/p \neq (1-2f+\eta)c_L$. If $(1-a^{I*})m_{P,u}^{I*} = 0$, then $R_D/p \in \mathcal{R}_{P,h}^{I*}$, whereas if $a^{I*}m_{P,h}^{I*} = 0$, then $R_D/p \in \mathcal{R}_{P,u}^{I*}$. Furthermore, if $R_D/p > (1-2f+\eta)c_L$, then $\min \mathcal{R}_{P,h}^{I*} = R_D/p$. Similarly, if $R_D/p < (1-2f+\eta)c_L$, but c is sufficiently small, then $\min \mathcal{R}_{P,h}^{I*} = R_D/p$.*

Proof. For the first part of the lemma, notice that, if $(1-a^{I*})m_{P,u}^{I*} = 0$ and $\min\{\mathcal{R}_{P,h}^{I*}\} > R_D/p$, then an $\varepsilon > 0$ exists such that $L_B(R_D/p + \varepsilon, m_P^{a*}, G_P^{a*}; p) > 0$, thus contradicting part 4 of the equilibrium definition C.1. A similar reasoning can be used to rule out $a^{I*}m_{P,h}^{I*} = 0$ and $\min\{\mathcal{R}_{P,u}^{I*}\} > R_D/p$.

To prove the next part of the lemma, we proceed by contradiction and assume $\min \mathcal{R}_{P,h}^{I*} \neq R_D/p$, thus implying $R_D/p \notin \mathcal{R}_{P,h}^{I*}$. Hence, we must have $R_D/p = \min \mathcal{R}_{P,u}^{I*}$. If $R_D/p > (1-2f+\eta)c_L$, Lemma D.1 implies $R_D/p \in \mathcal{R}_{P,h}^{I*}$, thus generating a contradiction.

We now focus on $R_D/p < (1-2f+\eta)c_L$. If $a^{I*} = 1$, the first result of this lemma shows $\min\{\mathcal{R}^{I*}_{P,h}\} = R_D/p$. If instead $a^{I*} \leq 1$, consider $R \in \mathcal{R}^{I*}_{P,h}$. Then, for a sufficiently small c,

$$\begin{aligned}
\psi L_P(R, m_B^{I*}, G_B^{I*}; p^h) &\leq L_P(R_D/p, m_B^{I*}, G_B^{I*}; p^u) - (1-\psi)L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h) + c \\
&\leq L_P(R_D/p, m_B^{I*}, G_B^{I*}; p^u) - (1-\psi)L_P(R_D/p, m_B^{I*}, G_B^{I*}; p^h) \\
&\qquad - (1-m_B^{I*})[(1-2f+\eta) - R_D/p] + c \\
&< \psi L_P(R_D/p, m_B^{I*}, G_B^{I*}; p^h),
\end{aligned}$$

where the last inequality equality follows from $R_D/p < (1-2f+\eta)c_L$ and Lemma D.6. Therefore, $\min \mathcal{R}^{I*}_{P,h} = R_D/p$ when $R_D/p < (1-2f+\eta)c_L$, but c is sufficiently small. $\square$

Lemma D.10. *If $m_B^{I*} > 0$ and $\bar{R} > (1-2f+\eta)c_L$, then $(1-2f+\eta)c_L \notin \mathcal{R}^{I*}_{P,i}$ for $i \in \{u,h\}$.*

Proof. Note that $L_P((1-2f+\eta)c_H, m_B^{I*}, G_B^{I*}; p^i) \leq L_P((1-2f+\eta)c_L, m_B^{I*}, G_B^{I*}; p^i)$ if and only if

$$(1-m_B^{I*})[p^i(1+\eta)c_H + (1-p^i)\eta c_L] \leq m_B^{I*}p^i[(1-2f+\eta)c_L - \bar{R}] + (1-m_B^{I*})[(1+\eta)c_L + 2p^i(c_H-c_L)f]$$

We have that $p^i(1+\eta)c_H + (1-p^i)\eta c_L > (1+\eta)c_L + 2p^i(c_H-c_L)f$ if an only if (C.3) holds.

Note that $R_D > c_L$ and $(1-f)c_H < (1-2f+\eta)(c_H-c_L)+c_L$. Hence, because we are considering $p \geq \frac{R_D}{(1-f)c_H}$, the inequality (C.3) is satisfied for $i \in \{u,h\}$. We must therefore have $L_P((1-2f+\eta)c_H, m_B^{I*}, G_B^{I*}; p^i) > L_P((1-2f+\eta)c_L, m_B^{I*}, G_B^{I*}; p^i)$ for for $i \in \{u,h\}$ whenever $(1-2f+\eta)c_L - \bar{R} < 0$. $\square$

Lemma D.11. *Assume $\bar{R} \leq R_D/p$. If $m_P^{a*} > 0$ and $m_B^{I*} \in (0,1)$, then $\max\{\mathcal{R}^{I*}_{P,u} \cup \mathcal{R}^{I*}_{P,h}\} \in \{(1-f)c_H, (1-2f+\eta)c_H\}$. Moreover, if $m_P^{a*} = 1$ then $\max \mathcal{R}^{I*}_{P,h} = (1-2f+\eta)c_H$.*

Proof. First, note $\sup \mathcal{R}^{I*}_{P,i} \in \mathcal{R}^{I*}_{P,i}$ for $i \in \{u,l,h\}$ by the left-continuity of $G_B^{I*}(\cdot)$ and the platform's objective function $L_P(\cdot, m_B, G_B; p^i)$. Hence, $\sup \mathcal{R}^{I*}_{P,i} = \max \mathcal{R}^{I*}_{P,i}*$. Also note that $L_P(R, m_B^{I*}, G_B^{I*}; p^i) < L_P((1-2f+\eta)c_H, m_B^{I*}, G_B^{I*}; p^i)$ for $R \in ((1-f)c_H, (1-2f+\eta)c_H)$ because $m_B^{I*} \in (0,1)$. Hence $((1-f)c_H, (1-2f+\eta)c_H) \cap \mathcal{R}^{I*}_{P,i} = \emptyset$. Finally, by Lemma D.5, $\sup \mathcal{R}^{I*}_B = (1-f)c_H$.

To prove the first part of the lemma, we proceed by contradiction and assume $R^M := \{\mathcal{R}^{I*}_{P,u} \cup \mathcal{R}^{I*}_{P,h}\} < (1-f)c_H$. In this case, $G_P^{a*}(R) = 0$ for all $R \geq R^M$, along with $\sup \mathcal{R}^{I*}_B = (1-f)c_H$, imply that $(1-f)c_H \in \mathcal{R}^{I*}_B$ and $R \notin \mathcal{R}^{I*}_B$ for all $R \in (R^M, (1-f)c_H)$. Otherwise, an $R' \geq R^M$ with $R' \in \mathcal{R}^{I*}_B$ would exist such that $L_B(R', m_P^{a*}, G_P^{a*}; p) \neq 0$, contradicting the definition of equilibrium. Moreover, $L_B((1-f)c_H, m_P^{a*}, G_P^{a*}; p) = 0$ and $R^M < (1-f)c_H$ imply $m_P^{a*} \in (0,1)$.

