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Platform Lending and Innovation*

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We analyse the impact of platform lending on innovation and e-commerce vendors' surplus. The platform generates revenues from both lending and marketplace fees, and can use lending to price discriminate vendors, thereby leading to higher marketplace fees and below-market interest rates. Prohibition of platforms lending may stifle innovation, not because of lack of platform funding, but because the high fee policy of the platform deters banks from financing innovators. Allowing platforms to lend may encourage innovation by providing access to subsidised credit, but it can also harm vendors who do not have financial needs. A sufficient condition for platform lending to be welfare-enhancing is that innovators would not receive funding from banks otherwise. However, if innovators would receive funding from banks, platform lending may reduce the overall vendor surplus. Cream skimming arises when the platform has better information than the bank about the prospects of the innovators' projects. To address the potential negative effects of platform lending on vendors' surplus, we also explore the impact of different regulatory instruments.

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1 Introduction

In recent years, big tech platforms have entered the credit market by offering loans to firms selling on their marketplaces. For example, Amazon.com provides selected small and medium-sized enterprises with access to fast and competitive credit. This credit enables them to expand their business on the marketplace, cover inventory costs, develop new products, and meet advertising and marketing expenses.[1] Similarly, Alibaba offers credit to vendors on Taobao, China's largest retail e-commerce platform. In this paper, we focus on the interplay between the financial side and the real side of a platform's ecosystem and the impact of platform lending on innovation and vendors' surplus.

This vendors' financing activity is of interest to the platform because it may help extract higher rents from transactions on the marketplace compared to scenarios where vendors can request loans only to banks. The fees collected on the marketplace and the interest rates offered to borrowers are inherently linked due to the dual activity of the platform. However, it is not clear a priori whether the entry of big tech platforms in the credit market would have a positive or negative impact on social welfare compared to an architecture where only banks are involved in lending, as not all vendors have investment opportunities.

We develop a model in which a monopoly platform enables transactions between consumers and vendors, which we interpret as small and medium-sized enterprises. Our model captures in a simplified manner the two main activities of a platform's ecosystem we are interested in: the marketplace and credit.[2] Vendors are of two private-information types: (i) "non-innovative" vendors with no growth opportunities, and (ii) "innovative" vendors who have the potential to expand their business through a fixed-size investment that requires external financing in the form of a loan. The outcome of their investment is risky and can result in either zero or high returns with a probability that is common across vendors. Both vendors' types have the possibility to stay out of the marketplace and exploit a random outside option, which we assume to be uniformly distributed for tractability. When vendors participate in the marketplace, they pay a fee proportional to their output. Vendors have no wealth, their loans lack collateral and they default if their realised output, net of the fee, is less than the repayment amount promised to the lender.[3] In such a case, the output is lost, and the platform does not earn the fee.

[1] The Amazon Lending program experienced an 80% yearly increase in 2023. See Insider, Eugene Kim, Jan 4, 2023. Leaked documents show Amazon's seller lending business is booming. But the company's economists are worried about defaulters. (https://www.businessinsider.com/amazon-seller-lending-program-growing-recession-fears-2023-1).

[2] Note that we capture these activities in a stylized way. Online platforms like Amazon offer additional services (e.g., logistics, payment services, marketing and data analytics) and their lending activity presents multiple alternatives to eligible vendors. See Amazon Lending (https://sell.amazon.com/programs/amazon-lending).

[3] Big tech loans tend to rely less on collateral than loans provided by banks (Gambacorta et al., 2023).

In this economy, both a representative competitive bank and a big tech platform can provide loans to innovative vendors. Specifically, we compare two alternative architectures: in the first one only the bank provides loans, and the platform operates the marketplace; in the second one the platform can also lend and compete with the bank. We begin by considering a baseline model that assumes a fixed level of buyer participation in the marketplace, identical funding costs, and no frictions or information asymmetries, except for the platform's inability to distinguish whether a vendor is innovative.[4]

Under the bank lending architecture, the platform can only extract surplus from vendors via fees. If the platform has information about which vendors are innovative, it could engage in fee discrimination by charging a higher fee for non-innovative vendors and a lower fee for innovative ones, enabling the latter to cover the fixed investment cost. However, since the platform ignores the vendor types, and only knows their fraction and the distribution of vendors' outside options, incentive compatibility prevents the platform from engaging in fee discrimination. Consequently, the platform faces two options: either it charges a pooling fee to attract both types of vendors, resulting in lower profits compared to a full-information fee, or it charges a high fee that discourages the bank from lending due to potential inability of innovators to repay the loan. We find that if the share of innovators is relatively low the platform gives up these vendors by setting a higher fee that induces the bank not to lend. As a result, innovation is not funded and there is credit-rationing. On the contrary, if the share of innovators is large, the platform sets a pooling fee, giving up higher margins from non-innovators, to enable innovators to secure funding from the bank.

Given that this outcome leads to a reduced expected innovation output there may be scope for the platform to enter the credit market, compete with the bank, and provide loans to innovators in addition to operating the marketplace. By lending to vendors, the platform can utilise the interest rate as a second instrument to extract surplus. In the baseline model, the platform always finds it optimal to engage in lending and sets a (weakly) higher fee for all vendors, while offering innovators a below-market interest rate as compensation. This cross-subsidy strategy emphasises the importance of lending as a tool for the platform to attract innovative vendors to the marketplace.

