Lending and monitoring: Big Tech vs Banks.*

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Abstract

We show that by lending to merchants and monitoring them, an e-commerce platform can price-discriminate between merchants with high and low financial constraints: the platform offers credit priced below market rates and designed to select merchants with lower capital or collateral while simultaneously increasing the platform's access fees. The credit market then becomes endogenously segmented with banks focusing on less financially constrained borrowers. Lending by the platform expands with its monitoring efficiency but can arise even when the platform is less efficient than banks at monitoring. Platform credit benefits more financially constrained merchants as well as buyers, but can hurt less financially constrained merchants if cross-side network effects with buyers are too small. The platform's propensity to offer credit and the financial inclusion of more constrained merchants depends on the platform's market power in its core business.

Keywords: Big Tech, banks, two-sided markets, financial constraints, financial inclusion, market power.

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1 Introduction

The expansion of big tech platforms into credit has been a major shift in an activity traditionally dominated by banks. Croxson, Frost, Gambacorta, and Valletti (2022) report that from 2018 onwards credit issuance from big tech platforms has also overcome other types of fintech lenders. Evidence suggests that credit provided by commercial platforms is particularly crucial for smaller and more financially constrained firms (Hau, Huang, Shan, and Sheng (2019)). At the same time, a growing concern is that the entry of big techs into credit may contribute to an already dominant competitive position, creating digital monopolies across markets (Croxson, Frost, Gambacorta, and Valletti (2022)). Questions abound: What is the relationship between Big Tech's traditional platform business and their more recent foray into credit? Does big tech credit substitute for bank credit, or do big techs target different customers, possibly neglected by traditional banks? Is big tech credit beneficial or detrimental to social welfare? The objective of this paper is to shed light on some determinants of big techs' credit activity, and to assess the welfare consequences of big techs' credit provision supply.

One explanation for the spectacular growth of big tech's credit is that large platforms are more efficient at providing credit. In particular, platforms may have an advantage over banks when screening borrowers ex ante based on a wider access to data (Berg, Burg, Gombović, and Puri (2020)). Platforms may also have an advantage ex post in monitoring borrowers and enforcing repayments either by directly seizing cash-flows or through the threat of exclusion from the platform (Liu, Lu, and Xiong (2022)). However, beyond efficiency, e-commerce platforms may also have different *incentives* to provide credit than the banking system. Where a bank evaluates the profitability of granting a loan solely based on the cash-flows this loan will generate, a platform may internalize that access to credit allows merchants to develop, and generate traffic or trading on the platform. This additional benefit can be amplified by the network effects inherent to multi-sided businesses. In this paper, we study how the nature of platforms' commercial activities and their competitive positions affect their decisions to enter the credit market, and conversely how providing credit affects the management of platforms' commercial activities.

To study the interaction between commercial and credit activities, we develop a model in which a platform sets access prices to attract buyers and sellers (merchants) to trade on the platform. Selling on the platform requires an initial outlay from merchants corresponding to a development cost or a working capital need (e.g., inventory). To fund this initial outlay merchants can borrow from a competitive banking system or from the platform itself if it enters the credit market. Each merchants' output is subject to moral hazard which, in the spirit of Holmström and Tirole (1997), can be mitigated through costly monitoring by the lender. As a result, merchants' ability to raise funds depends on their initial capital or more generally on the collateral they can pledge, as well as on the efficiency of the monitoring technology. Both the platform and banks have access to a monitoring technology but we allow the platform's monitoring efficiency to be higher or lower than the banks'. In this setting, we study the platform *joint* decision to set access fees for buyers and merchants and to offer credit to merchants.

A benchmark case is when only banks can provide credit. In that case, we obtain the standard result of Holmström and Tirole (1997) that less financially constrained merchants (those with sufficiently large initial capital) raise credit that does not require lender monitoring. Intuitively, their stake alone is high enough to preserve their incentives. For merchants with lower capital, monitoring by the lender mitigates moral hazard and allows access to credit despite a lower stake in the project. However, because monitoring by the lender is costly and the cost is passed on to merchants, more financially constrained merchants face less favorable credit terms. Finally, merchants with capital below a certain threshold are denied credit and do not access the platform. The platform's pricing decision then results from the following trade-off. If the platform sets a high access price, it increases its revenue per merchant, but it raises the minimum capital required for merchants to obtain credit. If the platform sets a lower price, it increases the number of merchants who can obtain financing, and thus the number of transactions on the platform, but decreases the revenue per merchant.

This interaction between the platform's access fee and merchants' financial constraints is key to understand the platform's motives in the credit market. To become active in the credit market, the platform needs to offer at least one type of credit contract priced below the banks' competitive contracts. While this could expand the range of merchants that join the platform, if *all* merchants take that contract, then credit and access fees are perfect substitute for the platform: providing credit at more favorable conditions is equivalent to lowering merchants' access fee. It follows that the platform's entry in the credit market is related to its ability to direct credit at a subset of merchants. We show that when offering credit, the platform optimally targets marginal merchants that are denied credit by traditional banks while charging a higher access fee than if only banks could provide funding. In doing so, the platform indirectly engages in price discrimination: all merchants pay the higher access fee but only the more constrained merchants benefit from below-market-rate credit. Through this implicit subsidy and monitoring by the platform, platform credit preserves these more constrained merchants' incentives despite the higher access fee. Platform credit is cheaper for these merchants than what they could obtain from banks, but more expensive than what less constrained merchants that do not require monitoring obtain from banks. This is the product of an incentive compatibility constraint which ensures that *only* the more constrained merchants take the platform's contract. Indeed, capital (collateral) is verifiable but not observable. That is, a borrower cannot lie about having more capital than she actually has, but can lie about having less. As a result, if the contract offered by the platform became too attractive, it would also be taken by merchants that can borrow from banks without monitoring, in which case the platform would lose the ability to price-discriminate through credit. Note that there is room for bank credit to remain cheaper and therefore for this incentive compatibility constraint to hold because banks focus on credit that does not require monitoring and is therefore fundamentally less costly than platform credit.

Through the platform's incentive to price-discriminate, the model endogenously generates segmentation where the platform focuses on the more financially constrained merchants. Consistent with the idea that that Big Tech lending relaxes the financial constraints of underserved borrowers, lending by the platform operates at an extensive margin: the mass of merchants that access credit is higher than in the benchmark where only banks can provide credit. However, platform credit is not a pure complement to bank credit: because the platform improves the terms for credit that requires monitoring, it captures part of the market banks hold when the platform is not lending. The amount of credit the platform provides expands with the efficiency of its monitoring technology, but the price-discrimination benefit implies that the platform may enter the credit market even in cases where its monitoring technology is inferior to that of the banking sector. This contrasts with the more common explanation that platform's entry into the credit market is driven by an inherent technological advantage over banks at screening or monitoring. Even in cases where the platform is more efficient than banks at monitoring, the price-discrimination motive remains which implies that the platform monitoring costs and the platform access fees are tied: access fees go up as the platform becomes more efficient at monitoring and gains market share in the credit market.

We then investigate the welfare implications of the platform's credit provision. Because the platform broadens the merchant base by targeting rationed merchants, buyers benefit from more interactions with the merchants' side and are therefore better off with platform credit.

Financially constrained merchants are also better off for two reasons. First, some merchants receive credit from the platform who could not access funding if only banks were present in the credit market. Second, merchants who borrow from the platform obtain better conditions not only than what they can get from banks when the platform lends, but also than what they could get if only banks were present in the credit market. This credit "subsidy" overcomes the increase in access price. Finally, for merchants with high capital, there are two opposing effects. On the one hand, they face higher access fees consistent with the platform's price discrimination motive. On the other hand, platform credit leads to higher merchants' participation, which in turn can lead to higher buyers' participation. We show that these cross-side network effects can be (but are not necessarily) strong enough that sellers with high capital also benefit from the platform entering the credit market. Note finally that price-discrimination through credit entails a deadweight loss: because the platform raises access fees, some merchants that could have borrowed without monitoring from banks have to turn to the platform once it enters the market. That is, platform's credit with monitoring substitutes for bank's credit without monitoring and the platform's monitoring cost is a social loss. An additional social loss materializes when the platform is less efficient at monitoring than banks but enters the credit market nevertheless. We show that in cases where cross-side network effects are small, this can lead to a decrease in total welfare.

In the last part of the paper, we relate the platform's incentive to enter the credit market to the market power it holds as a gateway between merchants and buyers. We show that an increase in the platform's market power leads to an expansion of its lending activity. Intuitively, the benefits of price discrimination are higher when the competitive pressure on the platform's fees is lower. This, however, does not imply that lower platform market power necessarily leads to fewer merchants receiving credit. In fact, as long as the platform remains active in the credit market, the opposite happens. Because of competitive pressure, the platform lowers its fees which allows more merchants to obtain credit from banks. This increase in bank credit overcomes the decline in platform credit. On the other hand, if competitive pressure intensifies and the platform is not very efficient at monitoring, the platform may leave the credit market altogether. This causes a discontinuity where the amount of merchants that receive funding abruptly drops. Overall, the analysis suggests that the issue of the financial inclusion of small constrained firms is tied not only to the structure of the credit market but also to the pricing power of large e-commerce platforms.

This paper lies at the intersection of a literature in industrial organization on two-sided markets and a literature in corporate finance on moral hazard and financial constraints. On the platform side, our model leverages the tractability of Rochet and Tirole (2003) but introduces fixed costs on each side that generate cross-side network effects similar to Armstrong (2006). On the corporate finance side, our model uses Holmström and Tirole (1997) as a building block to generate both financial constraints through a moral hazard problem and to capture monitoring as a way to mitigate this problem. Our paper is also related to a literature on trade credit or more generally vendor credit that investigates the motives for commercial firms to extend credit to their clients. Within that stream, the closest paper to ours is Brennan, Maksimovics, and Zechner (1988) which theoretically shows that vendor's credit can be motivated by price discrimination when clients are credit constrained.[1] There are two main differences with our approach. First, in Brennan, Maksimovics, and Zechner (1988), financing frictions are created by ex-ante adverse selection instead of ex-post moral hazard in our setup. Adverse selection implies that the pool of borrowers funded by the vendor is less risky than the pool that receives funding if only banks are active. By contrast, moral hazard in our setup predicts that at the extensive margin, the platform extends credit to observationally more risky borrowers (i.e., with lower collateral) consistent with empirical evidence on platform credit. Moral hazard also highlight the key function of platform monitoring. Second, the two-sided nature of the platform in our setup implies feedback effects between the side that receives credit (merchant) and the other side (buyers). This two-way interaction affects both the platform's incentive to provide funding and the welfare implications for both sides. Other theories of trade credit rely on the supplier having superior information about its clients (Biais and Gollier (1997)) or on clients having lower incentives to divert the inputs they directly receive from supplier than the cash they borrow to buy these inputs (Burkart and Ellingsen (2004)).

Our paper is also related to a growing literature on Fin Tech and more specifically on the rise of credit provided by e-commerce platforms. Liu, Lu, and Xiong (2022) provides an overview of the big tech's business model in the credit market which is consistent with ex-post monitoring and the ability to enforce debt contract terms being a key determinant of platform credit. Hau, Huang, Shan, and Sheng (2019) and Frost, Gambacorta, Huang, Shin, and Zbinden (2019) provide evidence that big tech credit flows to more financially constrained merchants. On the

[1] See Petersen and Rajan (1997) for the literature on trade credit including a review of empirical evidence consistent with a price discrimination motive.

theory side Huang (2021) and Li and Pegoraro (2022) explore the idea that platforms have a more direct access to merchants' cash-flows than banks as these cash-flows are generated through the platform. In Li and Pegoraro (2022), this ability to capture merchants' revenues gives the platform an edge for borrowers that are perceived as more likely to try and abscond with their profits and therefore are less likely to have access to bank credit. Our key difference with these papers is that we jointly model the platform's decision to provide credit and to set access fees. Credit market segmentation with the platform serving more financially constrained merchants is then driven by this global pricing strategy and does not require the platform to have superior monitoring abilities. Endogenizing platform pricing allows us to evaluate cross-side network effects and their welfare implications, as well as the relationship between the platform's incentive to enter the credit market and its overall market power. On the other hand, we abstract from ex-ante asymmetric information in the credit market and from information acquisition by the platform analyzed in Huang (2021) and in Li and Pegoraro (2022). Gambacorta, Khalil, and Parigi (2022) also study Big Tech's informational advantage over banks in the credit market but show that when this advantage is large, it may trigger privacy concerns from potential borrowers. Finally, Gambacorta, Madio, and Parigi (2023) develop a model where a platform uses credit to price-discriminate between incumbents and more risky innovative entrants. The key difference with our approach is that their model does not incorporate financial frictions and therefore speaks to the platform's incentives to favor entry by innovators rather than the financial inclusion of constrained borrowers.[2]

The remainder of the paper is organized as follows: Section 2 presents the model. The case with bank financing only is analyzed in Section 3 while the case with platform financing is analyzed in Section 4. Section 5 develops an extension in which buyers' demand depends on the number of merchants present on the platform, which generates cross-side network effects. Section 6 discusses the relationship between the platform's activity in the credit market and its market power as a gateway between merchants and consumers.

[2] See also Vives and Ye (2022) and He, Huang, and Zhou (2023), for broader models of competition between banks and Fin Tech firms.

2 Model

Our model of a two-sided market borrows from Rochet and Tirole (2003). Consider a platform serving two groups of agents, buyers and merchants. There is a continuum of buyers indexed by $i \in (0,1)$ who derive value V_i^b from transacting with each merchant. V_i^b is distributed according to the cumulative distribution function $F^b(.)$ over $[0, \overline{V^b}]$. There is a continuum of merchants indexed by $j \in (0,1)$ who, for simplicity, generate the same profit V^m from each transaction with a buyer. When providing a transaction service, the platform charges a per-transaction price (or fee, both terms are used interchangeably hereafter) P^b to buyers and P^m to merchants, and incurs a per-transaction cost $c > 0$. Denote N^b the number of buyers on the platform.

To transact on the platform, a merchant needs to invest in a risky project, which outcome can be "success" or "failure". If the project fails, the merchant cannot participate to the platform. The project's initial outlay is $I > 0$. Merchant j has wealth A_j distributed according to the cumulative distribution function $F^m(.)$ over $(0, A^{max})$. Assume that both distribution functions have a monotone hazard rate: $\frac{1-F^b(.)}{f^b(.)}$ and $\frac{1-F^m(.)}{f^m(.)}$ are both decreasing. We assume that A_j is not observable, that is, a merchant can always claim to have less funds than what he actually possesses. In our model, A can equivalently be interpreted as collateral that the merchant can pledge and that can be costlessly transferred to a lender upon default.

The investment project is subject to moral hazard. Following Holmström and Tirole (1997), we assume that each merchant can pick one of three types of projects. Project choice is not observable. The good project succeeds with probability $p_h > 0$ and yields no private benefit to the merchant. One bad project succeeds with probability $p_l \equiv p_h - \Delta_p$ with $\Delta_p > 0$ and yields a small private benefit $b > 0$ to the merchant. Another bad project also succeeds with probability p_l, and yields a large private benefit $B > b$ to the merchant. The three projects are summarized in the table below:

Project	1	2	3
Private Benefit	0	b	B
Prob. of Success	p_h	p_l	p_l

To satisfy his investment need, a merchant can borrow money from investors, which can be banks, or the platform itself. Both the bank and the platform can monitor the merchant to prevent him from choosing the large private benefit project. The monitoring cost is, respectively,

$\gamma_p \geq 0$ for the platform, and $\gamma_b \geq 0$ for the bank.

The project's value depends on the number of buyers on the platform N^b, as well as on the price per transaction P^m charged by the platform. The following assumptions ensure that only the good project can be profitable.

Assumption 1. $p_h V^m - \gamma_b > I$.

Assumption 1 implies that it can be profitable for a merchant to obtain financing with monitoring. It states that choosing the good project generates a strictly positive NPV when the bank monitors the merchant, when the number of buyers is maximal ($N^b = 1$) and the price paid per transaction is null ($P^m = 0$),

Assumption 2. $p_l(V^m + \overline{V}^b) + B < I$.

Assumption 2 states that the bad project yields a negative profit, for any platform fee P^m and number of buyers N^b.

The timing of the model is as follows. At date 1, the platform sets fees P^m and P^b. At date 2, investors make financial offers to merchants, specifying an amount of money lent $(I - A)$, a repayment R, and whether monitoring takes place. At date 3, the investor, i.e. the bank or the platform, exerts monitoring or not, depending on the contract accepted. At date 4, each merchant chooses the project type. Finally, transactions occur on the platform for successful projects.

3 Equilibrium with bank financing only

Let us first determine the equilibrium outcome on the platform when only banks provide financing to merchants. Denote N^m the number of merchants who invest in the project.