If $R^M > (1-2f+\eta)c_L$ or if $R^M < (1-f)c_H \leq (1-2f+\eta)c_L$ then $L_P((1-f)c_H, m_B^{I*}, G_B^{I*}; p^i) > L(R^M, m_B^{I*}, G_B^{I*}; p^i)$ for $i \in \{u,h\}$, contradicting $R^M := \max\{\mathcal{R}^{I*}_{P,u} \cup \mathcal{R}^{I*}_{P,h}\}$. It remains to consider $R^M \leq (1-2f+\eta)c_L < (1-f)c_H$. In this case, because $m_B^{I*} \in (0,1)$ and $\bar{R} \leq R_D/p$, $L_P(R_D/p, m_B^*, G_B^*; p^i) > m_B^*[2pc_H + (1-p)c_L]f$ for $i \in \{u,h\}$. But this implies $m_P^{a*} = 1$, which contradicts $L_B((1-f)c_H, m_P^{a*}, G_P^{a*}; p) = 0$. Hence, $\max\{\mathcal{R}^{I*}_{P,u} \cup \mathcal{R}^{I*}_{P,h}\} \in \{(1-f)c_H, (1-2f+\eta)c_H\}$

To prove the second part of the lemma for $m_P^{a*} = 1$, we proceed again by contradiction and assume $(1 - 2f + \eta)c_H \notin \mathcal{R}_{P,h}^{I*}$. By Lemma D.1, this observation also implies $(1 - 2f + \eta)c_H \notin \mathcal{R}_{P,u}^{I*}$ and, therefore, $G_P^{a*}((1 - f)c_H) = 0$. Furthermore, from the previous results, $(1 - f)c_H = \max\{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\}$. Hence, $L_B((1 - f)c_H, 1, G_P^{a*}; p) < 0$. Therefore, $G_B^{I*}((1 - f)c_H) = 0$. But then, $L_P((1 - 2f + \eta)c_H, m_B^{I*}, G_B^{I*}; p^i) > L_P((1 - f)c_H, m_B^{I*}, G_B^{I*}; p^i)$ for $i \in \{u, h\}$, contradicting that $\max\{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\} = (1 - f)c_H$. Thus, if $m_P^{a*} = 1$ and $m_B^{I*} \in (0, 1)$, then $\max \mathcal{R}_{P,h}^{I*} = (1 - 2f + \eta)c_H$.

□

Lemma D.12. *Suppose $m_B^{I*} \in (0, 1)$ and $m_P^{a*} > 0$. If $R_1 \in \mathcal{R}_B^{I*}$ and $R_2 \in \mathcal{R}_B^{I*}$ such that $R_1 < R_2 \le (1 - 2f + \eta)c_L$ or such that $(1 - 2f + \eta)c_L < R_1 < R_2$, then we must have $[R_1, R_2] \subseteq \mathcal{R}_B^{I*} \cap \{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,u}^{I*}\}$. In particular, $G_P^{a*}(\cdot)$ and $G_B^{I*}(\cdot)$ are strictly decreasing in $[R_1, R_2]$.*

Proof. Assume, by way of contradiction, that an $R^k \in (R_1, R_2)$ exists such that $R^k \notin \mathcal{R}_B^{I*}$. By the right-continuity of $G_P^{a*}(\cdot)$ and $L_B(\cdot, m_P^{a*}, G_P^{a*}; p)$, we have that an $\varepsilon > 0$ exists such that $L_B(R, m_P^{a*}, G_P^{a*}; p) < 0$ for all $R \in (R^k, R^k + \varepsilon)$. Let $R_1' := \sup\{R \colon R \in \mathcal{R}_B^{I*} \text{ and } R < R^k\}$. Hence, $L_B(R, m_P^{a*}, G_P^{a*}; p) < 0$ for all $R \in (R_1', R^k + \varepsilon)$, thus implying

$$G_P^{a*}(R) < \frac{(1 - m_P^{a*})(R_D - pR)}{m_P^{a*} p(R - R_D)} + \frac{(1 - p)R_D}{p(R - R_D)} \le \frac{(1 - m_P^{a*})(R_D - pR_1')}{m_P^{a*} p(R_1' - R_D)} + \frac{(1 - p)R_D}{p(R_1' - R_D)}. \quad \text{(D.1)}$$

Because $R \notin \mathcal{R}_B^{I*}$ for all $R \in (R_1', R^k + \varepsilon)$, we must have that $R \notin \{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,u}^{I*}\}$ for any $R \in (R_1', R^k + \varepsilon)$.

If $R_1' \in \mathcal{R}_B^{I*}$, then the last term in equation (D.1) coincides with $G_P^{a*}(R_1')$ and, therefore, $G_P^{a*}(R) < G_P^{a*}(R_1')$ for any $R \in (R_1', R^k + \varepsilon)$. But this implies there exists $R' \in (R_1', R)$ such that $R' \in \{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,u}^{I*}\}$, contradicting the previous result that $R' \notin \{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,u}^{I*}\}$ for any $R' \in (R_1', R^k + \varepsilon)$. If instead, $R_1' \notin \mathcal{R}_B^{I*}$, then we must have $\lim_{R \to R_1'^-} G_P^{a*}(R) > G_P^{a*}(R_1')$, which implies $R_1' \in \{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,u}^{I*}\}$. However, if $R_1' \notin \mathcal{R}_B^{I*}$, $L_P(R^k + \varepsilon, m_B^{I*}, G_B^{I*}; p) > L_P(R_1', m_B^{I*}, G_B^{I*}; p)$, generating a contradiction.

Hence, $[R_1, R_2] \subseteq \mathcal{R}_B^{I*}$. In particular, $L_B(R, m_P^{a*}, G_P^{a*}; p) = 0$ for all $R \in [R_1, R_2]$, which implies

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

is strictly decreasing for $R \in [R_1, R_2]$.

Suppose now, by way of contradiction, an $R^y \in [R_1, R_2]$ exists such that $R \notin \{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,u}^{I*}\}$. By the left-continuity of $G_B^{I*}(\cdot)$ and $L_P(\cdot, m_B^{I*}, G_B^{I*}; p^i)$ for $i \in \{u, h\}$, we have that an $\varepsilon > 0$ exists such that $R \notin \{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,u}^{I*}\}$ for all $R \in (R^y - \varepsilon, R^y)$. However, this observation implies $G_P^{a*}(R)$ is constant in $(R^y - \varepsilon, R^y)$, contradicting the previous result. Hence, we also obtain that $[R_1, R_2] \subseteq \{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,u}^{I*}\}$. □

D.3 Proof of Lemma C.1

To prove the first part, we proceed by contradiction and assume that $L_P(R, m_B^{I*}, G_B^{I*}; p^h) \le m_B^{I*}[2p^h c_H + (1 - p^h)c_L]f$ for all R. By Lemma D.3, we have $L_P(R, m_B^{I*}, G_B^{I*}; p^i) \le m_B^{I*}[2p^h c_H +$

$(1-p^h)c_L]f$ for $i \in \{u,l\}$. Therefore, for $i \in \{u,h,l\}$, $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^i) = m_B^{I*}[2p^i c_H + (1-p^i)c_L]f$ and the maximizer in (C.1) is $a^{I*} = 0$, contradicting $a^{I*} \in (0,1]$.

To prove the second part, we proceed again by contradiction and assume an R exists such that $R \in \mathcal{R}_{P,i}^{I*}$ and $L_P(R, m_B^{I*}, G_B^{I*}; p^i) \geq m_B^{I*}[2p^i c_H + (1-p^i)c_L]f$ for $i \in \{l,h\}$. In this case, for any $c > 0$,

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

contradicting that $a^{I*} > 0$.