3.1 Buyers

If the platform charges a price P^b per buyer transaction, buyer i's utility from transacting on the platform is $p_h N^m (V_i^b - P^b)$. Therefore, buyer i transacts on the platform if and only if $V_i^b > P^b$, which pins down the number of buyers present on the platform

$$N^b(P^b) = 1 - F^b(P^b). \tag{1}$$

Equation (1) implies that the number of buyers only depends on the price P^b charged for each buyer transaction. This is because buyers attribute the same value to each transaction with a merchant, irrespective of the number of transactions they perform: In that sense, there is no network effect on the buyer's side. This is not the case on the merchant side as the number of buyers determines the value of the investment project.

3.2 Merchants

The project's payoff upon success is $N^b(V^m - P^m)$, net of the platform transaction fee. Suppose first that the bank offers a contract without monitoring. The merchant chooses the good project if and only if

$$\begin{aligned} & p_h(N^b(V^m - P^m) - R) \geq p_l(N^b(V^m - P^m) - R) + B \\ \Leftrightarrow \quad & R \leq N^b(V^m - P^m) - \tfrac{B}{\Delta_p}. \end{aligned} \tag{2}$$

The right hand side of Condition (2) represents the pledgeable income, i.e. the maximum payoff that the bank can obtain while ensuring that the merchant chooses the good project. Assume next that the bank sector is competitive. The bank's participation constraint is $p_h R = I - A$, which, together with (2) implies that the merchant can only raise funds without monitoring if

$$A \geq I - p_h \left(N^b(V^m - P^m) - \frac{B}{\Delta_p} \right) \equiv \overline{A}(P^m, P^b). \tag{3}$$

Note that the minimum level of wealth required, $\overline{A}(P^m, P^b)$, depends on the number of buyers on the platform. From Equation (1), this number depends on the transaction fee P^b set by the platform. We therefore directly write that $\overline{A}$ depends on P^b. To make the financing problem non trivial, we further assume that merchants cannot obtain financing without investing some of their wealth, which is ensured by the following assumption.

Assumption 3. $p_h \left(V^m - \frac{B}{\Delta_p} \right) < I.$

Following Holmström and Tirole (1997), Assumption 3 implies that $\overline{A}(P^m, P^b) > 0$, whatever the number of buyers and platform fees.

Because the banking sector is competitive, the merchant's expected payoff is equal to the project's NPV, net of transaction fees, that is, if the bank does not monitor,

$$p_h N^b(V^m - P^m) - I. \tag{4}$$

Suppose next that the bank offers a contract with monitoring. Following the same reasoning as before, the pledgeable income is then equal to $N^b(V^m - P^m) - \frac{b}{\Delta_p}$. The bank's participation constraint is now

$$p_h R - \gamma_b \geq I - A. \tag{5}$$

Therefore, the merchant can only raise funds with monitoring if

$$A \geq I + \gamma_b - p_h \left(N^b(V^m - P^m) - \frac{b}{\Delta_p} \right) \equiv \underline{A}(P^m, P^b). \tag{6}$$

The merchant's expected payoff with monitoring is then

$$p_h N^b (V^m - P^m) - I - \gamma_b. \tag{7}$$

Comparing (7) and (4), it follows that only merchants with initial wealth strictly lower than $\overline{A}(P^m, P^b)$ accept a contract with monitoring. Next, the following assumption ensures that $\overline{A}(P^m, P^b) > \underline{A}(P^m, P^b)$, that is, monitoring expands the range of firms that can be funded.

Assumption 4. *$\gamma_b < \frac{p_h}{\Delta_p}(B - b)$.*

Assumption 4 states that the cost of monitoring is lower than the increase in the pledgeable income so that merchants who are not wealthy enough to obtain financing without monitoring opt for financing with monitoring when $A \geq \underline{A}(P^m, P^b)$. To summarize, when only banks provide financing, we obtain the standard result of Holmström and Tirole (1997):

- Merchants with $A \geq \overline{A}(P^m, P^b)$ get funding from the bank without monitoring;
- Merchants with $\underline{A}(P^m, P^b) \leq A < \overline{A}(P^m, P^b)$ get funding from the bank with monitoring;
- Merchants with $A < \underline{A}(P^m, P^b)$ do not get funding.

It follows that the number of merchants on the platform is

$$N^m(P^m, P^b) = 1 - F^m(\underline{A}(P^m, P^b)). \tag{8}$$

In principle, there exist many different contracts that grant merchants the project's NPV. To fix idea, we assume that the bank offers only two contracts. The first one includes monitoring, and requires an investment $\underline{A} = \underline{A}(P^b, P^m)$ from the merchant, and sets a repayment $\overline{R} = \frac{1}{p_h}(I + \gamma_b - \underline{A})$. The second one does not include monitoring, and requires an investment $\overline{A} = \overline{A}(P^b, P^m)$ and sets a repayment $\underline{R} = \frac{1}{p_h}(I - \overline{A})$.

3.3 Platform's optimal pricing strategy

We now derive the optimal transaction fees (P^b, P^m) charged by the platform, in the case in which financing is only provided by banks.

Denote π the platform's profit. The platform solves the following program:

$$\max_{P^b,P^m} \pi = p_h N^m(P^m, P^b)N^b(P^b)(P^m + P^b - c), \tag{9}$$

where $N^b(P^b)$ and $N^m(P^m, P^b)$ are defined in Equations (1) and (8) respectively. The first order condition with respect to P^m yields

$$\big(1 - F^m(\underline{A}(P^m, P^b))\big) - f^m(\underline{A}(P^m, P^b))p_h(1 - F^b(P^b))(P^m + P^b - c) = 0. \tag{10}$$

The first term represents the increase in profit when the platform charges a high price P^m to all merchants who access the platform. The second term represents the decrease in profit when the platform charges a higher price P^m and worsens financial frictions. As P^m increases, the minimal level of wealth necessary to obtain financing $\underline{A}(P^m, P^b)$ increases. Some merchants become credit rationed and cannot offer services through the platform, which reduces the latter's profit. Equation (10) reflects this tension and illustrates how the platform's pricing strategy interacts with financial frictions. If there was no moral hazard, the second term would not be there, and the platform would set P^m at its maximal value (i.e. $V^m - \frac{I}{p_h N^b}$).

The first order condition with respect to P^b yields

$$\begin{aligned}&(1 - F^b(P^b))(1 - F^m(\underline{A}(P^m, P^b))) - f^b(P^b)(1 - F^m(\underline{A}(P^m, P^b)))(P^m + P^b - c)\\ &-p_h f^m(\underline{A}(P^m, P^b))f^b(P^b)(V^m - P^m)(1 - F^b(P^b))(P^m + P^b - c) = 0\end{aligned} \tag{11}$$

The first term represents the increase in profit when charging a higher price to all buyers. The second term represents the decrease in profit from losing some buyers whose valuation falls below the transaction fee P^b. The third term represents the decrease in profit due to financial frictions: when the platform charges a higher buyer fee, it decreases the number of buyers present on the platform, which reduces the pledgeable income so that some merchants become credit rationed.

Rearranging (11) and (10) leads to the following proposition.

Proposition 1. *The optimal fee charged to buyers P^{b*} is defined by*

$$\frac{1 - F^b(P^{b*})}{f^b(P^{b*})} = V^m + P^{b*} - c. \tag{12}$$

The optimal fee charged to merchants P^{m*} is defined by

$$P^{m*} = \frac{1 - F^m(\underline{A}(P^{m*}, P^{b*}))}{p_h N^{b*} f^m(\underline{A}(P^{m*}, P^{b*}))} - P^{b*} + c, \tag{13}$$

where $N^{b*} \equiv 1 - F^b(P^{b*})$.

Equation (12) implicitly defines the optimal transaction fee for buyers, P^{b*}. Note that P^{b*} does not depend on the number of merchants. This is because the buyers' transaction value does not depend on the number of transactions they perform. In other words, the platform cannot induce more transactions from each buyer by modifying P^b. Thus, P^b only depends on the distribution of buyers' valuation per transaction. Next, using (12), Equation (13) implicitly defines the optimal transaction fee for merchants, P^{m*}.

From Equations (13) and (9), we can express the platform's profit under bank financing π^* as:

$$\pi^* = [1 - F^m(\underline{A}(P^{m*}, P^{b*}))] \frac{1 - F^m(\underline{A}(P^{m*}, P^{b*}))}{f^m(\underline{A}(P^{m*}, P^{b*}))}. \tag{14}$$

Through the financing constraint, the platform faces the familiar monopoly problem. On the one hand, increasing the price P^m raises the margin on merchants but tightens the financing constraints, hence merchants' demand. This can give an incentive to the platform to enter the credit market and offer financing to merchants, in order to increase its merchant base. We explore in the next section whether it is optimal for the platform to offer financing and compete with regular banks.

4 Equilibrium with bank and platform financing

Now consider the case in which the platform can also provide financing to merchants. Note that the competitive banking sector is still offering the contracts described in the previous subsection: $(\overline{R}, \underline{A}(P^m, P^b))$ with monitoring, and $(\underline{R}, \overline{A}(P^m, P^b))$ without monitoring. Since the bank observes platform fees before offering financing contracts, it can adjust its offers accordingly. Without loss of generality, the platform's offer is a contract $\mathcal{C}_p = (\mathcal{R}, \mathcal{A})$ where $\mathcal{R}$ is a repayment to the platform in case of success and $\mathcal{A}$ is the merchant's investment. The platform now optimizes jointly on the fees charged to buyers and merchants to access the platform, P^m and P^b, and on the contract $\mathcal{C}_p$. Assume as a tie-breaking rule that if a merchant is indifferent between bank financing and platform financing, he chooses the latter.

This assumption is immaterial for the results but simplifies the exposition. A first step is to simplify this optimization problem by narrowing down the space of contracts that can be optimal for the platform.

4.1 The platform's optimization problem

We first show in the next lemma that the platform does not have an incentive to offer financing without monitoring.

Lemma 1. *The platform does not gain at offering financing without monitoring.*

Proof. See Appendix. □

There are several cases to consider. Clearly, the platform cannot gain at offering a contract such that $\mathcal{A} \geq \overline{A}$. To be accepted by merchants, any such contract needs to grant merchants more than the corresponding project's NPV, i.e., it needs to subsidize merchants. So the platform makes losses on this contract, without increasing the number of merchants financed, and the platform's profit π decreases. The proof of Lemma 1 next shows that the platform never gains at offering a contract without monitoring such that $\mathcal{A} < \overline{A}$. Indeed, if $\underline{A} \leq \mathcal{A} < \overline{A}$, the platform makes losses on its financial contract without expanding the merchant base, and is better off not offering this contract. Last, if $\mathcal{A} < \underline{A}$, so that the platform aims at increasing the number of merchants, the contract is accepted by all merchants with an initial wealth larger than $\mathcal{A}$. Since the platform then subsidizes all merchants, it is equivalent to lowering the merchant's fee P^{m*}: offering financing does not increase the platform's profit.

Suppose now the platform offers a contract with monitoring to merchants whose wealth is at least equal to $\mathcal{A}$. A first observation we formalize in the next Lemma is that if offered, this contract is available for all merchants who can borrow from banks.

Lemma 2. *If in equilibrium some merchants are financed by the platform, then the amount lent by the platform, $I - \mathcal{A}$, satisfies $\mathcal{A} < \underline{A}(P^m, P^b)$.*

To understand Lemma 2, consider the financial contract offered by the platform $\mathcal{C}_p = \{\mathcal{R}, \mathcal{A}\}$. For a given $\mathcal{A}$ (and given P^m and P^b), the contract that maximizes the platform's financial income sets

$$\mathcal{R} = (1 - F(P^b))(V^m - P^m) - \frac{b}{\Delta_p},$$

and pays off the agency rent $p_h \frac{b}{\Delta_p}$ to the agent. In that case the platform's per-merchant financial payoff (i.e., gross of the monitoring cost γ_p) is

$$\varphi(\mathcal{A}, P^m, P^b) \equiv p_h \mathcal{R} - (I - \mathcal{A}) = p_h(1 - F^b(P^b))(V^m - P^m) - p_h \frac{b}{\Delta_p} - (I - \mathcal{A}). \qquad (15)$$

Note that this reduces the platform's contracting problem to the choice of a threshold $\mathcal{A}$. Consider now a merchant who accepts the platform's contract. His expected payoff is

$$p_h \frac{b}{\Delta_p} - \mathcal{A},$$

while his payoff with a bank's contract with monitoring is

$$p_h(1 - F(P^b))(V^m - P^m) - I - \gamma_b = p_h \frac{b}{\Delta_p} - \underline{A}(P^m, P^b),$$

where the equality comes from Equation (6). Comparing both payoffs, it is immediate that the merchant prefers the platform's contract with monitoring iff $\mathcal{A} < \underline{A}(P^m, P^b)$. So if the platform wants to provide financing, it has to attract merchants rationed by banks.

On the other hand, the platform never finds it optimal to attract *all* merchants when offering a contract with monitoring.

Lemma 3. *If the platform offers a contract with monitoring, this contract is such that merchants with wealth higher than $\overline{A}(P^m, P^b)$ prefer to be financed by banks.*

To understand the logic of Lemma 3, remember that firms with $A \geq \overline{A}(P^m, P^b)$ can borrow from banks and secure an expected payoff equal to

$$p_h(1 - F(P^b))(V^m - P^m) - I.$$

It follows that if $\varphi(\mathcal{A}, P^m, P^b) < 0$, the platform's contract dominates banks' contracts for firms with $A \geq \overline{A}(P^m, P^b)$. As a result, all merchants accept the platform contract. To see why this is suboptimal for the platform, suppose the platform starts lowering P^m keeping $\mathcal{A}$ constant. As long as $\varphi(\mathcal{A}, P^m, P^b) < 0$, this has no effect on the platform profit because what the platform loses by charging a lower price is exactly offset by a decrease in the financing subsidy necessary to preserve incentives for merchants above $\mathcal{A}$ to work. However, at the point where $\varphi(\mathcal{A}, P^m, P^b)$ turns positive, the platform makes a strict gain: total revenue (fees net of funding costs) from merchants who borrow with monitoring is still unchanged, but the platform economizes the monitoring cost γ^p on all the merchants who accepted the contract with monitoring at a higher P^m, and now turn to banks.

Using Lemmas 1, 2 and 3 we can now write the platform's optimization problem when it can offer financing: the platform needs to optimize on fees P^m and P^b, as well as on a funding threshold $\mathcal{A}$, subject to the constraints ensuring that only merchants that need to be monitored accept the platform's contract, and subject to the constraint that the platform's profit is larger than with bank financing only.

The platform picks fees P^m, P^b and $\mathcal{A}$ to solve

$$\begin{aligned}\max_{P^m,P^b,\mathcal{A}} \pi(P^m,P^b,\mathcal{A}) &= [1-F^b(P^b)](1-F^m(\mathcal{A}))p_h(P^m+P^b-c) \\ &\quad +[F^m(\overline{A}(P^m,P^b))) - F^m(\mathcal{A})](\varphi(\mathcal{A},P^m,P^b)-\gamma_p), \end{aligned} \tag{16}$$

$$\text{s.t.} \qquad \varphi(\mathcal{A},P^m,P^b) \geq 0 \tag{17}$$

$$\varphi(\mathcal{A},P^m,P^b) \leq \gamma_b \tag{18}$$

$$\pi(P^m,P^b,\mathcal{A}) \geq \pi^* \tag{19}$$

Condition (17) ensures that merchants who can obtain bank financing without monitoring (i.e. with wealth $A \geq \overline{A}(P^m,P^b)$) prefer to accept the bank's offer rather than the platform's contract with monitoring. Condition (18) ensures that merchants who need to be monitored (i.e. with wealth $A < \overline{A}(P^m,P^b)$) prefer to borrow from the platform. Last, Condition (19) ensures that the platform's profit increases compared to the case in which only banks provide financing.

Denote by λ_φ, $\lambda_\mathcal{A}$ and λ_π the multipliers associated to the constraints (17), (18), and (19) respectively. The first order conditions of the above defined Lagrangian with respect to P^m, P^b and $\mathcal{A}$ are

$$1-F^m(\overline{A}(P^m,P^b)) + f^m(\overline{A}(P^m,P^b))(\varphi(\mathcal{A},P^m,P^b)-\gamma_p) = \frac{\lambda_\varphi-\lambda_\mathcal{A}}{1+\lambda_\pi} \tag{20}$$

$$f^m(\mathcal{A})\left[p_h(1-F^b(P^b))(P^m+P^b-c)+\varphi(\mathcal{A},P^m,P^b)-\gamma_p\right]+F^m(\mathcal{A})-F^m(\overline{A}(P^m,P^b)) = \frac{\lambda_\varphi-\lambda_\mathcal{A}}{1+\lambda_\pi} \tag{21}$$

$$\frac{1-F^b(P^b)}{f^b(P^b)} = P^b+V^m-c \tag{22}$$

Corollary 1. *The optimal price set for buyers is the same with platform financing as with bank financing only.*

The proof of Corollary 1 is straightforward when comparing Equations (12) and (22). Intuitively, this result illustrates the fact that the price charged to buyers does not affect the number of transactions each buyer undertakes.

The optimal price set for merchants, as well as the platform financial contract, depend on which constraints are binding. If (19) is binding, there is no platform financing, and the optimal pricing strategy is defined as in Proposition 1. In the following, we assume that (19) is not binding, and consider three cases.

Consider first that constraints (17) and (18) are both not binding, i.e. $\lambda_\varphi = 0$, $\lambda_\mathcal{A} = 0$.

The first order condition for P^m, (20), then writes

$$1 - F^m(\overline{A}(P^m, P^b)) + f^m(\overline{A}(P^m, P^b))(\varphi(\mathcal{A}, P^m, P^b) - \gamma_p) = 0.$$

The trade-off faced by the platform when setting P^m is the following: by increasing P^m, it extracts more profit from all merchants who obtain financing without monitoring $(1-F^m(\overline{A}(P^m, P^b)))$. At the same time, the threshold $\overline{A}(P^m, P^b)$ increases and some merchants who previously obtained financing without monitoring now turn to the platform's financial contract. The platform loses $\varphi(\mathcal{A}, P^m, P^b) - \gamma_p$ on each of these merchants. Depending on the distribution of merchants, it can be that the latter effect dominates the former, which prevents the platform from increasing P^m.

The first order condition for $\mathcal{A}$, (21), writes

$$f^m(\mathcal{A})\left[p_h(1 - F^b(P^b))(P^m + P^b - c) + \varphi(\mathcal{A}, P^m, P^b) - \gamma_p\right] + F^m(\mathcal{A}) - F^m(\overline{A}(P^m, P^b)) = 0$$

The trade-off faced by the platform when setting $\mathcal{A}$ is the following: when decreasing $\mathcal{A}$, the platform increases the subsidy provided to each merchant who accepts the platform's offer. At the same time, more merchants borrow from the platform, which increases the platform fees. So for these additional merchants, the platform loses $\varphi(\mathcal{A}, P^m, P^b) - \gamma_p$ but gains $p_h(1 - F^b(P^b))(P^m + P^b - c)$. The optimal $\mathcal{A}$ is such that the net gain from attracting new merchants is exactly offset by the loss from providing the subsidy to all merchants $F^m(\mathcal{A}) - F^m(\overline{A}(P^m, P^b))$.

Rearranging (20) and (21), we obtain

$$P^m = \frac{1 - F^m(\mathcal{A})}{p_h(1 - F(P^b))f^m(\mathcal{A})} + \frac{1 - F^m(\overline{A}(P^m, P^b))}{p_h(1 - F(P^b))f^m(\overline{A}(P^m, P^b))}(1 - \frac{f^m(\overline{A}(P^m, P^b))}{f^m(\mathcal{A})}) - P^b + c,$$

and

$$\mathcal{A} = \frac{F^m(\overline{A}(P^m, P^b)) - F^m(\mathcal{A})}{f^m(\mathcal{A})} - p_h(1 - F^b(P^b))(V^m + P^b - c) + p_h\frac{b}{\Delta_p} + I + \gamma_p,$$

where P^b is defined by (22).

Constraints (17) and (18) can never bind at the same time. Consider next that (17) is binding while (18) is not, i.e. $\varphi(\mathcal{A}, P^m, P^b) = 0$ and $\lambda_{\mathcal{A}} = 0$. The optimal price set for merchants is implicitly defined by

$$P^m = \frac{1 - F^m(\mathcal{A})}{p_h(1 - F(P^b))f^m(\mathcal{A})} + \frac{\gamma_p}{p_h(1 - F(P^b))}(1 - \frac{f^m(\overline{A}(P^m, P^b))}{f^m(\mathcal{A})}) - P^b + c,$$

and $\mathcal{A}$ is given by the constrain (17), that is,

$$\mathcal{A} = I - p_h(1 - F^b(P^b))(V^m - P^m) - p_h\frac{b}{\Delta_p}. \tag{23}$$

Consider finally that (18) is binding while (17) is not, i.e. $\underline{A}(P^m, P^b) = \mathcal{A}$ and $\lambda_\varphi = 0$. The optimal price set for merchants and the platform's financial contract are defined implicitly as follows:

$$P^m = \frac{1 - F^m(\mathcal{A})}{p_h(1 - F(P^b))f^m(\mathcal{A})} + \frac{(\gamma_p - \gamma_b)}{p_h(1 - F(P^b))}(1 - \frac{f^m(\overline{A}(P^m, P^b))}{f^m(\mathcal{A})}) - P^b + c$$

$$\mathcal{A} = I + \gamma_b - p_h(1 - F^b(P^b))(V^m - P^m) - p_h\frac{b}{\Delta_p}$$

In that case, see that if $\gamma_p = \gamma_b$, we are back to the bank financing case, i.e., P^m is defined as in Equation (13).

4.2 Platform's optimal pricing and financing strategy

To analyze the platform's optimal strategy, we make the simplifying assumption that A follows a uniform distribution: $A \sim \mathcal{U}[0, A^{max}]$. This generates a linear demand from merchants. We further assume that A^{max} is large enough, in a sense we make precise in the Appendix. This ensures that solutions for P^m and $\mathcal{A}$ are interior.[3]

Let us first rewrite the platform's optimal fees and equilibrium profit when only banks provide financing. Using (13), the platform's optimal merchant fee under bank financing writes

$$P^{m*} = \frac{1}{2}(V^m - P^{b*} + c) - \frac{1}{2p_hN^{b*}}\left(p_h\frac{b}{\Delta_p} + I + \gamma_b - A^{max}\right) \tag{24}$$

[3]See Proof of Proposition 2.

where P^{b*} is still defined by (12). Next, the minimal wealth required by banks to provide financing is

$$\underline{A}(P^{m*}, P^{b*}) = \frac{1}{2}\left[I + \gamma_b + p_h\frac{b}{\Delta_p} + A^{max} - p_h N^{b*}(V^m + P^{b*} - c)\right]. \tag{25}$$

Last, using Equation (14), the platform's profit under bank financing now writes

$$\pi^* = \frac{\left(A^{max} - \underline{A}(P^{m*}, P^{b*})\right)^2}{A^{max}}. \tag{26}$$

It is worth noting that the impact of an improvement in banks' monitoring technology has an ambiguous impact on merchants' welfare. From (24), a decrease in γ_b leads to an increase in P_m: intuitively, reducing financial frictions makes merchants' demand less price-elastic. This price increase harms merchants who borrow without monitoring. On the other hand, a lower γ_b has an overall positive effect for the more constrained merchants:

$$\frac{\partial}{\partial \gamma_b}[p_h N^b(V^m - P^m) - \gamma_b] = -p_h N^b \frac{\partial P^m}{\partial \gamma_b} - 1 = -\frac{\gamma_b}{2}.$$

Let us now turn to the case in which the platform can offer financing. The platform maximizes

$$\max_{P^m, P^b, \mathcal{A}} \pi(P^m, P^b, \mathcal{A}) = \frac{1}{A^{max}}[(A^{max} - \mathcal{A})p_h(1 - F^b(P^b))(P^m + P^b - c) \tag{27}$$
$$+(\overline{A}(P^m, P^b) - \mathcal{A})(\varphi(\mathcal{A}, P^m, P^b) - \gamma_p)]$$
$$\text{s.t.} \quad \varphi(\mathcal{A}, P^m, P^b) \geq 0 \tag{28}$$
$$\varphi(\mathcal{A}, P^m, P^b) \leq \gamma_b \tag{29}$$
$$\pi(\mathcal{A}, P^m, P^b) \geq \pi^*. \tag{30}$$

We denote P^{m**}, P^{b**} and $\mathcal{A}^{**}$ the solutions to the above program.[4]

Proposition 2. *Suppose A is uniformly distributed. There exists $\overline{\gamma}_p > \gamma_b$ such that the platform offers financing if and only if $\gamma_p \leq \overline{\gamma}_p$. When the platform offers financing, it charges a higher fee to merchants and expands the range of merchants who receive funding relative to the benchmark case in which only banks can provide funding: $P^{m**} > P^{m*}$ and $\mathcal{A}^{**} < \underline{A}(P^{m*}, P^{b*})$.*

Proof. See Appendix. □

[4]From Corollary 1, we know that $P^{b**} = P^{b*}$ and we will use both notations interchangeably.

Proposition 2 combines two motives for platforms to enter the credit market. The first one is straightforward: when platforms are more efficient at monitoring than banks, i.e. $\gamma_p < \gamma_b$, they can capture the corresponding efficiency gain ($\gamma_b - \gamma_p$ per funded merchant) while at the same time offering credit to more merchants. In particular, the monitoring cost threshold $\overline{\gamma}_p$ below which the platform is willing to provide funding is increasing in γ_b: when the banking system is more inefficient, the platform is more likely to step in.

In addition, entering the credit market allows the platform to engage in a form of price discrimination. Financial frictions create differences in valuations across merchants, based on their financial wealth. Wealthier merchants borrow without monitoring, and capture a larger payoff than poorer merchants who borrow with monitoring. Ideally, the platform would like to set different fees based on these different valuations. When this is not possible, the platform can indirectly discriminate merchants through its credit contract. This second benefit explains why the platform provides credit even when it is *less* efficient than the banking sector at monitoring creditors: $\overline{\gamma}_p > \gamma_p > \gamma_b$.

Formally, we show that the equilibrium financial contract offered by the platform is loss-making when incorporating the monitoring cost:

$$\varphi(\mathcal{A}, P^{m**}, P^{b**}) < \gamma_p.$$

That is, the platform uses subsidized credit to lower the overall charge $p_h N^b P^m + \varphi(\mathcal{A}, P^{m**}, P^{b**})$ supported by the more financially constrained, thereby expanding equilibrium demand: $\mathcal{A}^{**} < \underline{A}(P^{m*}, P^{b*})$. Importantly, this subsidy only benefits merchants who need monitoring, which gives the platform an incentive to increase P^m in order to extract more surplus from less financially constrained merchants, who borrow from the banking sector without monitoring. Note that these wealthier merchants are still better off than the more financially constrained merchants who need monitoring: their financing cost is zero while it is positive (equal to $\varphi(\mathcal{A}, P^{m**}, P^{b**})$) for merchants with $A < \overline{A}(P^{m**}, P^{b**})$. However they are worse off than when only banks can provide funding. We formalize this intuition in the following corollary.

Corollary 2. *Relative to the benchmark case in which only banks provide funding, when the platform provides funding,*

- *merchants with wealth $A_j > \overline{A}(P^{m*}, P^{b*})$ are strictly worse off,*
- *merchants with wealth $\overline{A}(P^{m*}, P^{b*}) > A_j > \mathcal{A}^{**}$ are strictly better off,*

- *buyers are strictly better off.*

There are four categories of merchants. From Lemma 3, merchants with wealth $A_j > \overline{A}(P^{m**}, P^{b**})$ still borrow from the bank and their welfare decreases because of the price hike. Merchants with wealth $\overline{A}(P^{m**}, P^{b**}) > A_j > \overline{A}(P^{m*}, P^{b*})$ borrow without monitoring from banks when the platform cannot offer credit. However, once the platform enters the credit market and raises P^m, they cannot borrow from banks anymore and turn to the platform. The combination of the price hike and the higher cost of funding leads to a net loss of

$$p_h(1 - F^b(P^{b**}))(P^{m**} - P^{m*}) + \varphi(\mathcal{A}, P^m, P^b).$$

Note that this loss is not just a transfer from merchants to the platform: it entails an additional monitoring cost which is a deadweight loss.

Merchants with wealth $\overline{A}(P^{m*}, P^{b*}) > A_j > \underline{A}(P^{m*}, P^{b*})$ move from borrowing from banks with monitoring to borrowing from the platform. They now face a higher fee, but benefit from subsidized funding, which overall yield a strictly positive net gain:

$$-p_h(1 - F^b(P^{b**}))(P^{m**} - P^{m*}) - \varphi(\mathcal{A}, P^m, P^b) + \gamma_b] = [\underline{A}(P^{m*}, P^{b*}) - \mathcal{A}^{**}] > 0.$$

Finally, merchants with wealth $\underline{A}(P^{m*}, P^{b*}) > A_j > \mathcal{A}^{**}$ who could not get funded without the platform can now borrow and become active and are therefore strictly better off.

Buyers face the same per-transaction price P^{b*} whether the platform provides credit or not, but because the number of merchants N^m expand, their overall payoff,$p_h N^m(V^b - P^{b*})$, goes up.

4.3 Platform credit and social welfare

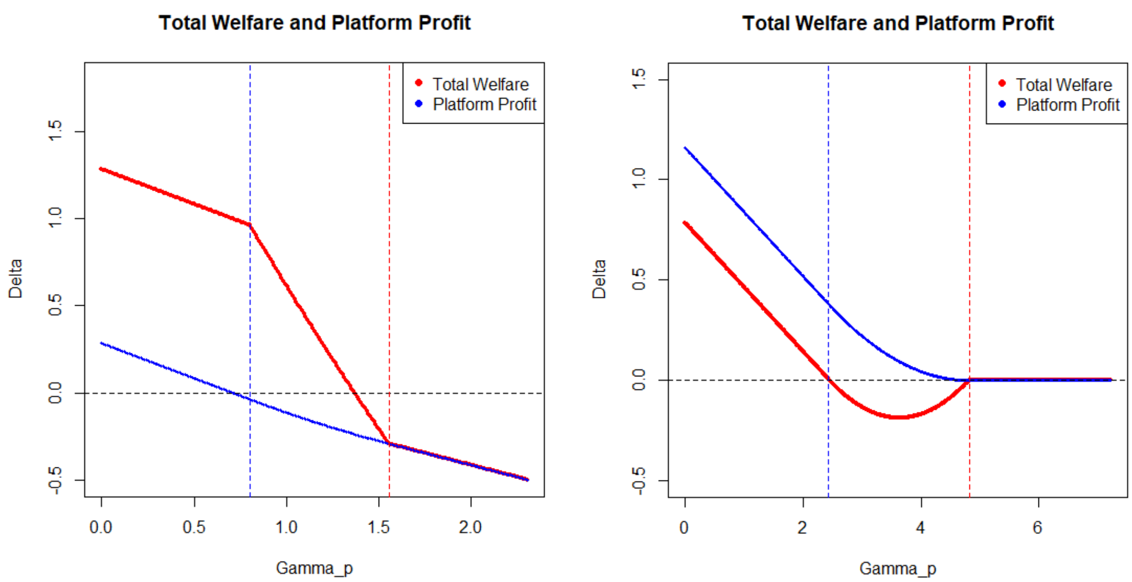
The result of Corollary 2 suggests that the impact of platform's financing on social welfare is ambiguous. When the platform enters the credit market, the social welfare (that includes the payoffs of merchants, buyers and the platform) changes by

$$\begin{aligned}
\Delta W &= \left[p_h(1 - F^b(P^{b*}))(V^m + P^{b*} - c) - I - p_h\frac{(V^b - P^{b*})^2}{2}\right]\frac{\underline{A}(P^{m*}, P^{b*}) - \mathcal{A}^{**}}{A^{max}} \\
&- (\gamma_p - \gamma_b)\frac{\overline{A}(P^{m*}, P^{b*}) - \underline{A}(P^{m*}, P^{b*})}{A^{max}} \\
&- \gamma_p\frac{(\overline{A}(P^{m**}, P^{b*}) - \overline{A}(P^{m*}, P^{b*})) + (\underline{A}(P^{m*}, P^{b*}) - \mathcal{A}^{**})}{A^{max}}.
\end{aligned}$$

In the above equation, the first line represents the social gain due to the credit expansion. The second line represents the gain or loss for merchants who switch from a bank contract with monitoring, to a platform contract. The monitoring cost changes by $\gamma_p - \gamma_b$. If $\gamma_p > \gamma_b$, there is a deadweight loss due to the platform being less efficient at monitoring than the bank. If at the opposite $\gamma_p < \gamma_b$, there is a social gain. The third line represents the deadweight loss associated with merchants who used to borrow without monitoring and now turn to platform financing (with $\overline{A}(P^{m**}, P^{b*}) > A > \overline{A}(P^{m*}, P^{b*})$), as well as newly financed merchants (with $\underline{A}(P^{m*}, P^{b*}) > A > \mathcal{A}^{**}$).

We now provide two numerical solutions to illustrate that the platform's entry in the credit market can either increase or decrease social welfare.

increases.png　　　　decrease.png



(a) Social welfare always increases with platform financing

(b) Social welfare may decrease with platform financing

Figure 1: Impact of platform financing on social welfare

In the two graphs above, the red solid line shows how the impact of platform financing on social welfare (i.e. ΔW) changes with γ_p, the blue solid line shows how the change in platform profit when the latter provides financing (i.e. $\Delta\pi = \pi^{**} - \pi^*$) varies with γ_p. To the left of the vertical blue dotted line, Constraint (17) is binding. To the right of the vertical red dotted line, Constraint (18) is binding.