□

D.4 Proof of Lemma C.3

When $p < \frac{R_D}{(1-f)c_H}$, Lemma D.4 implies $m_B^{I*} = 0$. The platform is thus a monopolistic lender for a merchant provided (C.2) is satisfied for $i = h$, and the results of Lemma C.2 apply.

For the rest of the proof, we thus focus on $p \geq R_D/\bar{R}$. By Lemma D.4, banks lend with positive probability $m_B^* > 0$. We want to show that $m_B^{I*} = 1$, $\mathcal{R}_B^{I*} = \{R_D/p\}$, and $m_P^{a*}(1 - G_P^{a*}(R_D/p)) = 0$. Together, these conditions imply merchants borrow exclusively from banks when $p \geq R_D/\bar{R}$

As a preliminary observation, notice that, if $m_P^{a*} > 0$, $R_D/p = \min\{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\}$. In fact, if $\bar{R} > (1-2f+\eta)c_L$, by Lemma D.10, $(1-2f+\eta)c_L \notin \mathcal{R}_{P,i}^{I*}$ for $i \in \{u,h\}$. If instead $\bar{R} \leq (1-2f+\eta)c_L$, we have $R_D/p \leq \bar{R} \leq (1-2f+\eta)c_L$. By Lemmas D.8, we thus have $R_D/p = \min\{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\}$ in both cases.

Suppose, by way of contradiction, $m_B^{I*} \in (0,1)$. Which, in turn, implies $m_P^{a*} > 0$, otherwise competitive banks would offer rate R_D/p with probability one and $m_B^{I*} = 1$. It also implies $\sup \mathcal{R}_B^{I*} = (1-f)c_H$ by Lemma D.5.

First, we exclude $m_P^{a*} = 1$. By the previous observation, $R_D/p = \min\{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\}$. Hence, $R_D/p \in \mathcal{R}_{P,i}^{I*}$ for some $i \in \{u,h\}$. We must therefore have $L_P(R_D/p, m_B^{I*}, G_B^{I*}; p^i) \geq L_P((1-2f+\eta)c_H, m_B^{I*}, G_B^{I*}; p^i)$, which implies

$$
\begin{aligned}
& m_B^{I*}\left\{p^i((1-2f+\eta)c_H - \bar{R}) - I(R_D/p)(1-p^i)[R_D/p - (\eta-2f)c_L]\right. \\
& \quad \geq p^i((1-2f+\eta)c_H - R_D/p) - I(R_D/p)(1-p^i)[R_D/p - (\eta-2f)c_L],
\end{aligned} \tag{D.2}
$$

where $I(R) = \mathbb{I}(R \leq (1-2f+\eta)c_L)$. Notice we have $(1-2f+\eta)c_H \geq R_D/p$ when $p \geq \frac{R_D}{(1-f)c_H}$

and $\eta \geq f$ and $(1-2f+\eta)c_H - \bar{R} \leq 1-2f+\eta)c_H - R_D/p$ because we are considering $\bar{R} \geq R_D/p$. Finally, we also have $p^i((1-2f+\eta)c_H - R_D/p) - I(R_D/p)(1-p^i)[R_D/p - (\eta-2f)c_L]$ because either $R_D/p > (1-2f+\eta)c_L$, or $R_D/p \leq (1-2f+\eta)c_L$, along with $p \geq \frac{R_D}{(1-f)c_H}$, implies $p^i((1-2f+\eta)c_H - R_D/p) - I(R_D/p)(1-p^i)[R_D/p - (\eta-2f)c_L] > 0$. Therefore, if $p^i((1-2f+\eta)c_H - \bar{R}) - I(R_D/p)(1-p^i)[R_D/p - (\eta-2f)c_L] \leq 0$, the inequality (D.2) is a contradiction. If $p^i((1-2f+\eta)c_H - \bar{R}) - I(R_D/p)(1-p^i)[R_D/p - (\eta-2f)c_L] > 0$, the inequality (D.2) implies $m_B^{I*} \geq 1$, which contradicts $m_B^{I*} \in (0,1)$. Therefore, when $p \geq R_D/\bar{R}$, $m_B^{I*} = 1$.

Next, we show $m_P^{a*}(1 - G_P^{a*}(R_D/p)) = 0$. Assume, by way of contradiction, $m_P^{a*}(1 - G_P^{a*}(R_D/p)) > 0$. By our previous result in the proof, if $m_P^{a*} > 0$, then $R_D/p \in \{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\}$. Consider, $p > R_D/\bar{R}$. Because $m_B^{I*} = 1$, the profits from lending for the platform are $L_P(R_D/p, 1, G_B^{I*}; p^i) < [2p^i c_H + (1-p^i)c_L]f$ for an $i \in \{u, l\}$, and hence $m_{P,i}^{I*} = 0$. By Lemma D.9, we must therefore have $R_D/p \in \mathcal{R}_{P,y}^{I*}$ for $y \in \{u, l\}$ and $y \neq i$. But this would also imply $m_{P,i}^{I*} = 0$, thus contradicting $m_P^{a*}(1 - G_P^{a*}(R_D/p)) = 0$.

Consider now $p = R_D/\bar{R}$, then for an $i \in \{u, l\}$ $L_P(R, 1, G_B^{I*}; p^i) \leq L_P(R_D/p, 1, G_B^{I*}; p^)$ for any $R > R_D/p$, thus implying $G_B^{I*}(R) \leq 0$. Hence, banks offer rate R_D/p with probability one, and, for this to be the banks' best response, we must have $m_P^{a*}(1 - G_P^{a*}(R_D/p)) = 0$. □

D.5 Proof of Lemma C.4

We prove $m_P^{a*} > 0$. Suppose $m_P^{a*} = 0$, then competitive banks would set $\mathcal{R}_B^{I*} = \{R_D/p\}$ and $m_B^{I*} = 1$. For a small enough $\varepsilon > 0$, $L_P(R_D/p - \varepsilon, 1, G_B^{I*}; p^i) > [p2c_H + (1-p)c_L]f$ for $i \in \{u, h\}$, which contradicts $m_P^{a*} = 0$. Hence $m_P^{a*} > 0$.

By Lemma D.4, we have $m_B^{I*} > 0$. We now prove $m_B^{I*} \in (0,1)$. We proceed by contradiction and assume $m_B^{I*} = 1$. In this case, for any $i \in \{u, h\}$, $L_P(R, 1, G_B^{I*}; p^i) = [2pc_H + (1-p)c_L]f < L_P(R_D/p, 1, G_B^{I*}; p^i)$ for any R such that $G_B^{I*}(R) = 0$. Hence, $m_{P,i}^{I*} = 1$ but $R \notin \mathcal{R}_{P,i}^{I*}$ if $G_B^{I*}(R) = 0$.

Next, we show $a^{I*} > 0$. Assume, by contradiction, that $a^{I*} = 0$. Then, the equilibrium is described by one of the cases of Section 4. In each of those cases, an $R \in \mathcal{R}_{P,u}^{I*} = \mathcal{R}_P^*$ exists such that $R \neq (1-2f+\eta)c_L$. Therefore, for a sufficiently small c,

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

where the strict inequality follows because $R \neq (1-2f+\eta)c_L$ and Lemma D.6, contradicting $a^{I*} = 0$.