Figure (1a) is plotted when assigning the following parameter values: $p_h = 0.8, p_l = 0.2, V^m = 10, \overline{V}^b = 8.5, c = 6, B = 2.6, b = 1.4, \gamma_b = 0.5, I = 1, A^{max} = 4$, and when assuming a uniform distribution for the buyer's valuation $V_i^b \sim U[0, \overline{V}^b]$. From the figure, we can see that social welfare always increases when the platform provides financing, although the impact is lower as γ_p increases.

Figure (1b) is plotted when assigning the following parameter values: $p_h = 0.8, p_l = 0.2, V^m = 10, \overline{V}^b = 8.5, c = 6, B = 2.6, b = 1.4, \gamma_b = p_h \frac{B-b}{p_h - p_l} = 1.6, I = 5.1, A^{max} = 5$, and when assuming that all buyers derive the same value $V_i^b = \overline{V}^b$ per transaction. This assumption mutes the impact of platform's financing on the buyers' payoff as the platform always charges $P^b = \overline{V}^b$, regardless of whether it provides financing or not. And we set $\gamma_b = p_h \frac{B-b}{p_h - p_l}$ so that no merchant who used to borrow from the bank with monitoring now turns to borrow from the platform. From the figure, we can see that when γ_p is small, social welfare increases when the platform provides financing, but as γ_p increases, there exists a parameter region when social welfare is lower with platform financing. This is because the deadweight loss due to platform's monitoring being less efficient than bank's monitoring more than compensates the social gain of having more merchants accessing the platform.

4.4 Impact of platform's monitoring efficiency

Our analysis suggests that both the number of merchants who access the platform, as well as the transaction fees they are charged, change with the platform's monitoring efficiency. We formalize the impact of γ_p on equilibrium platform size and pricing in the proposition below.

Proposition 3. *When the platform becomes more efficient at monitoring (when γ_p goes down),*

- *It provides more credit to merchant, i.e. $\overline{A}(P^m, P^b) - \mathcal{A}$ increases,*
- *It charges a higher fee P^{m**} to merchants.*

The results of Proposition 3 are illustrated in Fig. 2. To the left of the threshold $\hat{\gamma}_p$, Constraint (17) is binding: When monitoring costs are low, the platform would like to grant more credit to rationed merchants, but cannot do so without attracting also the wealthier merchants. To the right of $\overline{\gamma}_p$, the platform stops providing financing and only banks are active on the credit market.

The right panel of Fig. 2 illustrates the impact of γ_p on the provision of credit, measured by $\mathcal{A}$. As long as the platform is active on the credit market ($\gamma_p \leq \overline{\gamma}_p$), more merchants obtain financing than with bank financing only ($\mathcal{A} < \underline{A}(P^{m*})$), but the number of additional merchants who obtain financing decreases with γ_p: The platform provides less credit when its cost of doing so increases.

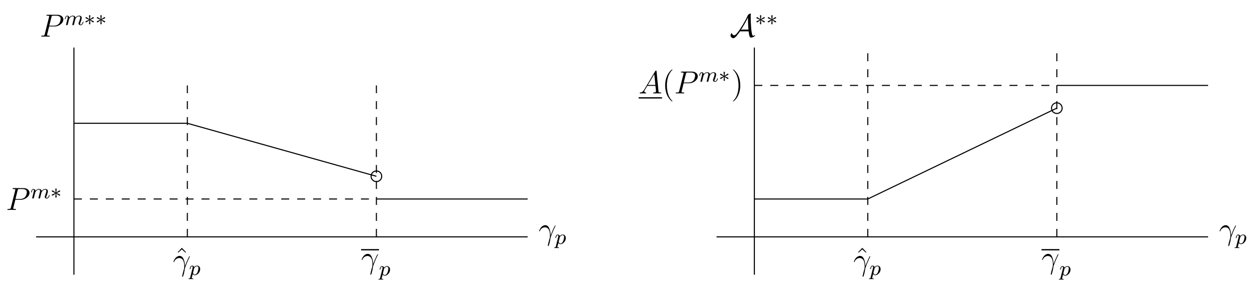


Figure 2: Impact of monitoring cost on credit and fees

The left panel of Fig. 2 illustrates the impact of monitoring costs on merchants' transaction fees. One can see from the curve that the fee charged to merchants is always higher when the platform provides credit ($P^{m**} > P^{m*}$), and that it decreases with monitoring costs. The intuition for that second result can be seen from the platform first-order condition with respect to the price P^m:

$$\frac{\partial \pi}{\partial P^m} = 1 - F^m(\overline{A}(P^m, P^b)) + f^m(\overline{A}(P^m, P^b))(\varphi(\mathcal{A}, P^m, P^b) - \gamma_p).$$

Keeping $\mathcal{A}$ constant, increasing P^m has a benefit that is directly proportional to the mass of unconstrained merchants, $1 - F^m(\overline{A}(P^m, P^b))$, who can borrow from the banking sector and end up paying a higher fee. That benefit is independent from γ_p. But increasing P^m also generates a cost $\varphi(\mathcal{A}, P^m, P^b) - \gamma_p$ that corresponds to the marginal merchant with $A = \overline{A}(P^m, P^b)$ becoming unable to borrow from the banking system (given a higher fee P^m) and turning to the platform. That loss $\varphi(\mathcal{A}, P^m, P^b) - \gamma_p$ becomes more severe when γ_p increases, hence a platform that is less efficient at monitoring has lower incentives to increase its fee.

5 Cross-side network effects

5.1 Setup

In the analysis above, buyers' willingness to pay only depends on their per-transaction surplus V^b. In particular, the number of merchants N^m is irrelevant to buyers' demand. This drives the result that equilibrium pricing on the buyers' side is not affected by the platform's ability to provide credit, even though platform credit leads to higher participation on the merchants' side. We show here that introducing network effects for buyers creates cross-side network effects: There is a feedback loop between buyers' and merchants' decisions to join the platform.

A natural way to make the number of merchants relevant to buyers' decisions is to introduce a fixed cost κ for buyers to join the platform. This can capture a monetary cost such as internet access, or a cognitive cost of understanding the functioning of the platform and merchants' offering. While this addition to the original model may seem minimal, it makes the analytical derivation of the results more challenging because it creates a feedback loop between buyers and sellers' decisions to join the platform. To preserve some tractability, we restrict attention to a 2-point distribution for buyers' (per transaction) valuation: It is equal to $\overline{V}^b$ with probability q and to $\underline{V}^b < \overline{V}^b$ with probability $1 - q$. As in Section 4.2, A is uniform over $(0, A^{max})$. To focus on the case in which the platform's entry in the credit market has the strongest impact, we present here the case in which the platform is relatively efficient at monitoring, and assume that the following assumption holds:[5]

Assumption 5.

$$\gamma_p \leq \frac{p_h}{2}\left[q(V^m + \underline{V}^b - c) - \frac{2B - b}{\Delta_p} - \frac{I - A^{max}}{p_h}\right].$$

Assumption 5 ensures that the platform has strong incentives to subsidize low-wealth merchants in order to increase merchants' fees, irrespective of whether the platform attracts all buyers, or high-valuation buyers only.

Note that given a mass N^m of sellers, buyers join the platform if and only if

$$N^m(V^b - P^b) \geq \kappa \Leftrightarrow P^b \leq V^b - \frac{\kappa}{N^m}. \tag{31}$$

Equation (31) makes it apparent that with a fixed cost κ, for a given price P^b, buyers' participation now depends on the number of merchants N^m.

5.2 Bank financing

As in the previous section, we start with the benchmark in which only banks provide financing. As earlier, the platform profit is

$$p_h N^m N^b (P^m + P^b - c).$$

[5]We show in Appendix B1 that the analysis extends to the case in which the platform's monitoring cost in higher (and in particular higher than the bank's monitoring cost γ_b).

Because of the binomial distribution of V^b, a marginal change in P^m does not affect N^b (although a large one might). We can therefore consider two cases: i) the case in which the platform attracts all buyers separately, ii) and the case in which it only attracts buyers with a high valuation $\overline{V}^b$. In both cases, optimal pricing on the buyer side is given by the first-order condition with respect to P^b below:

$$P^b(V^b, N^m) = V^b - \frac{\kappa}{N^m}, \tag{32}$$

where $N^b = q$ if $V^b = \overline{V}^b$ and $N^b = 1$ if $V^b = \underline{V}^b$.

The first-order condition with respect to P^m is then

$$\frac{\partial N^m}{\partial P^m}(P^m + P^b - c) + N^m \left(1 + \frac{\partial P^b}{\partial P^m}\right) = 0 \tag{33}$$

Note that this expression recognizes that through its effect on N^m, P^m affects pricing P^b on the buyers' side (from Equation (32)). From this first-order condition, we get a first interim lemma.

Lemma 4. *Optimal pricing by the platform is such that*

$$P^b = V^b - \frac{\kappa}{N^m},$$

$$P^m = \frac{1}{2}(V^m - V^b + c) - \frac{1}{2p_h N^b}\left(I + \gamma_b + p_h \frac{b}{\Delta_p} - A^{max}\right),$$

$$N^m = \frac{1}{2A^{max}}\left(p_h N^b (V^m + V^b - c) + A^{max} - \left(I + \gamma_b + p_h \frac{b}{\Delta_p}\right)\right) \tag{34}$$

where either $V^b = \overline{V}^b$ *and* $N^b = q$ *or* $V^b = \underline{V}^b$ *and* $N^b = 1$.

Proof. See Appendix. □

Now, Lemma 4 delivers optimal pricing up to the choice by the platform to include or exclude low-valuation buyers. Intuitively, the platform should choose the latter when the proportion of high-valuation buyers q is large enough. This point is established in the next lemma.

Lemma 5. *There exists* $\underline{q}$ *in* $(0, 1)$ *such that* $N^b = q$ *if* $q > \underline{q}$ *and* $N^b = 1$ *if* $q < \underline{q}$.

Proof. See Appendix. □

Combining Lemma 4 and Lemma 5 gives the platform's equilibrium pricing strategy in the benchmark with bank financing only.

5.3 Platform financing

Turn now to the case in which the platform can also provide funding. As in the case with bank financing (see Lemma 4), we can derive the platform's optimal choice conditional on either including or excluding low-valuation buyers in closed form. Then comparing the platform's profit in each case, we can show the counterpart to Lemma 5. The derivation combines elements from the benchmark bank financing case in Section 3 with elements from the baseline model with platform financing in Section 4. So the details are left to the Appendix and we only state here an intuitive result.

Lemma 6. *The platform enters the credit market and there exists $\overline{q} \in (0,1)$ such that $N^b = q$ if $q > \overline{q}$ and $N^b = 1$ otherwise.*

Proof. See Appendix. □

We show now that platform financing affects buyers not only at the intensive margin (for buyers who already participated under bank financing) but also at the extensive margin. That is, when the platform becomes active in the credit market, more buyers join the platform than when the platform is inactive.

Proposition 4. *When the platform offers financing, the mass of buyers who join the platform expands relative to the case with bank financing only, i.e., $\overline{q} > \underline{q}$.*

Proof. See Appendix. □

From Proposition 4, the mass of buyers who join the platform is the same when the platform provides funding as under bank financing if either $q > \overline{q}$ or if $q < \underline{q}$. Indeed, when $q > \overline{q}$, only high-valuation buyers are present irrespective of whether the platform offers financing or not. When $q < \underline{q}$, the platform prefers to attract all buyers, again irrespective of whether it provides financing or not. However, in the intermediate region $q \in (\underline{q}, \overline{q})$, more buyers become active under platform financing. This is because the platform attracts more merchants when it provides financing, which in turn makes it profitable to set a lower buyers' fee and attract also low-valuation buyers. This strategy is less profitable under bank financing because less merchants have access to the platform, reducing low-valuation buyers' willingness to pay the fixed cost κ of using the platform. Therefore, cross-side network effects are amplified when the platform can offer financing.

5.4 Welfare

We proceed in two steps. We start with the case in which $q < \underline{q}$ or $q > \underline{q}$. When q is extreme, there is no participation externality: the mass of active buyers does not depend on the platform's entry into the credit market, as in the baseline model. We then show that the welfare results from the baseline model extend, even though the platform's entry into the credit market now affects pricing not only on the merchants' side but also on the buyers' side. We next turn to the intermediate case $q \in (\underline{q}, \overline{q})$ to focus the impact of participation externality on welfare.

5.4.1 No participation externality

We assume here that $q < \underline{q}$ or $q > \overline{q}$. In that case, because the mass of buyers is independent from the platform being active in the credit market, the analysis of the merchants' side is as in the baseline model. The entry of the platform in the credit market leads to higher merchant participation but also a higher price P^m. The welfare effect is negative for the less constrained merchants (those who can borrow without monitoring when the platform is not active) but positive for the more constrained ones. The analysis of the buyers' side exhibits one difference: the price P^b now depends on the platform's activity in the credit market:

$$P^b = V^b - \frac{\kappa}{N^m}, \tag{35}$$

where V^b is either $\overline{V}^b$ or $\underline{V}^b$, although it does not depend on the platform providing credit (since $q < \underline{q}$ or $q > \overline{q}$). This immediately implies that when the platform provides credit, the access fee P^b is higher for buyers since merchant participation N^m is higher than under bank financing only. Intuitively, a higher mass of merchants relaxes the participation constraint of buyers by spreading the fixed cost κ over a larger number of transactions. However, as in the baseline model, buyers' welfare improves when the platform provides credit. To illustrate this point, consider the case in which $q < \underline{q}$. Then, from Equation (35), high-valuation buyers' welfare is

$$N^m(\overline{V}^b - P^b) = N^m(\overline{V}^b - \underline{V}^b) - \kappa,$$

which is strictly higher under platform financing since the number of merchants N^m is higher. More generally, all types of buyers are at least weakly better off with platform financing. We summarize this in the next proposition

Proposition 5. *If $q < \underline{q}$ or $q > \overline{q}$, the welfare implications of the platform entering the credit market are as in the baseline model (see Corollary 2).*

5.4.2 Participation externality

We now turn to the case in which $q \in (\underline{q}, \overline{q})$. In this case, the mass of active buyers is q under bank financing and 1 when the platform provides credit. As in the previous section, buyers are better off when the platform offers funding. In particular, high-type buyers' welfare goes up by

$$N^m_{pf}(\overline{V}^b - \underline{V}^b),$$

where N^m_{pf} is the equilibrium mass of active merchants when the platform is active and therefore charges merchants a price P^m_{pf}. Similarly, we let N^m_{bank}, P^m_{bank} and P^b_{bank} denote equilibrium participation and fees when only banks are active.

The novelty relative to the baseline case comes from the merchants' side. In the baseline case, unconstrained merchants with $A > \overline{A}(P^{m*}, P^{b*})$ are always worse off when the platform enters into the credit market because it provides an indirect form of price-discrimination (see Corollary 2). With participation externalities, the impact on these merchants' payoff of the platform providing credit is

$$p_h(V^m - P^m_{pf}) - p_h q(V^m - P^m_{bank}). \tag{36}$$

With participation externality, the platform fee still goes up for merchants: $P^m_{pf} > P^m_{bank}$. Note that this price difference now compounds two effects. First, price discrimination is still at work: offering funding allows the platform to charge higher prices to less constrained merchants without losing more constrained merchants. In addition, because the number of buyers increases under platform credit, joining the platform becomes more profitable for merchants everything else equal, which allows the platform to further increase prices. Now, despite this price increase, unconstrained merchants can potentially be better off because, as is apparent from (36), the mass of buyers is 1 when the platform provides funding versus only q when it does not. The key question is therefore which of the price effect or the participation effect dominates.

Define[6]

$$\overline{\gamma}_b \equiv 2p_h\left((1-\underline{q})(V^m - c) + \underline{V}^b - \underline{q}\overline{V}^b\right). \tag{37}$$

We show the following result.

Proposition 6. *Suppose $q \in (\underline{q}, \overline{q})$. Then, if $\gamma_b < \overline{\gamma}_b$, there exists $\hat{q}(\gamma_b) \in (\underline{q}, \overline{q}]$ such that when the platform provides funding,*

[6] Although $\overline{q}$ is an endogenous variable, it does not depend on γ_b, and so neither does $\overline{\gamma}_b$ which is therefore a proper upper bound for γ_b.

- *if $q < \hat{q}(\gamma_b)$, merchants with $A > \overline{A}(P^m_{bank}, P^b_{bank})$ are strictly better off than if only banks provide funding,*

- *if $q > \hat{q}(\gamma_b)$, merchants with $A > \overline{A}(P^m_{bank}, P^b_{bank})$ are strictly worse off than if only banks provide funding.*

If $\gamma_b > \overline{\gamma}_b$, merchants with $A > \overline{A}(P^m_{bank}, P^b_{bank})$ are worse off than if only banks provide funding.

Proof. See Appendix. □

The results of Proposition 6 can be interpreted as follows. When banks' monitoring cost is low, the platform can charge a high merchant price P^m_{bank} under bank financing without losing too many merchants (recall that P^m decreases with γ_b). The increase in the price the platform charges to merchants when providing credit is then relatively lower, and unconstrained merchants are not hurt too much by platform financing. In addition, when q is low, the impact of buyers' participation when the platform provides credit is large, which benefits unconstrained merchants. When both effects are present jointly, unconstrained merchants are better off with platform financing.

6 Market Power

6.1 Setup

In this section, we explore how the platform's incentive to enter the credit market is related to the market power it exerts on merchants. To introduce and calibrate this market power in the model we assume that merchants and buyers have an alternative mode of transaction. Specifically, they can by-pass the platform and directly transact with each other. We make three additional assumptions that streamline the analysis. First, we assume that merchants are single-homers: they need to decide ex-ante whether they want to transact on the platform or off the platform. Another way to state this assumption is that the investment I is specific to the distribution channel they choose. Then since buyers interact with a given seller only once, duplicating the investment to be present both on and off-platform would be inefficient. Buyers on the other hand can simultaneously trade on and off the platform, i.e., they are multi-homers, consistent with the assumption that they do not support any cost for joining one particular channel. We assume the required investment I does not depend on the distribution channel but we capture the technological superiority of the platform through a lower per-transaction cost. That is, every transaction off-platform generates a cost $c+\Delta c$, where $\Delta c > 0$ captures the platform's technological advantage, which we will refer to as its *market power*. Finally, whenever a merchant and a buyer meet off-platform, they Nash-bargain over the surplus with each player having equal bargaining power. This implies the surplus the merchant and the buyer get per off-platform meeting is

$$\frac{1}{2}(V^m + V^b - c - \Delta c). \tag{38}$$

Consider first buyers' decision to transact offline. This only requires (38) to be positive, i.e., $c + \Delta c \leq V^m + V^b$. We will assume this inequality to be true as otherwise the off-platform channel become irrelevant. Then since buyers multihome, there is a mass one of buyers for each merchant that sets up shop off-platform. For a merchant who can borrow from a bank without monitoring, choosing to sell on platform is more profitable than selling off the platform if

$$p_h(V^m - P^m) - I > \frac{p_h}{2}(V^m + V^b - c - \Delta c) - I \Leftrightarrow P^m \leq V^m - \frac{(V^m + V^b - c - \Delta c)}{2} \equiv \overline{P}^m(\Delta c).$$

That is, the possibility for merchants to sell off-platform limits the platform's ability to increase the price P^m or else lose all merchants who can borrow without monitoring, which is never optimal if A^{max} is large enough.[7] Note that the price cap $\overline{P}^m(\Delta c)$ increases with the platform's market power Δc.

6.2 Analysis

The platform's optimal fee if only banks can finance and there is no constraint on P^m is $P^{m*} < V^m$ given by (24). Since $\overline{P}^m(\Delta c)$ tends to V^m for Δc large enough and $\overline{P}^m(\Delta c)$ is strictly increasing in Δc, there exists a unique $\underline{\Delta c}$ such that $\overline{P}^m(\underline{\Delta c}) = P^{m*}$. In the rest of this section, we focus on the case where $\Delta c > \underline{\Delta c}$, i.e., the platform's profit under bank lending only is as in the baseline case in Section 4.2.[8]

[7] If buyers were not homogeneous, then $\overline{P}^m(\Delta c)$ would depend on P^b through the mass of buyers willing to buy on-platform that can be different from the mass of buyers willing to buy off-platform. While preliminary analysis suggests this section's results would be similar, this remains to be formally checked in a subsequent version.

[8] If $\Delta c < \underline{\Delta c}$, the analysis of the case where the platform provides funding in equilibrium is unchanged. However, the point at which the platform stops lending might change. This point needs to be formalized in a subsequent version.

Consider now the case where the platform can provide funding. Recall from Proposition 2 that the platform equilibrium (unconstrained) price P^{m**} when it provides funding is strictly larger than the price P^{m*} when it does not (Section 4.2). Therefore if we define $\overline{\Delta}c$ as the solution to $\overline{P}^m(\overline{\Delta}c) = P^{m**}$, we get that $\overline{\Delta}c > \underline{\Delta}c$. If $\Delta c \geq \overline{\Delta}c$, the constraint $P^m \leq \overline{P}^m(\Delta c)$ is not binding and we are back to the analysis of the baseline model leading to Proposition 2. The novel case is when the platform's market power is low enough, $\Delta c < \overline{\Delta}c$, that at optimum, $P^m \leq \overline{P}^m(\Delta c)$ binds. In that case, the merchant's fee is pinned down by the constraint, therefore the platform's profit if it provides funding is[9]

$$\begin{aligned}\Pi(\gamma_p, \Delta c) \quad \equiv \quad & \max_{P^m, P^b, \mathcal{A}} \frac{1}{A^{max}} [(A^{max} - \mathcal{A}) p_h(\overline{P}^m(\Delta c) + V^b - c) \quad (39)\\ & + (\overline{A}(\overline{P}^m(\Delta c), V^b) - \mathcal{A})(\varphi(\mathcal{A}, \overline{P}^m(\Delta c), V^b) - \gamma_p)] \\ & \text{s.t. } \varphi(\mathcal{A}, \overline{P}^m(\Delta c), V^b) \geq 0 \quad (40)\end{aligned}$$

Because the constraint $P^m \leq \overline{P}^m(\Delta c)$ is binding, we know that $\Pi(\gamma_p, \Delta c)$ is lower than the unconstrained platform profit $\pi(\mathcal{A}^{**}, P^{m**}, P^{b**})$ in the baseline model. Furthermore, since $\Pi(., \Delta c)$ is decreasing, the threshold $\overline{\gamma}'_p(\Delta c)$ above which the platform stops providing funding is strictly lower than $\overline{\gamma}_p$ defined in Proposition 2. Finally, since $\Pi(\gamma_p, .)$ is increasing, $\overline{\gamma}'_p(\Delta c)$ also increases in Δc and tends to $\overline{\gamma}_p$ when Δc tends to $\overline{\Delta}c$. That is, for a high enough platform monitoring cost, lower market power makes it less likely that the platform enters the credit market at all.

Now suppose the platform does find it profitable to provide credit, that is, Δc is high enough that $\gamma_p < \overline{\gamma}'_p(\Delta c)$. Further, suppose (40) is not binding. Then consider the first-order derivative of the objective function (39) with respect to $\mathcal{A}$,

$$-\left(p_h(\overline{P}^m(\Delta c) + V^b - c) + \varphi(\mathcal{A}, \overline{P}^m(\Delta c), V^b) - \gamma_p\right) + (\overline{A}(\overline{P}^m(\Delta c), V^b) - \mathcal{A}) \frac{\partial \varphi}{\partial \mathcal{A}}. \quad (41)$$

The first term in (41) captures the benefit of lowering $\mathcal{A}$, that is, each marginal merchant generates an additional revenue of $p_h(\overline{P}^m(\Delta c) + V^b - c) + \varphi(\mathcal{A}, \overline{P}^m(\Delta c), V^b) - \gamma_p$. Importantly, this term does not depend on $\overline{P}^m(\Delta c)$ once expliciting $\varphi(\mathcal{A}, \overline{P}^m(\Delta c), V^b)$ using (15). Intuitively, a higher fee P^m increases the platform direct revenue but decreases the platform's financial income φ by the same amount. It follows that the impact of $\overline{P}^m(\Delta c)$ on the platform' marginal

[9]We can show as in the proof of Proposition 2 that the constraint $\varphi(\mathcal{A}, P^m, P^b) \leq \gamma_b$ that ensures merchants with $A < \overline{A}(P^m, P^b)$ prefer platform credit to bank credit is never binding. Recall also that buyers are homogenous therefore $P^b = V^b$.

incentive to lower $\mathcal{A}$ runs through the second term in (41), that captures the effect of $\mathcal{A}$ on the platform's financial revenue. We know that $\frac{\partial \varphi}{\partial \mathcal{A}} > 0$, i.e., lowering the funding threshold $\mathcal{A}$ reduces the platform's financial revenue. This financial revenue is generated from the range of merchants with $A \in [\overline{A}(\overline{P}^m(\Delta c), V^b), \mathcal{A}]$. The key observation is that $\overline{A}(., V^b)$ is increasing: increasing P_m makes it more difficult for merchants to obtain funding (without monitoring) from banks therefore increases the range of merchants that borrow from the platform. But then a cap on P_m reduces this range, thereby making it less costly at the margin to lower $\mathcal{A}$ and thus the financial income per merchant. It follows that conditional on the platform being willing to enter the credit market, lower market power Δc leads to further financial inclusion, i.e., the platform offers funding to more financially constrained merchants (merchants with lower A). This, however, does not imply that lower market power leads to more funding by the platform since it also leads to more merchants borrowing from banks. In fact, using (41), we can show

$$\frac{\partial [\overline{A}(\overline{P}^m(\Delta c), V^b) - \mathcal{A})]}{\partial \Delta c} = \frac{1}{2} p_h > 0.$$

That is, when the platform's market power weakens, it finances fewer merchants. Using the expression for φ in (15), it is straightforward to check that if (40) binds then $\mathcal{A}$ is also increasing in $\overline{P}^m(\Delta c)$. In that case however, the mass of merchants financed by the platform is constant. This leads us to the next Proposition.

Proposition 7. *Lower market power Δc induces the platform to provide funding to fewer merchants. However, for γ_p large enough, the effect of Δc on the total mass of merchants that access credit from banks or the platform is non-monotonic: lower market power first leads to an expansion of credit (a decrease in $\mathcal{A}$), then to a contraction as the platform exits the credit market.*

7 Conclusion

We develop a model in which an e-commerce platform can benefit from offering credit to merchants in addition to access to its commercial services. By jointly charging a higher access fee and offering better credit terms, the platform endogenously selects to offer credit to the more financially constrained merchants. Wealthier merchants still prefer to borrow from banks that provide cheaper funding by avoiding monitoring costs. This enables the platform to price discriminate between more and less financially constrained merchants. This indirect price discrimination leads to higher trading volume on the platform and justifies the platform's entry into the credit market even in cases where it is less efficient than banks at monitoring. The platform's incentives to provide credit are related to its market power as a gateway between merchants and consumers. Our model suggests that the issue of the financial inclusion of small constrained firms is inherently related to the dominant competitive position that major e-commerce platforms occupy.

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Appendix A: Proofs

Proof of Lemma 1

Suppose the platform offers a contract without monitoring such that $\mathcal{A} < \overline{A}$ and $R = \underline{R}$, where $\overline{A}$ is the minimum merchant's investment required by the bank without monitoring, for given transaction fees P^m and P^b. In that case, the loss incurred by the platform for each merchant accepting the contract is

$$L(\mathcal{A}, P^b, P^m) \equiv \overline{A} - \mathcal{A}.$$

Clearly, all merchants with $A \geq \overline{A}$ accept the platform contract, as they obtain the project's NPV, $p_h N^b(V^m - P^m) - I$, plus $\overline{A} - \mathcal{A}$.

Consider now merchants with $\mathcal{A} \leq A < \overline{A}$. All these merchants are better off accepting the platform contract. We now show that the platform is worse off by providing financing. We need to distinguish two cases.

- If $\mathcal{A} \geq \underline{A}$, where $\underline{A}$ is the minimum merchant's investment required by the bank with monitoring, for given transaction fees P^m and P^b. Then, the platform's contract does not increase the merchant base, so that the platform's profit is strictly lower. To see this, consider the platform's profit:

$$\begin{aligned}\pi &= p_h N^m N^b (P^m + P^b - c) - (1 - F^m(\mathcal{A}))L(\mathcal{A}, P^m, P^b) \\ &= p_h[1 - F^b(P^b)][1 - F^m(\underline{A})](P^m + P^b - c) - (1 - F^m(\mathcal{A}))L(\mathcal{A}, P^m, P^b) \qquad (42)\end{aligned}$$

  The first term in (42) is the same as with bank financing, while the second term is strictly decreasing in $\mathcal{A}$.

- If $\mathcal{A} \leq \underline{A}$, then the platform contract increases the number of merchants who can obtain financing. In that case, the platform ends up financing all merchants.

$$\begin{aligned}\pi &= p_h[1 - F^m(\mathcal{A})]N^b(P^m + P^b - c) - (1 - F^m(\mathcal{A}))L(\mathcal{A}, P^m, P^b) \\ &= p_h[1 - F^b(P^b)][1 - F^m(\mathcal{A})](P^m + P^b - c) - (1 - F^m(\mathcal{A}))L(\mathcal{A}, P^m, P^b) \qquad (43)\end{aligned}$$

  First order conditions

$$\frac{\partial \pi}{\partial P^m} = p_h[1 - F^b(P^b)][1 - F^m(\mathcal{A})] - [1 - F^m(\mathcal{A})]p_h[1 - F^b(P^b)] = 0 \qquad (44)$$

$$\frac{\partial\pi}{\partial\mathcal{A}} = p_h[1-F^b(P^b)](-f^m(\mathcal{A}))(P^m+P^b-c)+f^m(\mathcal{A})L(\mathcal{A},P^m,P^b)+[1-F^m(\mathcal{A})]=0$$

$$\Leftrightarrow P^m = \frac{1-F^m(\mathcal{A})+f^m(\mathcal{A})L(\mathcal{A},P^m,P^b)}{p_h[1-F^b(P^b)]f^m(\mathcal{A})} - P^b + c \tag{45}$$

$$\frac{\partial\pi}{\partial P^b} = 0 \Leftrightarrow P^b = \frac{1-F^b(P^b)}{f^b(P^b)} - V^m + c \tag{46}$$

Equation (44) always holds, thus as long as the relationship between P^m and $\mathcal{A}$ satisfies equation (45), the platform's profit reaches its maximum. Let $\mathcal{A} = \underline{A}^*$, and get the value of P^{m**} from equation (45)

$$P^{m**} = \frac{1-F^m(\underline{A}^*)+f^m(\underline{A}^*)L(\underline{A}^*,P^{m*},P^b)}{p_h[1-F^b(P^b)]f^m(\underline{A}^*)} - P^b + c$$

Rewrite equation (43)

$$\Leftrightarrow \pi = [1-F^m(\underline{A}^*)]\frac{1-F^m(\underline{A}^*)}{f^m(\underline{A}^*)}$$

which is the same as the platform's profit under the bank financing case (i.e. equation (14)). Since the profit doesn't increase, the platform has no incentive to provide funding.