Let $\tilde{R} = \sup \mathcal{R}_B^{I*} \leq (1-f)c_H$. If $\tilde{R} \in \mathcal{R}_B^{I*}$, $L_B(\tilde{R}, 1, G_P^{a*}; p) = 0$ implies $G_P^{a*}(\tilde{R}) > 0$ and an $R > \tilde{R}$ exists with $R \in \mathcal{R}_{P,i}^{I*}$ for some $i \in \{u, h\}$. If instead $\tilde{R} \notin \mathcal{R}_B^{I*}$, then $\lim_{R \to \tilde{R}^-} G_P^{a*}(R) > 0$, implying an $R \geq \tilde{R}$ exists with $R \in \mathcal{R}_{P,i}^{I*}$ for some $i \in \{u, h\}$. In either case, $G_B^{I*}(R) = 0$, thus contradicting the previous result.

Because $m_B^{I*} \in (0,1)$, Lemma D.5 implies $\sup \mathcal{R}_B^* = (1-f)c_H$, Moreover, by Lemmas D.7 and D.8, we have that $\min\{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\} \leq R_D/p$ and $\min\{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\} \in \{(1-2f+\eta)c_L, R_D/p\}$. The result that $\max \min\{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\} \in \{(1-f)c_H, (1-2f+\eta)c_H\}$ follows from Lemma D.11. □

D.6 Proof of Lemma C.5

Throughout the proof, recall that $m_B^{I*} \in (0,1)$, $m_P^{a*} > 0$, and $a^{I*} > 0$ by Lemma C.4. In particular, an R exists such that $L_P(R, m_B^{I*}, G_B^{I*}; p^h) \geq m_B^{I*}[2p^h c_H + (1-p)c_L]f$.

We first consider a merchant with $p^h(1+\eta)c_H + (1-p^h)\eta c_L > \bar{R}$. Suppose, by contradiction, that $m^{a*} \in (0,1)$. By Lemma C.1, we must have $a^{I*} \in (0,1)$ and $m_{P,u}^{I*} \in (0,1)$. By Lemma D.3, we derive also $m_{P,l}^{I*} = 0$. Note that

$$
\begin{aligned}
L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h) &- m_B^{I*}[p^h 2c_H + (1-p^h)c_L]f \\
&\geq L_P((1-2f+\eta)c_H, m_B^{I*}, G_B^{I*}; p^h) - m_B^{I*}[p^h 2c_H + (1-p^h)c_L]f \\
&= (1-m_B^{I*})[p^h(1+\eta)c_H + (1-p^h)\eta c_L - \bar{R}] > 0
\end{aligned}
$$

where the second inequality follows from $p^h(1+\eta)c_H + (1-p^h)\eta c_L > \bar{R}$. Therefore, for a sufficiently small $c > 0$,

$$
\begin{aligned}
\psi L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h) &+ (1-\psi)L_P^{I*}(m_B^{I*}, G_B^{I*}; p^l) - c \\
&\geq m_B^{I*}[p^h 2c_H + (1-p^h)c_L]f + (1-m_B^{I*})[p^h(1+\eta)c_H + (1-p^h)\eta c_L - \bar{R}] - c \\
&= L_P^{I*}(m_B^{I*}, G_B^{I*}; p^u) + (1-m_B^{I*})[p^h(1+\eta)c_H + (1-p^h)\eta c_L - \bar{R}] - c \\
&\geq L_P^{I*}(m_B^{I*}, G_B^{I*}; p^u) + (1-\bar{m})[p^h(1+\eta)c_H + (1-p^h)\eta c_L - \bar{R}] - c \\
&> L_P^{I*}(m_B^{I*}, G_B^{I*}; p^u),
\end{aligned}
$$

where the second inequality follows from Lemma D.6 and the last one from c being sufficiently small. However, this result contradicts $a^{I*} \in (0,1)$. Therefore, $m_P^{a*} = 1$.

Next, we consider $p^h(1+\eta)c_H + (1-p^h)\eta c_L \leq \bar{R}$. Because (C.3) holds for $i = h$ when $p \geq \frac{R_D}{(1-f)c_H}$, we also have $R_D/p \geq \bar{R} > (1-2f+\eta)c_L$. By Lemmas D.7, D.8, and D.10, we thus have $\min \mathcal{R}_{P,i}^{I*} \geq R_D/p > (1-2f+\eta)c_L$ for $i \in \{u,h\}$.

Because $a^{I*} > 0$, we need to rule out $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^u) < \psi L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h) + (1-\psi)L_P^{I*}(m_B^{I*}, G_B^{I*}; p^l) - c$ by contradiction. If this inequality holds, then also $m_P^{a*} = 1$ because $m_{P,h}^{I*} = 1$. From Lemma D.11, D.1, and $R_D/p > (1-2f+\eta)c_L$, we obtain $\max \mathcal{R}_{P,h}^{I*} = (1-2f+\eta)c_H$. But then

$$L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h) = L_P((1-2f+\eta)c_H, m_B^{I*}, G_B^{I*}; p^h) \leq m_B^{I*}[p2c_H + (1-p)c_L]f.$$

By Lemma D.3, $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^i) = m_B^{I*}[p2c_H + (1-p)c_L]f$ also for $i \in \{u,l\}$, contradicting $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^u) < \psi L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h) + (1-\psi)L_P^{I*}(m_B^{I*}, G_B^{I*}; p^l) - c$.

We therefore have $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^u) = \psi L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h) + (1-\psi)L_P^{I*}(m_B^{I*}, G_B^{I*}; p^l) - c$. It remains to show that $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^u) = m_B^{I*}[p2c_H + (1-p)c_L]f$. We proceed by contradiction and assume $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^u) > m_B^{I*}[p2c_H + (1-p)c_L]f$. Then, $m_{P,u}^{I*} = 1$ and $m_P^{a*} = 1$. From the previous reasoning, we would then conclude $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h) \leq m_B^{I*}[p2c_H + (1-p)c_L]f$, which implies $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^u) = m_B^{I*}[p2c_H + (1-p)c_L]f$ by Lemma D.3, thus generating a contradiction. Therefore, when $p^h(1+\eta)c_H + (1-p^h)\eta c_L \leq \bar{R}$, we have

$$\psi L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h) + (1-\psi)L_P^{I*}(m_B^{I*}, G_B^{I*}; p^l) - c = m_B^{I*}[p2c_H + (1-p)c_L]f = L_P^{I*}(m_B^{I*}, G_B^{I*}; p^u)$$

When $\bar{R} > (1-2f+\eta)c_L$, Lemma D.10 implies $\min \mathcal{R}_{P,i}^{*I} \neq (1-2f+\eta)c_L$ for $i \in \{u,h\}$. Therefore, by Lemmas D.7, D.8, and D.9, we obtain $\min \mathcal{R}_{P,h}^{*} = \min \mathcal{R}_{P,u}^{*} = R_D/p > (1-2f+\eta)c_L$, where the inequality follows because $\bar{R} > (1-2f+\eta)c_L$ and $p \leq R_D/\bar{R}$.