□

Proof of Lemma 2

Suppose the platform offers a contract $\mathcal{C}^p = (R^p, \mathcal{A})$ where R^p is the merchant repayment in case of success and $\mathcal{A}$ is the minimum investment from the merchant. The platform can only benefit from offering $\mathcal{C}^p$ if the contract is more attractive to some merchants than the contract $\mathcal{C}^b = (R^b, A^*(P^m, P^b))$ that banks offer:

$$\begin{aligned} & p_h(N^b(V^m-P^m)-R^b)-\underline{A}(P^m,P^b) < p_h(N^b(V^m-P^m)-R^p)-\mathcal{A} \\ \Leftrightarrow\ & p_hR^P+\mathcal{A} \le p_hR^b+\underline{A}(P^m,P^b) \\ \Leftrightarrow\ & p_hR^P+\mathcal{A} \le I+\gamma_b \end{aligned} \tag{47}$$

where the last inequality follows from banks breaking even. If it is optimal for the platform to set $\mathcal{A} > \underline{A}(P^m, P^b)$, then the platform should maximize its revenue from financial contracts since offering funding does not affect the mass of merchant that join the platform, $1 - F(\underline{A}(P^m, P^b)$, therefore does not affect the platform's revenues from charging fees (P^m, P^b). It follows that (47) is binding, i.e., the platform's revenu from offering $\mathcal{C}^p$ is then

$$[F(\overline{A}(P^m,P^b))-F(\mathcal{A})](p_hR^P-(I-\mathcal{A})-\gamma_p) = [F(\overline{A}(P^m,P^b))-F(\mathcal{A})](\gamma_b-\gamma_p).$$

Therefore if $\gamma_b \leq \gamma_p$, offering a financial contract with $\mathcal{A} > \underline{A}(P^m, P^b)$ does not improve the platform's payoff, and if $\gamma_b > \gamma_p$, $\mathcal{A} > \underline{A}(P^m, P^b)$ is strictly dominated by $\mathcal{A} = \underline{A}(P^m, P^b)$. $\square$

Proof of Lemma 3

Suppose the platform offers a contract such that $\varphi(\mathcal{A}, P^m, P^b) < 0$. The platform overall profit is then

$$\begin{aligned} & [1 - F^m(\mathcal{A})]\left[(1 - F^b(P^b))p_h(P^m + P^b - c) + \varphi(\mathcal{A}, P^m, P^b) - \gamma_p\right] \quad (48) \\ = \; & [1 - F^m(\mathcal{A})]\left[(1 - F^b(P^b))p_h(V^m + P^b - c) - p_h\frac{b}{\Delta p} - (I - \mathcal{A}) - \gamma_p\right] \quad (49) \end{aligned}$$

Note (49) does not depend on P^m and consider two cases. First, suppose $\varphi(\mathcal{A}, 0, P^b) < 0$. Then the platform strategy is akin to charging 0 to merchants and getting a strictly negative profit from providing credit which cannot be optimal. Second, suppose $\varphi(\mathcal{A}, 0, P^b) \geq 0$. Then since $\varphi(\mathcal{A}, ., P^b)$ is decreasing, there exists $P^{m'} < P^m$ such that $\varphi(\mathcal{A}, P^{m'}, P^b) = 0$ and (49) (and therefore (48)) is unchanged. But given $(\mathcal{A}, P^{m'}, P^b)$ merchants with $A > \overline{A}(P^{m'}, P^b)$ borrow from banks, which yields a profit for the platform equal to

$$\begin{aligned} & [1 - F^m(\mathcal{A})](1 - F^b(P^b))p_h(P^{m'} + P^b - c) - [F^m(\overline{A}(P^{m'}, P^b)) - F^m(\mathcal{A})]\gamma_p \\ > \; & [1 - F^m(\mathcal{A})]\left[(1 - F^b(P^b))p_h(P^{m'} + P^b - c) - \gamma_p\right] \\ = \; & [1 - F^m(\mathcal{A})]\left[(1 - F^b(P^b))p_h(P^m + P^b - c) + \varphi(\mathcal{A}, P^m, P^b) - \gamma_p\right], \end{aligned}$$

where the last expression is (48). This shows $\varphi(\mathcal{A}, P^m, P^b) < 0$ cannot be optimal for the platform. $\square$

Proof of Proposition 2

As mentioned in the main text, we assume A^{max} is large enough that we get interior solutions for $\mathcal{A}$ and P^m. Specifically,

$$A^{max} \geq \max\{\underline{A}_1^{max}, \underline{A}_2^{max}, \underline{A}_3^{max}, \underline{A}_4^{max}\}$$

where $\underline{A}_1^{max}$, $\underline{A}_2^{max}$, $\underline{A}_3^{max}$, $\underline{A}_4^{max}$ are defined as follows:

$$\underline{A}_2^{max} \equiv -p_h\frac{b}{\Delta_p} + p_h[1 - F^b(P^{b*})](V^m + P^{b*} - c) - I, \quad (50)$$

$$\underline{A}_3^{max} \equiv -p_h \frac{B+b}{\Delta_p} - \gamma_p + 2p_h[1-F^b(P^{b*})](V^m + P^{b*} - c) - 2I, \tag{51}$$

$$\underline{A}_4^{max} \equiv p_h \frac{2B-b}{\Delta_p} - \left(p_h[1-F^b(P^{b*})](V^m + P^{b*} - c) - I\right), \tag{52}$$

We already know from Section 4, Corollary 1 that pricing on the buyers' side does not change, i.e., the platform charges $P^{b**} = P^{b*}$ where P^{b*} is the unique solution to

$$\frac{1-F^b(P^b)}{f^b(P^b)} = V^m + P^b - c. \tag{53}$$

Consider next the optimization program (27) and ignore constraints (29) and (30) for the moment. First-order conditions with respect to P^m and $\mathcal{A}$ are respectively

$$\frac{p_h(1-F^b(P^b))}{A^{max}}[A^{max} - \overline{A}(P^m, P^b) + \varphi(\mathcal{A}, P^m, P^b) - \gamma_p] + \lambda p_h[1-F(P^b)] = 0, \tag{54}$$

$$-\frac{1}{A^{max}}[p_h(1-F^b(P^b))(P^m + P^b - c) + \varphi(\mathcal{A}, P^m, P^b) - \gamma_p - \overline{A}(P^m, P^b) + \mathcal{A}] - \lambda = 0, \tag{55}$$

where λ is the Lagrange multiplier associated with constraint (28).

Note that second-order condition are satisfied,

$$\frac{\partial^2 \hat{\pi}}{\partial P^{m2}} = -2\frac{p_h(1-F^b(P^{b**}))}{A^{max}} \left(p_h(1-F^b(P^{b**}))\right) < 0,$$

and

$$\frac{\partial^2 \hat{\pi}}{\partial \mathcal{A}^2} = -\frac{2}{A^{max}} < 0,$$

i.e., $\hat{\pi}(., P^{b**}, .)$ is strictly concave.

We then delineate two cases that depend on a threshold

$$\hat{\gamma}_p \equiv \frac{p_h}{2}\left[(1-F^b(P^{b**}))(V^m + P^{b**} - c) - \frac{2B-b}{\Delta_p} - \frac{I - A^{max}}{p_h}\right] \geq -\frac{\gamma_b}{2}, \tag{56}$$

where the inequality of follows from (52).

Case 1: The platform monitoring cost γ_p is large: $\gamma_p \geq \hat{\gamma}_p$

We first show that if $\gamma_p \geq \hat{\gamma}_p$, then (28) is not binding. To see this note that if (28) does not bind, solutions to the platform's optimization problem are given by (54) and (55) with $\lambda = 0$, which yields

$$P^{m**} = \frac{1}{3}(2V^m - P^{b**} + c) - \frac{1}{3p_h(1-F^b(P^{b**}))}\left(p_h \frac{B+b}{\Delta_p} + \gamma_p + 2I - 2A^{max}\right), \tag{57}$$

$$\mathcal{A}^{**} = A^{max} - \frac{p_h}{3}\left[2(1-F^b(P^{b**}))(V^m + P^{b**} - c) - \left(\frac{B+b}{\Delta_p} + \frac{\gamma_p}{p_h} + 2\frac{I - A^{max}}{p_h}\right)\right]. \tag{58}$$

Plugging these expressions into (15) yields

$$\varphi(\mathcal{A}, P^m, P^{b*}) = \frac{2}{3}(\gamma_p - \hat{\gamma}_p), \tag{59}$$

which is positive if $\gamma_p \geq \hat{\gamma}_p$. That is, the solutions to the unconstrained optimization problem satisfy (28), which is therefore not binding.

Next, combine (24), (57) and (59) to show

$$P^{m**} - P^{m*} = \frac{1}{2}(1 - F^b(P^{b**}))(\gamma_b - \varphi(\mathcal{A}, P^{m**}, P^{b*})). \tag{60}$$

Similarly, combine (25), (58) and (59) to show

$$\underline{A}(P^{m*}, P^{b*}) - \mathcal{A}^{**} = \frac{1}{2}(\gamma_b - \varphi(\mathcal{A}^{**}, P^{m**}, P^{b*})). \tag{61}$$

Suppose $\gamma_p = \frac{3}{2}\gamma_b + \hat{\gamma}_p > \gamma_b$, then $\varphi(\mathcal{A}, P^m, P^{b*}) = \gamma_b$ and

$$\hat{\pi}(P^{m**}, P^{b**}, \mathcal{A}^{**})\big|_{\gamma_p = \frac{3}{2}\gamma_b + \hat{\gamma}_p} = \pi^* - [\overline{A}(P^{m**}, P^{b**}) - \underline{A}(P^{m**}, P^{b**})](\gamma_p - \gamma_b) < \pi^*.$$

Suppose $\gamma_p = \gamma_b$, then $\varphi(\mathcal{A}, P^m, P^{b*}) = \frac{2}{3}(\gamma_b - \hat{\gamma}_p) < \gamma_b$. Furthermore, since $\hat{\pi}(., P^{b**}, .)$ reaches a maximum at $\hat{\pi}(P^{m**}, P^{b**}, \mathcal{A}^{**})$, $P^{m**} > P^{m*}$ and $\mathcal{A}^{**} < \underline{A}(P^{m*}, P^{b*})$, the strict concavity of $\hat{\pi}(., P^{b**}, .)$ implies

$$\hat{\pi}(P^{m**}, P^{b**}, \mathcal{A}^{**})\big|_{\gamma_p = \gamma_b} > \hat{\pi}(P^{m*}, P^{b**}, \underline{A}(P^{m*}, P^{b*})\big|_{\gamma_p = \gamma_b} = \pi^*$$

Finally, using the envelope theorem,

$$\frac{\partial \hat{\pi}(P^{m**}, P^{b**}, \mathcal{A}^{**})}{\partial \gamma_p} = \mathcal{A}^{**} - \overline{A}(P^{m**}, P^{b**}) < 0.$$

It follows there is a unique $\overline{\gamma}_p$ such that

$$\hat{\pi}(P^{m**}, P^{b**}, \mathcal{A}^{**})\big|_{\gamma_p = \overline{\gamma}_p} = \pi^*,$$

and $\gamma_b < \overline{\gamma}_p < \frac{3}{2}\gamma_b + \hat{\gamma}_p$, which implies (29) never binds. Therefore if $\gamma_p > \overline{\gamma}_p$, the optimization problem has no solution, i.e., the platform gives up financing. If $\gamma_p \leq \overline{\gamma}_p$, (29) does not bind, the optimum is given by (57) and (58), and (60) and (61) imply $P^{m**} > P^{m*}$ and $\mathcal{A}^{**} < \underline{A}(P^{m*}, P^{b*})$.

Case 2: The platform monitoring cost γ_p is small: $\gamma_p < \hat{\gamma}_p$

Then (28) is binding. It follows that $\varphi(\mathcal{A}, P^m, P^b) = 0$ in equilibrium. Using (54) and (55) with $\varphi(\mathcal{A}, P^m, P^b) = 0$, we get

$$A^{max} - \mathcal{A} = p_h(1 - F^b(P^b))(P^m + P^b - c),$$

$$p_h(1 - F^b(P^b))(V^m - P^m) - p_h \frac{b}{\Delta_p} - (I - \mathcal{A}) = 0,$$

which yields

$$P^{m**} = \frac{1}{2}(V^m - P^{b**} + c) - \frac{1}{2p_h(1 - F^b(P^{b**}))} \left(p_h \frac{b}{\Delta_p} + I - A^{max} \right) > P^{m*} \tag{62}$$

$$\mathcal{A}^{**} = I - \frac{p_h}{2} \left[(1 - F^b(P^{b**}))(V^m + P^{b*} - c) - \frac{b}{\Delta_p} + \frac{I - A^{max}}{p_h} \right] < \underline{A}(P^{m*}, P^{b*}) \tag{63}$$

□

Proof of Lemma 4

We have discussed P^b in the text. From Equation (32), the first-order condition (33) writes

$$\frac{\partial N^m}{\partial P^m}(P^m + P^b - c) + N^m \left(1 + \frac{\kappa}{(N^m)^2} \frac{\partial N^m}{\partial P^m} \right) = 0. \tag{64}$$

Using

$$N^m = \Pr[A \geq \underline{A}] = 1 - F^m(\underline{A}), \tag{65}$$

$$\underline{A} = I + \gamma_b - p_h \left(N^b(V^m - P^m) - \frac{b}{\Delta_p} \right), \tag{6}$$

and the uniform distribution of A over $(0, A^{max})$, Equation (64) becomes

$$-\frac{1}{A^{max}} p_h N^b (P^m + P^b + \frac{\kappa}{N^m} - c) + N^m = 0,$$

and using (32) again,

$$-\frac{1}{A^{max}} p_h N^b (P^m + V^b - c) + N^m = 0. \tag{66}$$

Using Equations (65) and (6) again to substitute into Equation (66) yields P^m. □

Proof of Lemma 5

Let

$$\overline{\pi}_{bank}(q) \equiv \max_{P^m} p_h N^m q(P^m + P^b(\overline{V}^b, N^m) - c)$$

and

$$\underline{\pi}_{bank} \equiv \max_{P^m} p_h N^m (P^m + P^b(\underline{V}^b, N^m) - c)$$

be the platform's profits under the optimal pricing defined in Lemma 4 when it respectively excludes and includes low-valuation buyers. The envelope theorem implies

$$\overline{\pi}'_{bank}(.) > 0.$$

Furthermore

$$0 = \overline{\pi}_{bank}(0) < \underline{\pi}_{bank} < \overline{\pi}_{bank}(1),$$

where the last inequality follows from $P^b(\underline{V}^b, N^m) < P^b(\overline{V}^b, N^m)$. Therefore by continuity, there is a unique $\underline{q}$ such that

$$\overline{\pi}_{bank}(\underline{q}) = \underline{\pi}_{bank}.$$

If $q < \underline{q}$, then $\overline{\pi}_{bank}(q) < \underline{\pi}_{bank}$, and if $q > \underline{q}$, then $\overline{\pi}_{bank}(q) > \underline{\pi}_{bank}$. □

Proof of Lemma 6

Step 1: Optimal choice of P^m and $\mathcal{A}$ for a given $N^b \in \{q, 1\}$.

To simplify notation we write V^b in the following program, omitting that V^b is a function of N^b: $V^b = \overline{V}^b$ if $N^b = q$ and $V^b = \underline{V}^b$ if $N^b = 1$. The platform's optimization program conditional on being active on the credit market is:

$$\max_{P^m, \mathcal{A}} \frac{1}{A^{max}}[(A^{max} - \mathcal{A})p_h N^b(P^m + P^b - c) + (\overline{A}(P^m, P^b) - \mathcal{A})(\varphi(\mathcal{A}, P^m, P^b) - \gamma_p)] \tag{67}$$

s.t.

$$\varphi(\mathcal{A}, P^m, P^b) \geq 0 \tag{68}$$

$$\varphi(\mathcal{A}, P^m, P^b) \leq \gamma_b. \tag{69}$$

As in the proof of Proposition 2, we can show that under Assumption 5, Constraint (68) binds and therefore (69) does not bind. First-order conditions with respect to P^m and $\mathcal{A}$ are

$$N^m - \frac{1}{A^{max}}\left[\gamma_p + (\overline{A} - \mathcal{A})\right] = -\lambda \tag{70}$$

$$-\frac{1}{A^{max}}\left[p_h N^b(P^m + P^b - c + \frac{\kappa}{N^m}) - \gamma_p - (\overline{A} - \mathcal{A})\right] = \lambda, \tag{71}$$

where λ is the Lagrange multiplier associated with Constraint (68). Using $P^b + \frac{\kappa}{N^m} = V^b$, $N^m = \frac{A^{max} - \mathcal{A}}{A^{max}}$, $\varphi(\mathcal{A}, P^m, P^b) = 0$ and substituting $\overline{A}$, we get

$$N^m = \frac{A^{max} - \mathcal{A}}{A^{max}} = \frac{1}{2A^{max}}\left(p_h N^b(V^m + V^b - c) + A^{max} - I - p_h\frac{b}{\Delta_p}\right), \tag{72}$$

$$P^m = \frac{1}{2}(V^m - V^b + c) - \frac{1}{2p_h N^b}\left(I + p_h\frac{b}{\Delta_p} - A^{max}\right). \tag{73}$$

Step 2: Existence of platform financing.

Let $\overline{\pi}_{pf}(q)$ be the solution to (67) when $N^b = q$ and $V^b = \overline{V}^b$, and $\underline{\pi}_{pf}$ be the solution to (67) when $N^b = 1$ and $V^b = \underline{V}^b$. As in the proof of Proposition 2, Assumption 5 implies

$$\overline{\pi}_{pf}(q) > \overline{\pi}_{bank}(q) \text{ and } \underline{\pi}_{pf} > \underline{\pi}_{bank}.$$

Therefore

$$\pi_{pf} \equiv \max\{\overline{\pi}_{pf}(q), \underline{\pi}_{pf}\} > \max\{\overline{\pi}_{pf}(q), \underline{\pi}_{pf}\} \equiv \pi_{bank}, \tag{74}$$

i.e., the platform's profit with platform financing is strictly higher than the platform's profit with only bank financing.

Step 3: Optimal pricing.

Using the same arguments as in the proof of Lemma 5, there exists a unique $\overline{q}$ such that $\overline{\pi}_{pf}(\overline{q}) = \underline{\pi}_{pf}$. Furthermore, $\overline{\pi}_{pf}(q) > \underline{\pi}_{pf}$ if $q > \overline{q}$ and $\overline{\pi}_{pf}(q) < \underline{\pi}_{pf}$ if $q < \overline{q}$. □

Proof of Proposition 4

Consider first the bank-financing case. Equation (66) is equivalent to

$$\frac{1}{A^{max}} p_h N^b(P^m + P^b + \frac{\kappa}{N^m} - c) = N^m,$$

which implies that the platform's profit under bank financing is

$$\pi_{bank} = A^{max}(N^m_{bank})^2 - p_h N^b \kappa,$$

where N^m_{bank} is given by Equation (34). We use the notation

- $\overline{N}^m_{bank}(q)$ for the solution to Equation (34) with $N^b = q$ and $V^b = \overline{V}^b$,
- $\underline{N}^m_{bank}$ for the solution to Equation (34) with $N^b = 1$ and $V^b = \underline{V}^b$.