Finally, when $R_D/p < (1-2f+\eta)c_L$, Lemmas D.7, D.8, and D.9 imply $\min \mathcal{R}_{P,h}^{I*} = R_D/p \leq (1-2f+\eta)c_L$ when c is sufficiently small. □

D.7 PROOF OF PROPOSITION C.1

By Lemmas C.1, C.4 and C.5, we have $m_{P,h}^{I*} = m_P^{a*} = 1$, $a^{I*} > 0$, $m_B^{I*} \in (0,1)$, and $\min\{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,h}^{I*}\} = R_D/p > (1-2f+\eta)c_L$. Because $\arg\max_{R>(1-2f+\eta)c_L} L_P(R, m_B, G_B; p^i)$ does not depend on p^i, $\mathcal{R}_{P,u}^{*} = \mathcal{R}_{P,h}^{*}$.

First notice,

$$L_P(R, m_B^{I*}, G_B^{I*}; p^l) < L_P((1-2f+\eta)c_L, m_B^{I*}, G_B^{I*}; p^l) \tag{D.3}$$

for all $R \neq (1-2f+\eta)c_L$. Thus, if $\bar{R} > (1+\eta)c_L$, $m_{P,l}^{I*} = 0$. If, instead, $\bar{R} \in ((1-2f+\eta), (1+\eta)c_L]$, $m_{P,l}^{I*} = 1$ and $\mathcal{R}_{P,l}^{I*} = \{(1-2f+\eta)c_L\}$.

Because $\mathcal{R}^*_{P,u} = \mathcal{R}^*_{P,h}$, consider $R \in \mathcal{R}^*_{P,u}$. Then, for a sufficiently small c,

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

where the strict inequality follows from (D.3) and Lemma D.6. Hence, $a^{I*} = 1$.

Using Lemma D.8 and D.5, we obtain $(1-2f+\eta)c_L < R_D/p = \min \mathcal{R}_B^{I*} \leq \sup \mathcal{R}_B^{I*} = (1-f)c_H$. By Lemma D.12 we have $G^{I*}_{P,h}(\cdot)$ and $G^{I*}_B(\cdot)$ are strictly decreasing in $[R_D/p, (1-f)c_H]$ because $a^{I*} = 1$. Moreover, by D.11, we have $(1-2f+\eta)c_H \in \mathcal{R}^{I*}_{P,h}$.

The rest of the proof is thus identical to the proof of Proposition 1 with m_B^{I*} replacing m_B^*, G_B^{I*} replacing G_B^*, and $G^{I*}_{P,h}$ replacing G_P^*. □

D.8 PROOF OF PROPOSITION C.2

By Lemmas C.1, C.4 and C.5, we have $m^{I*}_{P,h} = m_P^{a*} = 1$, $a^{I*} > 0$, and $m_B^{I*} \in (0,1)$. By D.11, we have $(1-2f+\eta)c_H \in \mathcal{R}^{I*}_{P,h}$. Finally note that, because $\bar{R} < (1+\eta)c_H$, $m^{I*}_{P,l} = 1$ and $\mathcal{R}^{I*}_{P,l} = \{(1-2f+\eta)c_L\}$. Thus, by C.1, $(1-2f+\eta)c_L \notin \mathcal{R}^{I*}_{P,h}$.

First, we observe that, because $\bar{R} < R_D/p < (1+\eta)c_H$, $m^{I*}_{P,l} = 1$ and $\mathcal{R}^{I*}_{P,l} = \{(1-2f+\eta)c_L\}$.

Next, by Lemma D.8 , $\min \mathcal{R}^{I*}_{P,h} = R_D/p$. By Lemma D.11, $\max \mathcal{R}^{I*}_{P,h} = (1-2f+\eta)c_H$. From $L_P((1-2f+\eta)c_H, m_B^{I*}, G_B^{I*}; p^h) = L_P(R_D/p, m_B^{I*}, G_B^{I*}; p^h)$, we thus obtain m_B^{I*} is given by (C.4).

We first consider $T = (1-f)c_H < (1-2f+\eta)c_L$. We want to show that, in this case, $a^{I*} = 1$. Suppose, by way of contradiction, that $a^{I*} \in (0,1)$. I want to show that, if $R < (1-2+\eta)c_L$, then $R \notin \mathcal{R}^{I*}_{P,u}$ for a sufficiently small c. We proceed by contradiction and assume an $R < (1-2+\eta)c_L$ exist such that $R \in \mathcal{R}^{I*}_{P,u}$ for all c. Then

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

where strict inequality follows because $R < (1-2+\eta)c_L$ and because of Lemma D.6. But this result contradicts $a^{I*} < 1$. Hence, for a sufficiently small c, $\min \mathcal{R}^{I*}_{P,u} > (1-f)c_H$. Because (C.3) holds for $i = u$, we must thus have $\mathcal{R}^{I*}_{P,u} = \{(1-2f+\eta)c_H\}$, thus contradicting the previous result that $\mathcal{R}^{I*}_{P,u} \subseteq [R^c, (1-2f+\eta)c_H]$.

Therefore, if $T = (1-f)c_H < (1-2f+\eta)c_L$, we have $a^{I*} = 1$. The rest of the results can then be derived as in the proof of Proposition 2 when $T < (1-2f+\eta)c_L$ with m_B^{I*} replacing m_B^*, G_B^{I*} replacing G_B^*, and $G_{P,h}^{I*}$ replacing G_P^*. In particular, using $L_P(R, m_B^{I*}, G_B^{I*}; p^h) = L_P(R_D/p, m_B^{I*}, G_B^{I*}; p^h)$ for all $R \in [R_D/p, T]$, we obtain (C.5). Using using $L_B(R, 1, G_{P,h}^{I*}; p) = L_B(R_D/p, 1, G_{P,h}^{I*}; p^h)$ for all $R \in [R_D/p, T]$, we obtain $G_{P,h}^{I*}$ is given by (C.10).

Next, we consider $T \geq (1-2f+\eta)c_L$. By a reasoning identical to the one in the proof of Proposition 2, we have $(1-2f+\eta)c_L = \sup\{\mathcal{R}_B^{I*} \cap [R_D/p, (1-2f+\eta)c_L]\}$. By Lemma D.12, $[R_D/p, (1-2f+\eta)c_L] \subseteq \mathcal{R}_B^{I*}$ and $[R_D/p, (1-2f+\eta)c_L] \subseteq \{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,u}^{I*}\}$. By the left-continuity of G_B^{I*}, an $R^c \in [R_D/p, (1-2f+\eta)c_H)$ exists such that $R^c = \max\{\mathcal{R}_{P,h}^{I*} \cap [R_D/p, (1-2f+\eta)c_L]\}$. Otherwise, we would have $(1-2f+\eta)c_L \in \mathcal{R}_{P,h}^{I*}$, contradicting a result we established earlier.

Because $(1-2f+\eta)c_L > R_D/p \in \mathcal{R}_{P,h}^{I*}$, Lemma D.2 implies $R \notin \mathcal{R}_{P,u}^{I*}$ for all $R > (1-2f+\eta)c_L$. Furthermore, by the same Lemma and because $[R_D/p, (1-2f+\eta)c_L] \subseteq \{\mathcal{R}_{P,u}^{I*} \cup \mathcal{R}_{P,u}^{I*}\}$, we must also have $\mathcal{R}_{P,u}^{I*} = [R^c, (1-2f+\eta)c_H]$. Finally, because $G_P^{a*}(R)$ is strictly decreasing from $R \in [R_D/p, (1-2f+\eta)cL]$, but $R \notin \mathcal{R}_{P,h}^{I*}$ for $R \in (R^c, (1-2f+\eta)cL]$, then $a^{I*} \in (0,1)$.