Similarly, using Equations (70) and (71), we get the platform profit when the platform can provide funding:

$$\pi_{pf} = A^{max}(N^m_{pf})^2 - p_h N^b \kappa - p_h \frac{(B-b)\gamma_p}{\Delta_p A^{max}},$$

where N^m_{pf} is given by Equation (72). We use the notation

- $\overline{N}^m_{pf}(q)$ for the solution to Equation (72) with $N^b = q$ and $V^b = \overline{V}^b$,
- $\underline{N}^m_{pf}$ for the solution to Equation (72) with $N^b = 1$ and $V^b = \underline{V}^b$.

Then $\overline{\pi}_{pf}(\overline{q}) = \underline{\pi}_{pf}$ is equivalent to

$$(\underline{N}^m_{pf})^2 - (\overline{N}^m_{pf}(\overline{q}))^2 = (1-\overline{q})\frac{p_h\kappa}{A^{max}} \Leftrightarrow (\underline{N}^m_{pf} - \overline{N}^m_{pf}(\overline{q}))(\underline{N}^m_{pf} + \overline{N}^m_{pf}(\overline{q})) = (1-\overline{q})\frac{p_h\kappa}{A^{max}}. \quad (75)$$

From Equations (34) and (72), we have $\underline{N}^m_{pf} > \underline{N}^m_{bank}$ and $\overline{N}^m_{pf}(\overline{q}) > \overline{N}^m_{bank}(\overline{q})$, therefore

$$\underline{N}^m_{pf} + \overline{N}^m_{pf}(\overline{q}) > \underline{N}^m_{bank} + \overline{N}^m_{bank}(\overline{q}). \quad (76)$$

Furthermore

$$\underline{N}^m_{bank} - \overline{N}^m_{bank}(\overline{q}) = \frac{p_h}{2A^{max}}((1-\overline{q})(V^m - c) + \underline{V}^b - \overline{q}\overline{V}^b)$$

and

$$\underline{N}^m_{pf} - \overline{N}^m_{pf}(\overline{q}) = \frac{p_h}{2A^{max}}((1-\overline{q})(V^m - c) + \underline{V}^b - \overline{q}\overline{V}^b),$$

that is,

$$\underline{N}^m_{pf} - \overline{N}^m_{pf}(\overline{q}) = \underline{N}^m_{bank} - \overline{N}^m_{bank}(\overline{q}). \quad (77)$$

Then using Equations (75), (76) and (77), we have

$$(\underline{N}^m_{bank})^2 - (\overline{N}^m_{bank}(\overline{q}))^2 < (\underline{N}^m_{pf})^2 - (\overline{N}^m_{pf}(\overline{q}))^2 = (1-\overline{q})\frac{p_h\kappa}{A^{max}},$$

and therefore

$$\overline{\pi}_{bank}(\overline{q}) > \underline{\pi}_{bank}. \quad (78)$$

Since from the proof of Lemma 5, $\overline{\pi}_{bank}(.)$ is strictly increasing and $\overline{\pi}_{bank}(\underline{q}) = \underline{\pi}_{bank}$, Equation (78) implies

$$\underline{q} < \overline{q}.$$

□

Proof of Proposition 6

As in the proof of Proposition 5, we start from

$$\frac{1}{A^{max}} p_h N^b (P^m + P^b + \frac{\kappa}{N^m} - c) = N^m,$$

which holds both in the bank and the platform financing cases. Using $P^b = V^b - \frac{\kappa}{N^m}$ and rearranging we get

$$p_h N^b (V^m - P^m) = p_h N^b (V^m + V^b - c) - A^{max} N^m.$$

It follows that Equation (36), i.e., the welfare difference for a merchant with $A > \overline{A}(P^m_{bank}, P^b_{bank})$ between the cases with and without platform credit is

$$p_h((1-q)(V^m - c) + \underline{V}^b - q\overline{V}^b) - A^{max}(N^m_{pf} - N^m_{bank}) \tag{79}$$

Using (34) and (72), Equation (79) becomes

$$p_h((1-q)(V^m - c) + \underline{V}^b - q\overline{V}^b) - \frac{\gamma_b}{2}, \tag{80}$$

which is decreasing in q over $(\underline{q}, \overline{q})$. It follows that if $\gamma_b > \overline{\gamma}_b$, Equation (79) is always negative. If $\gamma_b < \overline{\gamma}_b$, then either

$$p_h((1-\overline{q})(V^m - c) + \underline{V}^b - \overline{q}\overline{V}^b) - \frac{\gamma_b}{2} < 0,$$

and $\hat{q}(\gamma_b) \in (\underline{q}, \overline{q})$, or $q(\gamma_b) = \overline{q}$. □

Proof of Proposition 7

Define $\underline{\Delta}c$ as the solution to $\overline{P}^m(\underline{\Delta}c) = P^{m*}$, $\overline{\Delta}c$ as the solution to $\overline{P}^m(\overline{\Delta}c) = P^{m**}$ (where P^{m**} is the equilibrium **constrained** price in Proposition 2), $\overline{\overline{\Delta}}c$ as the solution to $\overline{P}^m(\overline{\overline{\Delta}}c) = P^{m**}$ (where P^{m**} is the equilibrium **unconstrained** price in Proposition 2).

Recall from Proposition 2 that the platform charges a higher price when it provides credit (i.e. $P^{m**} > P^{m*}$). And the equilibrium constrained price is smaller than the equilibrium unconstrained price. Since $\overline{P}^m(\Delta c)$ is strictly increasing in Δc, we get $\underline{\Delta}c < \overline{\Delta}c < \overline{\overline{\Delta}}c$.

Case 1: If $\Delta c \geq \overline{\overline{\Delta}}c$, the constraint $P^m \leq \overline{P}^m(\Delta c)$ is not binding and we are back to the analysis of the baseline model leading to Proposition 2. The platform's decision to enter into the credit market does not depend on Δc.

Case 2: If $\overline{\Delta}c \leq \Delta c \leq \overline{\overline{\Delta}}c$, the constraint $P^m \leq \overline{P}^m(\Delta c)$ is not binding when only the bank provides credit. Then we focus on the situation where the platform also provides credit and delineate 2 cases depending on a threshold:

$$\hat{\gamma}'_p \equiv \frac{1}{2}p_h(V^m + V^b - c + \Delta c) - p_h\frac{B-b}{\Delta_p}$$

Case 2.1: The platform monitoring cost γ_p is large: $\gamma_p \geq \hat{\gamma}'_p$

We first show that if $\gamma_p \geq \hat{\gamma}'_p$, then (40) is not binding. To see this, note that if (40) is not binding, then under the condition $\Delta c \leq \overline{\overline{\Delta}}c$, the constraint $P^m \leq \overline{P}^m(\Delta c)$ is binding. Solving the platform's objective function (39) yields

$$\mathcal{A} = \frac{1}{2}\left[-\frac{3}{2}p_h(V^m + V^b - c) + p_h\frac{\Delta c}{2} + 2I + p_h\frac{B+b}{\Delta_p} + \gamma_p\right] \tag{81}$$

together with (15) and $P^m = \overline{P}^m(\Delta c)$ yields

$$\varphi(\mathcal{A}, P^m, P^{b*}) = \frac{1}{2}(\gamma_p - \hat{\gamma}'_p), \tag{82}$$

which is positive if $\gamma_p \geq \hat{\gamma}'_p$.

From (81), we see that $\mathcal{A}$ is increasing in Δc, i.e. $\frac{\partial \mathcal{A}}{\partial \Delta c} = \frac{p_h}{4} > 0$. Therefore, lower market power Δc gives more merchants access to credit. However, $\frac{\partial\left[\overline{A}(\overline{P}^m(\Delta c), V^b) - \mathcal{A}\right]}{\partial \Delta c} = \frac{p_h}{4} > 0$, which means a lower market power Δc also induces more merchants to borrow from the banks. Even if more merchants have access to credit, the platform provides funding to fewer merchants.

The platform's profit increases with Δc:

$$\frac{\partial \pi(\gamma_p, \Delta c)}{\partial \Delta c} = \frac{p_h}{2A^{max}}\left[A^{max} - \overline{A}(\overline{P}^m(\Delta c), V^b) + \varphi(\mathcal{A}, \overline{P}^m(\Delta c), V^b) - \gamma_p\right] > 0$$

which is always positive according to the first-order condition of the platform's profit with respect to P^m. Precisely, when the constraint on P^m is not binding (i.e. $P^m = \overline{P}^m(\overline{\overline{\Delta}}c)$), solving the first-order condition with respect to P^m (i.e. $\frac{\partial \pi}{\partial P^m} = 0$) leads to $A^{max} - \overline{A}(P^m, V^b) + \varphi(\mathcal{A}, P^m, V^b) - \gamma_p = 0$. Then when the platform has to charge a lower price $P^m = \overline{P}^m(\Delta c) < \overline{P}^m(\overline{\overline{\Delta}}c)$ due to the competitive pressure from off-platform, we must have $\frac{\partial \pi}{\partial P^m}|_{P^m = \overline{P}^m(\Delta c)} > 0$, which in turn leads to $A^{max} - \overline{A}(\overline{P}^m(\Delta c), V^b) + \varphi(\mathcal{A}, \overline{P}^m(\Delta c), V^b) - \gamma_p > 0$.

A lower market power Δc leads to a decrease in the platform's profit. Therefore, there exists a $\hat{\Delta}c$ below which the platform exits the credit market. When $\hat{\Delta}c < \overline{\Delta}c$, the platform always enters the credit market and a lower market power leads to an expansion of credit (a decrease in

$\mathcal{A}$). When $\overline{\Delta}c < \hat{\Delta}c < \overline{\overline{\Delta}}c$, the platform enters the credit market only if $\hat{\Delta}c < \Delta c < \overline{\overline{\Delta}}c$. A lower market power first leads to an expansion of credit, then to a contraction as the platform exits the credit market. When $\hat{\Delta}c > \overline{\overline{\Delta}}c$, the platform never enters the credit market, the number of merchants that have access to credit is irrelavent to the platform's market power.

Case 2.2: The platform monitoring cost γ_p is small: $\gamma_p < \hat{\gamma}'_p$

Then constraint (40) is binding. And under the condition $\Delta c \geq \overline{\Delta}c$, the constraint $P^m \leq \overline{P}^m(\Delta c)$ is not binding. Then the platform's decision to enter into the credit market does not depend on Δc, we are then back to the analysis of the baseline model leading to Proposition 2.

Case 3: If $\underline{\Delta}c \leq \Delta c \leq \overline{\Delta}c$, the constraint $P^m \leq \overline{P}^m(\Delta c)$ is not binding when only the bank provides credit, and it's binding when the platform also provides credit. We still delineate 2 cases depending on whether the constraint (40) is binding or not:

Case 3.1: The platform monitoring cost γ_p is large: $\gamma_p > \hat{\gamma}'_p$

We are back to the analysis in Case 2.1.

Case 3.2: The platform monitoring cost γ_p is small: $\gamma_p < \hat{\gamma}'_p$

Then constraint (40) is binding. And under the condition $\Delta c \leq \overline{\Delta}c$, the constraint $P^m \leq \overline{P}^m(\Delta c)$ is also binding. $\varphi(\mathcal{A}, \overline{P}^m(\Delta c), V^b) = 0$ gives

$$\mathcal{A} = -\frac{1}{2}p_h(V^m + V^b - c - \Delta c) + I + p_h\frac{b}{\Delta_p}$$

which is increasing in Δc, i.e. $\frac{\partial \mathcal{A}}{\partial \Delta c} = \frac{p_h}{2} > 0$. Therefore, lower market power Δc gives more merchants access to credit. However, $\frac{\partial\left[\overline{A}(\overline{P}^m(\Delta c), V^b) - \mathcal{A}\right]}{\partial \Delta c} = 0$, which means a lower market power Δc does not affect the number of merchants that borrow from the banks. Thanks to the expansion of platform credit, more merchants have access to credit.

The platform's profit still increases with Δc:

$$\frac{\partial \pi(\gamma_p, \Delta c)}{\partial \Delta c} = \frac{p_h}{2A^{max}}\left[A^{max} - \mathcal{A} - p_h(\overline{P}^m(\Delta c) + V^b - c)\right] > 0, \tag{83}$$

this is because the first-order condition with respect to P^m and $\mathcal{A}$ gives

$$\frac{p_h}{A^{max}}[A^{max} - \overline{A}(\overline{P}^m(\Delta c), P^b) + \varphi(\mathcal{A}, \overline{P}^m(\Delta c), P^b) - \gamma_p] + \lambda p_h > 0, \tag{84}$$

$$-\frac{1}{A^{max}}[p_h(\overline{P}^m(\Delta c) + P^b - c) + \varphi(\mathcal{A}, \overline{P}^m(\Delta c), P^b) - \gamma_p - \overline{A}(\overline{P}^m(\Delta c), P^b) + \mathcal{A}] - \lambda = 0, \tag{85}$$

where λ is the Lagrange multiplier associated with constraint (40). The inequality in condition (84) comes from the fact that P^m is binding at $\overline{P}^m(\Delta c)$.

Rearranging equation (84) and (85), we obtain $A^{max} - \mathcal{A} - p_h(\overline{P}^m(\Delta c) + V^b - c) > 0$, which gives equation (83) to be positive.

From (83), we conclude that a lower market power Δc leads to a decrease in the platform's profit. Therefore, there exists a $\hat{\Delta} c$ below which the platform exits the credit market. When $\hat{\Delta} c < \underline{\Delta} c$, the platform always enters the credit market and a lower market power leads to an expansion of credit (a decrease in $\mathcal{A}$). When $\underline{\Delta} c < \hat{\Delta} c < \overline{\Delta} c$, the platform enters the credit market only if $\hat{\Delta} c < \Delta c < \overline{\Delta} c$. A lower market power first leads to an expansion of credit, then to a contraction as the platform exits the credit market. When $\hat{\Delta} c > \overline{\Delta} c$, the platform never enters the credit market, the number of merchants that have access to credit is irrelevant to the platform's market power.

Case 4: If $\Delta c \leq \underline{\Delta} c$, the constraint $P^m \leq \overline{P}^m(\Delta c)$ is binding in both cases (i.e. bank financing and platform financing). When platform also provides funding, the analysis is the same as what we did in the case 3 (when $\underline{\Delta} c \leq \Delta c \leq \overline{\Delta} c$). When only the bank provides funding, the bank charges $P^m = \overline{P}^m(\Delta c)$ and the platform's profit is

$$\Pi(\Delta c) \equiv \frac{A^{max} - \mathcal{A}}{A^{max}} p_h(\overline{P}^m(\Delta c) + V^b - c)$$

Still, a lower market power Δc gives more merchants access to credit:

$$\underline{A}(\overline{P}^m(\Delta c), V^b) = I + \gamma_b + p_h\left(\frac{b}{\Delta_p} - \frac{V^b + V^b - c - \Delta c}{2}\right)$$

$$\frac{\partial \underline{A}(\overline{P}^m(\Delta c), V^b)}{\partial \Delta c} = \frac{p_h}{2}$$

Comparing the platform's profit with and without platform financing, we show that the platform may exit the credit market if its market power Δc is too low:

Case 4.1: The platform monitoring cost γ_p is large: $\gamma_p > \hat{\gamma}'_p$

Then constraint (40) is not binding.

$$\begin{aligned} \frac{\partial\left[\Pi(\gamma_p, \Delta c) - \Pi(\Delta c)\right]}{\partial \Delta c} &= \frac{p_h}{2A^{max}}[\varphi(\mathcal{A}, \overline{P}^m(\overline{\Delta} c), V^b) - \gamma_p + \underline{A}(\overline{P}^m(\Delta c), V^b) - \overline{A}(\overline{P}^m(\Delta c), V^b) \\ &\quad + p_h(\overline{P}^m(\Delta c) + V^b - c)] \end{aligned} \tag{86}$$

where $\Pi(\gamma_p, \Delta c)$ is the platform's profit when the platform also provides funding, $\Pi(\Delta c)$ is the platform's profit when only the bank provides funding.

By solving $\frac{\partial \Pi(\gamma_p,\Delta c)}{\partial \mathcal{A}} = 0$, we obtain $p_h(\overline{P}^m(\Delta c) + V^b - c) + \varphi(\mathcal{A}, \overline{P}^m(\overline{\Delta}c), V^b) - \gamma_p = \overline{A}(\overline{P}^m(\Delta c), V^b) - \mathcal{A}$, with which we can rearrange equation 86:

$$\frac{\partial\left[\Pi(\gamma_p,\Delta c) - \Pi(\Delta c)\right]}{\partial \Delta c} = \frac{p_h}{2A^{max}}[\underline{A}(\overline{P}^m(\Delta c), V^b) - \mathcal{A}] > 0,$$

equation above is always positive since platform financing expands the range of merchants that can obtain funding.