Because, $a^{I*} \in (0,1)$, $R_D/p \in \mathcal{R}_{P,h}^{I*}$, $R^c \in \mathcal{R}_{P,i}^{I*}$ for $in\{u,h\}$, and $(1-2f+\eta)c_L \in \mathcal{R}_{P,i}^{I*}$, for $i \in \{u,l\}$, we use the following system of equations to determine $G_B^{I*}((1-2f+\eta)c_L)$, $G_B^{I*}(R^C)$, and R^c respectively:

$$\begin{aligned}
L_P((1-2f+\eta)c_L, m_B^{I*}, G_B^{I*}; p^u) &= \psi L_P(R_D/p, m_B^{I*}, G_B^{I*}; p^h) \\
&\quad + (1-\psi) L_P((1-2f+\eta)c_L, m_B^{I*}, G_B^{I*}; p^l) - c \\
L_P(R_D/p, m_B^{I*}, G_B^{I*}; p^h) &= L_P(R^c, m_B^{I*}, G_B^{I*}; p^h) \\
L_P(R^c, m_B^{I*}, G_B^{I*}; p^u) &= L_P((1-2f+\eta)c_L, m_B^{I*}, G_B^{I*}; p^u).
\end{aligned}$$

In particular, we obtain R^c is given by (C.6) and the the first equation implies

$$G_B^{I*}((1-2f+\eta)c_L) > 0. \tag{D.4}$$

From $L_P(R, m_B^{I*}, G_B^{I*}; p^h) = L_P(R_D/p, m_B^{I*}, G_B^{I*}; p^h)$ for all $R \in [R_D/p, R^c]$, we obtain G_B^{I*} coincides with the expression in (C.5) for $R \in [R_D/p, R^c]$. From $L_P(R, m_B^{I*}, G_B^{I*}; p^u) = L_P((1-2f+\eta)c_L, m_B^{I*}, G_B^{I*}; p^u)$ for all $R \in [R^c, (1-2f+\eta)c_L]$, we obtain G_B^{I*} coincides with (C.7) for $R \in [R^c, (1-2f+\eta)c_L]$.

Let $U^c := (1-f)c_L$ if $(1-f)c_H = (1-2f+\eta)c_L$; otherwise let $U^c := \min\{\mathcal{R_B}^{I*} \cap ((1-2f+\eta)c_L, (1-f)c_H]\}$ if $(1-f)c_H > (1-2f+\eta)c_L$. In the first case with $(1-f)c_H = (1-2f+\eta)c_L$, (D.4) implies $P(R_B = (1-f)c_H) = G_B^{I*}((1-2f+\eta)c_L) > 0$.

In the second case with $(1-f)c_H > (1-2f+\eta)c_L$, note that such a U^c exists because $\sup \mathcal{R}_B^{I*} = (1-f)_H > (1-2f+\eta)c_L$ and because of a reasoning analogous to that in Lemma D.7. By Lemmas D.5, D.12, and D.2, if $U^c < (1-f)c_H$, $[U,(1-f)c_H)$ is a set of best responses for banks and the optimistic platform. Because $l_P^0((1-2f+\eta)c_L, m_B^{I*}, G_B^{I*}; p^h) > \lim_{R\to(1-2f+\eta)c_L^+} l_P^1(R, m_B^{I*}, G_B^{I*}; p^h)$, a $\delta > 0$ exists such that $U^c \geq (1-2f+\eta)c_L + \delta$. The same result holds immediately if $U^c = (1-f)c_H$. Also note $l_P^1(U, m_B^{I*}, G_B^{I*}; p^h) > l_P^1(R, m_B^{I*}, G_B^{I*}; p^h)$ for all $R \in ((1-2+\eta)c_L, U^c)$. Hence, from $L_B(U^c, 1, G_P^{a*}; p) = 0$ and $U^c \geq (1-2f+\eta)c_L + \delta$, we obtain

$$(1-a^{I*})P(R_{P,u} = (1-2f+\eta)c_L) = \lim_{R\to(1-2f+\eta)c_L^-} G_P^{a*}(R) - G_P^{a*}(U^c) > 0. \tag{D.5}$$

Hence, $G_P^{a*}(U^c) < \lim_{R\to(1-2f+\eta)c_L^-} G_P^{a*}(R)$, thus implying $L_B((1-2f+\eta), 1, G_P^{a*}; p) < \lim_{R\to(1-2f+\eta)c_L^-} L_B(R, 1, G_P^{a*}; p) = 0$. This result implies $(1-2f+\eta)c_L \notin \mathcal{R}_B^{I*}$ and $G_B^{I*}((1-2f+\eta)c_L) = G_B^{I*}(U^c)$.

Let R^{Uc} be such that

$$m_B^{I*}p^h G_B^{I*}((1-2f+\eta)c_L)(R^{Uc}-\bar{R}) + (1-m_B^{I*})[p^h R^{Uc} + (1-p^h)(\eta-f)c_L - \bar{R}] + [2p^h c_H + (1-p^h)c_L]f \\ = l_P^0((1-2f+\eta)c_L, m_B^{I*}, G_B^{I*}; p^h),$$

from which we obtain

$$R^{Uc} := (1-2f+\eta)c_L + \frac{(1-m_B^{I*})(1-p^h)c_L}{p[m_B^{I*}G_B^{I*}((1-2f+\eta)c_L) + (1-m_B^{I*})]} > (1-2f+\eta)c_L.$$

We thus set $U^c := \min\{R^{Uc}, (1-f)c_H\}$.

If $R^{Uc} \in ((1-2f+\eta)c_L, (1-f)c_H)$, then $U^c = R^{Uc}$, and Lemma D.12 implies $[U,(1-f)c_H)$ is a set of best responses for banks and the optimistic platform. From $l_P^1(R, m_B^{I*}, G_B^{I*}; p^h) = l_P^1((1-2f+\eta)c_H, m_B^{I*}, G_B^{I*}; p)$ for $R \in [U,(1-f)c_H)$, we obtain the expression for G_B^{I*} in (C.8). Note that $\lim_{R\to(1-f)c_H^-} G_B^{I*}(R) > 0$, hence $(1-f)c_H \in \mathcal{R}_B^{I*}$. From $L_B(R, 1, G_P^{a*}; p) = 0$ and $G_{P,u}^{I*}(R) = 0$ for $R \in [U^c, (1-f)c_H]$ we obtain $G_{P,h}^{I*}$ as in (C.11) for $R \in [U^c, (1-f)c_H]$.

If $R^{Uc} \geq (1-f)c_H$, then $U^c = (1-f)c_H$. Banks offer rate $(1-f)c_H$ with probability $G_B^{I*}((1-2f+\eta)c_L) > 0$ and, from $L_B((1-f)c_H, 1, G_P^{a*}; p) = 0$, we obtain $P(R_{P,h} = (1-2f+\eta)c_H) = G_P^{a*}(U)$.