Case 4.2: The platform monitoring cost γ_p is small: $\gamma_p < \hat{\gamma}_p'$

Then constraint (40) is binding. We obtain directly

$$\frac{\partial\left[\Pi(\gamma_p,\Delta c) - \Pi(\Delta c)\right]}{\partial \Delta c} = \frac{p_h}{2A^{max}}[\underline{A}(\overline{P}^m(\Delta c), V^b) - \mathcal{A}] > 0,$$

A lower market power Δc reduces the platform's profit both in the bank financing case and in the platform financing case. With a lower market power, $\Pi(\gamma_p, \Delta c)$ gets closer to $\Pi(\Delta c)$, the platform is less likely to enter the credit market. There exists a $\hat{\Delta}c$ below which the platform exists the credit market. When $\hat{\Delta}c > \underline{\Delta}c$, the platform never enters the credit market, the number of merchants that have access to credit does not depend on the platform's market power. When $\hat{\Delta}c < \underline{\Delta}c$, the platform enters the credit market only if $\hat{\Delta}c < \Delta c < \underline{\Delta}c$. A lower market power first leads to an expansion of credit, then to a contraction as the platform exits the credit market.

Appendix B: Robustness

B1. Cross-side effects with high monitoring costs

The case we examined in the text is when the incentive compatibility constraint $\varphi(\mathcal{A}, P^m, P^b)$ is always binding. In this appendix, we make the following assumption which ensure this constraint never binds and the solution is interior:

Assumption 6.

$$\min\{\gamma_p, \gamma_b\} \geq \frac{p_h}{2}\left[(V^m + \overline{V}^b - c) - \frac{2B-b}{\Delta_p} - \frac{I - A^{max}}{p_h}\right]$$

Note that this assumption does not affect the case in which only banks provide funding which is analyzed in Section 5.2. Turn now to the case in which the platform can also provide funding. The analysis follows the same steps as the one in the main text.

Lemma 7. *There exists $\overline{\gamma}'_p$ and $\overline{q}$ such that $N^b = q$ if $q > \overline{q}$ and $N^b = 1$ otherwise. Platform offers credit only if $\gamma_p < \overline{\gamma}'_p$.*

Proof.

Step 1: optimal choice of P^m and $\mathcal{A}$ for a given $N^b \in \{q, 1\}$.

To simplify notation we write V^b in the following program, omitting that V^b is a function of N^b: $V^b = \overline{V}^b$ if $N^b = q$ and $V^b = \underline{V}^b$ if $N^b = 1$. The platform optimization program conditional on being active on the credit market is:

$$\max_{P^m, \mathcal{A}} \frac{1}{A^{max}}[(A^{max} - \mathcal{A})p_h N^b(P^m + P^b - c) + (\overline{A}(P^m, P^b) - \mathcal{A})(\varphi(\mathcal{A}, P^m, P^b) - \gamma_p)] \tag{87}$$

s.t.

$$\varphi(\mathcal{A}, P^m, P^b) \geq 0 \tag{88}$$

$$\varphi(\mathcal{A}, P^m, P^b) \leq \gamma_b \tag{89}$$

As in the proof of Proposition 2, we can show that if Assumption 6 is satisfied, then the constraints (88) and (89) do not bind. First-order conditions with respect to P^m and $\mathcal{A}$ are

$$N^m + \frac{1}{A^{max}}\left[\varphi(\mathcal{A}, P^m, P^b) - \gamma_p - (\overline{A} - \mathcal{A})\right] = 0 \tag{90}$$

$$p_h N^b(P^m + P^b - c + \frac{\kappa}{N^m}) + \varphi(\mathcal{A}, P^m, P^b) - \gamma_p - (\overline{A} - \mathcal{A}) = 0 \tag{91}$$

Using $P^b + \frac{\kappa}{N^m} = V^b$, $N^m = \frac{A^{max} - \mathcal{A}}{A^{max}}$, and substituting $\varphi(.)$ and $\overline{A}$, we get

$$N^m = \frac{A^{max} - \mathcal{A}}{A^{max}} = \frac{1}{A^{max}} \left(p_h \frac{2N^b}{3}(V^m + V^b - c) - \frac{1}{3}\left(p_h \frac{b+B}{\Delta_p} + \gamma_p + 2I - 2A^{max} \right) \right), \quad (92)$$

$$P^m = \frac{1}{3}(2V^m - V^b + c) - \frac{1}{3p_h N^b} \left(\frac{b+B}{\Delta_p} + \frac{\gamma_p}{p_h} + 2\frac{I - A^{max}}{p_h} \right). \quad (93)$$

Step 2: Existence of platform financing.

Let $\overline{\pi}_{pf}(q)$ be the solution to (87) when $N^b = q$ and $V^b = \overline{V}^b$, and $\underline{\pi}_{pf}$ be the solution to (87) when $N^b = 1$ and $V^b = \underline{V}^b$. As in the proof of Proposition 2 we can show that if $\gamma_p = \gamma_b$ then

$$\overline{\pi}_{pf}(q) > \overline{\pi}_{bank}(q) \text{ and } \underline{\pi}_{pf} > \underline{\pi}_{bank}.$$

Furthermore $\overline{\pi}_{pf}(q)$ and $\underline{\pi}_{pf}$ are strictly decreasing in γ_p while $\overline{\pi}_{bank}(q)$ and $\underline{\pi}_{bank}$ are independent from γ_p. It follows that if $\gamma_p = \gamma_b$,

$$\pi_{platform} \equiv \max\{\overline{\pi}_{pf}(q), \underline{\pi}_{pf}\} > \max\{\overline{\pi}_{pf}(q) \equiv \pi_{bank}, \underline{\pi}_{pf}\}, \quad (94)$$

i.e., the platform's profit with platform financing is strictly higher than the platform's profit with only bank financing. This implies also that $\pi_{platform}$ is strictly decreasing in γ_p, therefore Eq. 74 holds for γ_p below a threshold $\overline{\gamma}'_p$. Therefore the platform is active in the credit market for $\gamma_p < \overline{\gamma}'_p$.

Step 3: Optimal pricing

Using the same arguments as in the proof of Lemma 5, there exists a unique $\overline{q}$ such that $\overline{\pi}_{pf}(\overline{q}) = \underline{\pi}_{pf}$. Furthermore, $\overline{\pi}_{pf}(q) > \underline{\pi}_{pf}$ if $q > \overline{q}$ and $\overline{\pi}_{pf}(q) < \underline{\pi}_{pf}$ if $q < \overline{q}$. □

The next result shows that as in the case studied in the main text, platform funding can expand the range of buyers who become active. It is therefore the counterpart of Proposition 5.

Proposition 8. *When the platform offers financing, the mass of buyers who join the platform expands relative to the case with bank financing only, i.e.,* $\overline{q} > \underline{q}$.

Proof. Consider first, the bank-financing case, Eq. 33 is equivalent to

$$\frac{1}{A^{max}} p_h N^b (P^m + P^b + \frac{\kappa}{N^m} - c) = N^m,$$

which implies that the platform's profit under bank financing is

$$\pi_{bank} = A^{max}(N^m_{bank})^2 - p_h N^b \kappa,$$

where N^m_{bank} is given by Eq. 34. We use the notation

- $\overline{N}^m_{bank}(q)$ for the solution to Eq. 34 with $N^b = q$ and $V^b = \overline{V}^b$,
- $\underline{N}^m_{bank}$ for the solution to Eq. 34 with $N^b = 1$ and $V^b = \underline{V}^b$.

Similarly, using Eq. 90 and Eq. 91, we get the platform profit when the platform can provide funding:

$$\pi_{pf} = A^{max}(N^m_{pf})^2 - p_h N^b \kappa - p_h \frac{(B-b)\gamma_p}{\Delta_p A^{max}},$$

where N^m_{pf} is given by Eq. 92. We use the notation

- $\overline{N}^m_{pf}(q)$ for the solution to Eq. 72 with $N^b = q$ and $V^b = \overline{V}^b$,
- $\underline{N}^m_{pf}$ for the solution to Eq. 72 with $N^b = 1$ and $V^b = \underline{V}^b$.

Then $\overline{\pi}_{pf}(\overline{q}) = \underline{\pi}_{pf}$ is equivalent to

$$(\underline{N}^m_{pf})^2 - (\overline{N}^m_{pf}(\overline{q}))^2 = (1-\overline{q})\frac{p_h\kappa}{A^{max}} \Leftrightarrow (\underline{N}^m_{pf} - \overline{N}^m_{pf}(\overline{q}))(\underline{N}^m_{pf} + \overline{N}^m_{pf}(\overline{q})) = (1-\overline{q})\frac{p_h\kappa}{A^{max}} \quad (95)$$

From Eq. 34 and Eq. 92, we have $\underline{N}^m_{pf} > \underline{N}^m_{bank}$ and $\overline{N}^m_{pf}(\overline{q}) > \overline{N}^m_{bank}(\overline{q})$, therefore

$$\underline{N}^m_{pf} + \overline{N}^m_{pf}(\overline{q}) > \underline{N}^m_{bank} + \overline{N}^m_{bank}(\overline{q}) \quad (96)$$

Furthermore

$$\underline{N}^m_{bank} - \overline{N}^m_{bank}(\overline{q}) = \frac{p_h}{2A^{max}}((1-\overline{q})(V^m - c) + \underline{V}^b - \overline{q}\overline{V}^b)$$

and

$$\underline{N}^m_{pf} - \overline{N}^m_{pf}(\overline{q}) = \frac{2p_h}{3A^{max}}((1-\overline{q})(V^m - c) + \underline{V}^b - \overline{q}\overline{V}^b),$$

which implies

$$\underline{N}^m_{pf} - \overline{N}^m_{pf}(\overline{q}) > \underline{N}^m_{bank} - \overline{N}^m_{bank}(\overline{q}). \quad (97)$$

Then using Eq. 95, Eq. 96 and Eq. 97 we have

$$(\underline{N}^m_{bank})^2 - (\overline{N}^m_{bank}(\overline{q}))^2 < (\underline{N}^m_{pf})^2 - (\overline{N}^m_{pf}(\overline{q}))^2 = (1-\overline{q})\frac{p_h\kappa}{A^{max}},$$

and therefore

$$\overline{\pi}_{bank}(\overline{q}) > \underline{\pi}_{bank}. \quad (98)$$

Since from the proof of Lemma 5, $\overline{\pi}_{bank}(.)$ is strictly increasing and $\overline{\pi}_{bank}(\underline{q}) = \underline{\pi}_{bank}$, Eq. 98 implies

$$\underline{q} < \overline{q}.$$

□

B1. Market power with heterogeneous buyers

As in Section 5, we restrict our attention to a binary distribution for buyers' valuation V_i^b: It is equal to $\overline{V}^b$ with probability q and to $\underline{V}^b < \overline{V}^b$ with probability $1-q$. Buyers pay a fixed cost κ for joining the platform, this enables us to introduce the network effect. Otherwise, the platform's credit decision would be irrelevant to the buyer's side.

Given a mass N^m of sellers, buyers join the platform if and only if

$$N^m(V^b - P^b) \geq \kappa \Leftrightarrow P^b \leq V^b - \frac{\kappa}{N^m}. \tag{99}$$

where $N^b = q$ if $V^b = \overline{V}^b$ and $N^b = 1$ if $V^b = \underline{V}^b$.

As in Section 6, merchants are single homers and need to decide ex-ante whether to transact on the platform or off the platform. Buyers are multi-homers, therefore there is a mass one of buyers that is active off the platform. The number of buyers that is active on the platform depends on the price charges to buyers (i.e. as defined in 99). Still, merchants strictly prefer selling on the platform than selling off the platform if

$$p_h q(V^m - P^m) - I > \frac{p_h}{2}(V^m + V^b - c - \Delta c) - I \Leftrightarrow P^m \leq V^m - \frac{(V^m + V^b - c - \Delta c)}{2q} \equiv \overline{P}^m(\Delta c, q).$$

Since $\overline{P}^m(\Delta c, q)$ is strictly increasing in Δc, there's a unique $\underline{\Delta} c$ such that $\overline{P}^m(\underline{\Delta} c, q) = P^{m*}|_{N^b=q}$. And there's a unique $\overline{\Delta} c$ such that $\overline{P}^m(\overline{\Delta} c, q) = P^{m**}|_{N^b=q}$.

Case 1: If $\Delta c \geq \overline{\Delta} c$, the constraint $P^m \leq \overline{P}^m(\Delta c, q)$ is not binding and the platform's decision of entering the credit market does not depend on Δc. As in the proof of Lemma 6 and Lemma 7, we can show that there exists a $\overline{\gamma}_p''$ such that the platform offers credit only if $\gamma_p < \overline{\gamma}_p''$. And there exists a $\overline{q}$ such that $N^b = q$ if $q > \underline{q}$ and $N^b = 1$ otherwise.

Case 2.1: If $q \in (\overline{q}, 1)$ and $\underline{\Delta} c \leq \Delta c \leq \overline{\Delta} c$, the constraint $P^m \leq \overline{P}^m(\Delta c, q)$ is binding when the platform provides funding. The platform charges $P^m = \overline{P}^m(\Delta c, q)$ and solves

$$\begin{aligned} \Pi(\gamma_p, \Delta c, q) \quad \equiv \quad & \max_{\mathcal{A}} \frac{1}{A^{max}}[(A^{max} - \mathcal{A})p_h q(\overline{P}^m(\Delta c, q) + P^b - c) \\ & + (\overline{A}(\overline{P}^m(\Delta c, q), P^b) - \mathcal{A})(\varphi(\mathcal{A}, \overline{P}^m(\Delta c, q), P^b) - \gamma_p)] \\ & \text{s.t. } \varphi(\mathcal{A}, \overline{P}^m(\Delta c, q), P^b) \geq 0 \end{aligned} \tag{100}$$

Consider first that constraint 100 is not binding, the first-order condition with respect to $\mathcal{A}$ gives

$$\mathcal{A} = \frac{1}{2}\left[-(1 + \frac{1}{2q})p_h(V^m + \overline{V}^b - c) + p_h\frac{\Delta c}{2q} + 2I + p_h\frac{B+b}{\Delta_p} + \gamma_p\right]$$

which is increasing in Δc, i.e. $\frac{\partial \mathcal{A}}{\partial \Delta c} = \frac{p_h}{4q} > 0$. Therefore, lower market power Δc gives more merchants access to credit. However, $\frac{\partial\left[\overline{A}(\overline{P}^m(\Delta c), V^b) - \mathcal{A}\right]}{\partial \Delta c} = \frac{p_h}{2} - \frac{p_h}{4q} > 0$, which means a lower market power Δc also induces more merchants to borrow from the banks. Even if more merchants have access to credit, the platform provides funding to fewer merchants.

The platform's profit increases with Δc:

$$\frac{\partial \pi(\gamma_p, \Delta c, q)}{\partial \Delta c} = \frac{p_h}{2A^{max}} \left[A^{max} - \overline{A}(\overline{P}^m(\Delta c, q), P^b) + \varphi(\mathcal{A}, \overline{P}^m(\Delta c, q), P^b) - \gamma_p\right] > 0$$

The above equation is always positive because when the price is binding by a cap (i.e. $P^m = \overline{P}^m(\Delta c, q) < \overline{P}^m(\overline{\Delta}c, q)$, define $\overline{P}^m(\overline{\Delta}c, q)$ as the equilibrium price obtained from solving equation 67 when the constraint 68 is not binding.) due to the competitive pressure from the off-platform option, we must have $\frac{\partial \pi}{\partial P^m}|_{P^m = \overline{P}^m(\Delta c, q)} > 0$, which in turn leads to $A^{max} - \overline{A}(\overline{P}^m(\Delta c, q), P^b) + \varphi(\mathcal{A}, \overline{P}^m(\Delta c, q), P^b) - \gamma_p > 0$.

Consider next that constraint 40 is binding, $\varphi(\mathcal{A}, \overline{P}^m(\Delta c), V^b) = 0$ gives

$$\mathcal{A} = -\frac{1}{2} p_h (V^m + \overline{V}^b - c - \Delta c) + I + p_h \frac{b}{\Delta_p}$$

Case 2.2: If $q \in (\underline{q}, \overline{q})$ and $\underline{\Delta}c \leq \Delta c \leq \overline{\Delta}c$, the constraint $P^m \leq \overline{P}^m(\Delta c, q)$ is binding when the platform provides funding. Solving the platform's objective function of maximizing its profit, and consider first that constraint 100 is not binding, we obtain

□