To characterize the distribution of the optimistic and informed platform when $T \geq (1-2f+\eta)c_L$, $L_B(R, 1, G_P^{a*}; p) = 0$ for all $R \in [R_D/p, (1-2f+\eta)c_L)$. If $R \in [R_D/p, R^c]$, $G_P^{I*}(R) = 1$ and we obtain the first case in (C.11) for $G_{P,h}^{I*}(R)$. If $R \in [R^c, (1-2f+\eta)c_L,$,

$G^{I*}_{P,h}(R) = G^{I*}_{P,h}(U^c)$ and we obtain (C.12) for $G^{I*}_{P,h}(R)$.

To pin down a^{I*} when $T \geq (1-2f+\eta)c_L$, note $G^{I*}_{P,u}(R^c) = 1$ and

$$G^{I*}_{P,h}(R^c) = G^{I*}_{P,h}(U^c) = \frac{1}{a^{I*}} \frac{(1-p)R_D/p}{U^c - R_D}.$$

Using $L_B(R^c, 1, G^{a*}_P; p) = 0$, we obtain

$$-(1-p)R_D + (1-a^{I*})p(R^c - R_D) + (1-p)R_D \frac{(1-p)R_D}{U^c - R_D},$$

which yields (C.9).

Finally, we compare m^{I*}_B with m^*_B from Proposition 2. Let

$$M_{B1}(x;c) := \frac{x(1-2f+\eta)c_H + (1-x)(\eta-2f)c_L - R_D/p}{x(1-2f+\eta)c_H + (1-x)(\eta-2f)c_L - R_D/p + xR_D/p - x\bar{R}}$$

and notice $m^{I*}_B = M_{B1}(p^h; c)$ and $m^*_B = M_{B1}(p; 0)$. Taking the derivative for $c = 0$, we have

$$\frac{dM_{B1}(x;0)}{dx} = \frac{(R_D/p - \bar{R})[(R_D/p - (\eta-2f)c_L)]}{\{x(1-2f+\eta)c_H + (1-x)(\eta-2f)c_L - R_D/p + xR_D/p - x\bar{R}^{\;2}} > 0$$

because $R_D/p > \bar{R}$ and $R_D/p \geq R_D > c_L \geq (\eta-2f)c_L)$. Hence, for a sufficiently small c, $m^{I*}_B = M_{B1}(p^h; c) > M_{B1}(p; 0) = m^*_B$. □

D.9 PROOF OF PROPOSITION C.3

By Lemmas C.1, C.4 and C.5, we have $m^{I*}_{P,h} = m^{a*}_P = 1$, $a^{I*} > 0$, and $m^{I*}_B \in (0,1)$. By D.11, we have $(1-2f+\eta)c_H \in \mathcal{R}^{I*}_{P,h}$. Finally note that, because $\bar{R} < (1+\eta)c_H$, $m^{I*}_{P,l} = 1$ and $\mathcal{R}^{I*}_{P,l} = \{(1-2f+\eta)c_L\}$. Thus, by C.1, $(1-2f+\eta)c_L \notin \mathcal{R}^{I*}_{P,h}$.

We proceed as in the proof of Proposition 3. Specifically, Let $V^c := \min \mathcal{R}^{I*}_B$. Note that such a V^c exists because $\sup \mathcal{R}^{I*}_B = (1-f)_H > (1-2f+\eta)c_L$ and because of a reasoning analogous to that in Lemma D.7. Note also that $V^c \geq R_D/p > (1-2f+\eta)c_L$. By Lemmas D.5 an D.12, if $V^c < (1-f)c_H$, $[V^c, (1-f)c_H)$ is a set of best responses for lenders. Because $l^0_P((1-2f+\eta)c_L, m^{I*}_B, G^{I*}_B; p^i) > \lim_{R \to (1-2f+\eta)c_L^+} l^1_P(R, m^*_B, G^*_B; p^i)$ for any $i \in \{u, h\}$, a $\delta > 0$ exists such that $V^c \geq (1-2f+\eta)c_L + \delta$. The same result holds immediately if $V^c = (1-f)c_H$.

Because $L_B(V^c, 1, G^{a*}_P; p) = 0$, we have $G^{a*}_P = \frac{(1-p)R_D/p}{V^c - R_D}$. We thus observe that $l^1_P(R, m^{I*}_B, G^{I*}_B; p^i) < l^1_P(V, m^{I*}_B, G^{I*}_B; p^i)$ for all $R \in ((1-2f+\eta)c_L, V)$ and all $i \in \{u, h\}$, and $l^0_P(R', m^{I*}_B, G^{I*}_B; p^i) < l^0_P((1-2f+\eta)c_L, m^{I*}_B, G^{I*}_B; p^i)$ for all $R < (1-2f+\eta)c_L$. After recalling $(1-2f+\eta)c_L \notin \mathcal{R}^{I*}_{P,h}$, we conclude

$$(1-a^{I*})P(R_{P,u}=(1-2f+\eta)c_L) = \frac{V^c - R_D/p}{V-R_D}. \tag{D.6}$$

In particular, if $V^c > R_D/p$, we must have $(1-a^{I*})P(R_{P,u}=(1-2f+\eta)c_L) > 0$ and hence, $(1-2f+\eta)c_L \in \mathcal{R}^{I*}_{P,u}$.

For a sufficiently small c, because $\max \mathcal{R}^{I*}_{P,h} = (1-2f+\eta)c_H$ and $(1-2f+\eta)c_L \notin \mathcal{R}^{I*}_{P,h}$, we must have $L_P((1-2f+\eta)c_H, m^{I*}_B, G^{I*}_B; p) \geq L_P((1-2f+\eta)c_L, m^{I*}_B, G^{I*}_B; p^h) + c/\psi$, which implies

$$m^{I*}_B \leq \frac{p^h(1-2f+\eta)(c_H-c_L) - (1-p^h)c_L - c/\psi}{p^h(1-2f+\eta)c_H - (1-p^h)c_L - p^h\bar{R}}.$$

If $V^c > R_D/p$ and hence, $(1-a^{I*})P(R_{P,u}=(1-2f+\eta)c_L) > 0$, this expression holds as an equality because it is equivalent to

$$\psi L^{I*}_P(m^{I*}_B, G^{I*}_B; p^h) + (1-\psi)L^{I*}_P(m^{I*}_B, G^{I*}_B; p^l) - c = L^{I*}_P(m^{I*}_B, G^{I*}_B; p^u).$$

Moreover, from $L_P((1-2f+\eta)c_H, m^{I*}_B, G^{I*}_B; p^h) \geq L_P(V^c, m^{I*}_B, G^{I*}_B; p^h)$, we obtain

$$m^{I*}_B \leq \tilde{m}_B(V^c) \coloneqq \frac{(1-2f+\eta)c_H - V^c}{(1-2f+\eta)c_H - \bar{R}}.$$

By Lemmas D.12 and D.1, if $V^c < (1-f)c_H$, $V^c \in \mathcal{R}^{I*}_{P,h}$ and this expression holds as an equality.

Let $R^{V,c}$ be defined so that

$$\tilde{m}_B(R^{Vc}) = \frac{p^h(1-2f+\eta)(c_H-c_L) - (1-p^h)c_L - c/\psi}{p^h(1-2f+\eta)c_H + (1-p^h)c_L + p^h\bar{R}},$$

which implies

$$R^{Vc} = (1-2f+\eta)c_L \frac{(1-2f+\eta)c_H - \bar{R} - \frac{1-p^h}{p^h}c_L \frac{\bar{R}}{(1-2f+\eta)c_L}}{(1-2f+\eta)c_H - \bar{R} - \frac{1-p^h}{p^h}c_L} > (1-2f+\eta)c_L.$$

The rate V^c is thus determined as $V^c \coloneqq \min\{(1-f)c_H, \max\{R_D/p, R^{Vc}\}\}$.

If $V^c = R_D/p$, then $\min \mathcal{R}^{I*}_{P,h} = \min \mathcal{R}^{I*}_B = R_D/p$ and the equilibrium is as described in Proposition C.1.

If $V^c \in (R_D/p, (1-f)c_H)$, by Lemmas A.7 and D.1, all rates in $[V, (1-f)c_H)$ are best responses for banks and the optimistic platform. Therefore, for any $R \in \mathcal{R}^{I*}_{P,h}$,

$$
\begin{aligned}
L_P(R, m_B^{I*}, G_B^{I*}; p^h) &= L_P((1-2f+\eta)c_H, m_B^{I*}, G_B^{I*}; p^h) \\
&= L_P((1-2f+\eta)c_L, m_B^{I*}, G_B^{I*}; p^h) + c/\psi,
\end{aligned}
$$

as previously discussed. From the last equality, we obtain m_B^{I*} is given by (C.13). From the first equality, we obtain G_B^{I*} is given by (A.16).

Furthermore, by Lemma D.3, for a sufficiently small c, $L_P(R, m_B^{I*}, G_B^{I*}; p^u) < L_P((1-2f+\eta)c_L, m_B^{I*}, G_B^{I*}; p^u)$. Hence, for all $\mathcal{R}^{I*}_{P,u} = \{(1-2f+\eta)c_L\}$. From D.6 with $P(R_{P,u} = (1-2f+\eta)c_L) = 1$, we obtain (C.15).

The rest of the proof for the case $V^C \in (R_D/p, (1-f)c_H)$ is identical to the proof of Proposition 3 with m_B^{I*} replacing m_B^*, G_B^{I*} replacing G_B^*, and $G_{P,h}^{I*}$ replacing G_P^*.

Finally, if $V^c = (1-f)c_H$, we have $\mathcal{R}^{I*}_{P,h} = (1-2f+\eta)c_L$, $\mathcal{R}^{I*}_{P,u} = (1-2f+\eta)c_H$, a^{I*} is still given by (C.15), and m_B^{I*} is given by (C.13). Banks lend at rate $(1-f)c_H$ with probability 1.

To conclude, we compare m_B^{I*} with m_B^* from Proposition 3. Let

$$
M_{B2}(x;c) := \frac{x(1-2f+\eta)(c_H - c_L) - (1-x)c_L - c/\psi}{x(1-2f+\eta)c_H - (1-x)c_L - x\bar{R}}
$$

and notice $m_B^{I*} = M_{B2}(p^h; c)$ and $m_B^* = M_{B2}(p; 0)$. Taking the derivative for $c = 0$, we have

$$
\frac{dM_{B2}(x;0)}{dx} = \frac{c_L[(1-2f+\eta)c_L - \bar{R}]}{\{x(1-2f+\eta)c_H - (1-x)c_L - x\bar{R}^{\ 2}} > 0
$$

because $\bar{R} < (1-2f+\eta)c_L$ when $R^{Vc} > R_D/p \geq (1-2f+\eta)c_L$. Hence, for a sufficiently small c, $m_B^{I*} = M_{B2}(p^h; c) > M_{B2}(p; 0) = m_B^*$. □

D.10 Proof of Proposition C.4

By Lemmas C.1, C.4 and C.5, we have $m_{P,h}^{I*} = 1$, $a^{I*} > 0$, $m_B^{I*} \in (0,1)$, and $\min\{\mathcal{R}^{I*}_{P,u} \cup \mathcal{R}^{I*}_{P,h}\} = R_D/p > (1-2f+\eta)c_L$. Notice $\arg\max_{R>(1-2f+\eta)c_L} L_P(R, m_B, G_B; p^i)$ does not depend on p^i. Therefore, $\mathcal{R}^*_{P,u} = \mathcal{R}^*_{P,h}$.

For a sufficiently small c, by Lemma C.5 we have

$$
\psi L_P^{I*}(m_B^{I*}, G_B^{I*}; p^h) + (1-\psi) L_P^{I*}(m_B^{I*}, G_B^{I*}; p^l) - c = m_B^{I*}[p2c_H + (1-p)c_L]f = L_P^{I*}(m_B^{I*}, G_B^{I*}; p^u).
$$

By Lemma D.3, we also have $L_P^{I*}(m_B^{I*}, G_B^{I*}; p^l) = m_B^{I*}[p2c_H + (1-p)c_L]f$. Using $R_D/p \in \mathcal{R}_{P,h}^*$,

$$\psi L_P(R_D/p, m_B^{I*}, G_B^{I*}; p^h) = \psi m_B^{I*}[p2c_H + (1-p)c_L]f + c,$$

from which we obtain (C.16). The previous equation also implies that, for a sufficiently small c, $L_P(R_D/p, m_B^{I*}, G_B^{I*}; p^u) < \psi m_B^{I*}[p2c_H + (1-p)c_L]f$ and, hence, $m_{P,u}^{I*} = 0$.

Using Lemma D.8 and D.5, we obtain $(1-2f+\eta)c_L < R_D/p = \min \mathcal{R}_B^{I*} \leq \sup \mathcal{R}_B^{I*} = (1-f)c_H$. By Lemma D.12 we have $G_{P,h}^{I*}(\cdot)$ and $G_B^{I*}(\cdot)$ are strictly decreasing in $[R_D/p, (1-f)c_H]$ because $(1-a^{I*})m_{P,u}^{I*} = 1$. Further note $m^{a*} = a^{I*}$ and $G_P^{a*}(\cdot) = G_{P,h}^{I*}(\cdot)$. Hence, the rest of the proof is identical to the proof of Proposition 4 with a^{I*} replacing m_P^*, $G_{P,h}^{I*}$ replacing G_P^*, and G_B^{I*} replacing G_B^{I*}. In particular, from $L_P(R, m_B^{I*}, G_B^{I*}; p^h) = m_B^{I*}[p2c_H + (1-p)c_L]f + \frac{c}{\psi}$ we obtain (C.17).

We then need to compare m_B^{I*} with m_B^* from Proposition 4. Let

$$M_C(x;c) := \frac{\bar{R} - xR_D/p - (1-x)(\eta - f)c_L - [2xc_H + (1-x)c_L]f + c/\psi}{(1-x)\bar{R} - (1-p^h)(\eta - f)c_L - [2xc_H + (1-x)c_L]f}$$

and notice $m_B^{I*} = M_C(p^h; c)$ and $m_B^* = M_C(p; 0)$. Taking the derivative for $c = 0$, we have

$$\frac{dM_C(x;0)}{dx} = \frac{[\bar{R} - \eta c_L](\bar{R} - R_D/p)}{\left\{(1-x)\bar{R} - (1-p^h)(\eta - f)c_L - [2xc_H + (1-x)c_L]f\right.^{2}} < 0$$

because $\bar{R} \geq R_D/p > \eta c_L$ and $\bar{R} < R_D/p$. Hence, for a sufficiently small c, $m_B^{I*} = M_C(p^h; c) < M_C(p; 0) = m_B^*$. □