The lending activity of the platform has two opposite effects on the overall vendor surplus. On one hand, it has a positive impact on innovation by providing funding to innovators and offering them below-market interest rates. On the other hand, non-innovators have to pay a (weakly) higher fee and do not benefit from the reduced interest rate, resulting in a negative effect. Considering both effects and acknowledging that the platform's profit

[4]The case in which platforms have the same funding costs as the bank may resemble the scenario in which big techs have direct access to deposits. For example, before 2020 the Alibaba's Ant Group allowed individuals to deposit funds via Alipay. In 2023, a big tech platform, Apple, started offering high yield saving accounts.

increases through lending, we show that a sufficient condition for platform lending to enhance welfare is that for the same parameter range the bank would not fund innovation within the bank lending architecture, i.e., the share of innovators is low. In this scenario, under the bank lending architecture, the platform charges a high fee that discourages banks from financing innovators. By providing its own funding, the platform promotes innovation through cross-subsidy, avoids harming non-innovators, and increases its own profit, thereby boosting social welfare.

However, within the same parameter range in which the platform sets a pooling fee under the bank lending architecture (i.e., the share of innovators is high), platform lending has a strictly negative net effect on vendors' surplus. The higher fee imposed by the platform negatively impacts non-innovators, and the benefits of subsidized credit for innovators do not fully offset these losses.

To address the potential negative effects of platform lending on vendors' surplus, we explore the impact of different regulatory instruments on the platform's strategy and vendors' welfare. First, we find that implementing a cap on the fee (see e.g., Gomes and Mantovani 2020; Bisceglia and Tirole 2023) would reduce the platform's benefit from cross-subsidies, subsequently reducing its incentive to enter the credit market. Second, we find that a sufficient condition for an outright ban on platform lending to be beneficial to vendors is that platform lending harms innovators. Otherwise, such a ban may result in either a decrease or increase in the overall vendors' surplus. Third, the structural separation of the lending platform from the marketplace would neutralize the cross-subsidy, thus reducing the incentive of the platform to enter the credit market and potentially hampering innovation.

We further extend and generalize the model by introducing various factors that can amplify or mitigate the platform's incentives to engage in the lending activity, as well as its potential impact on vendors' surplus.

First, unlike banks, platforms do not have deposits because they usually lack a banking licence. Thus, their lending supply can be more costly and entail a trade-off: on one hand, the platform can better discriminate vendors by cross subsidizing the innovative ones with a higher fee, and on the other hand, lending itself is a costly activity. The platform always finds it optimal to enter the lending market in those circumstances in which, within the bank lending architecture, innovators would not be funded by the bank. Therefore, platform lending has a positive effect on innovation and total vendors' surplus. However, a qualitatively new effect arises when the bank would offer loans to innovators (i.e., when there is a large share of innovators). In such cases, the platform may not always find it profitable to engage in lending activities. This is because serving a substantial portion of innovators can be prohibitively expensive for the platform, and the cost of funding would be passed on to innovators in the form of higher interest rates. As a result, the effectiveness of the cross-subsidy mechanism may diminish, making it unprofitable for the platform to continue lending. Interestingly, we also identify circumstances where platform lending persists at equilibrium, but it can have negative consequences for both innovators and non-innovators, resulting in a decrease in the vendors' surplus.

Second, we assume that the platform receives a more precise signal than the bank regarding the probability of output realizations. This assumption aligns with the recent literature (see Section 2) suggesting that big techs benefit from a data-driven information advantage relative to banks. We capture this feature by assuming that in the population of innovators a fraction has a "high" probability of success, and the rest has a probability of success so low that the net present value (NPV) of their project is negative. When the bank cannot distinguish the two fractions whereas the platform can, the phenomenon of cream-skimming arises. The platform will want to grant a loan to the high-types only, and be willing to offer a lower rate than the bank. That means that the bank receiving applications from the low-types only would not offer any. All other remaining insights from the baseline model, including the presence of the cross-subsidy, continue to hold qualitatively.

Third, we expand our analysis to incorporate elastic buyer participation that depends on the number of vendors present in the marketplace (i.e., cross-group network effects). We demonstrate that under the bank lending architecture, the platform may have a greater interest in attracting innovators due to the presence of cross-group network effects. This can result in the bank being less likely to deny credit to innovators. However, if the bank already provides credit to innovators, the presence of cross-group network effects can create new dynamics that may either mitigate or amplify the platform's incentive to engage in lending as a means of vendor discrimination. Fourth, we introduce the possibility also for non-innovators to borrow and benefit from the subsidized interest rate. Importantly, in this scenario, the platform faces a new challenge as lending to this group is a pure loss-making activity. As a result, the platform must carefully consider the trade-off between the advantages of improved price discrimination and the drawbacks of lending to non-innovators, which diminish its incentives to engage in lending.

Furthermore, we also show that, in our model, the platform would not have the incentive to lend to those vendors that operate outside the marketplace because the cross-subsidy would not be applicable in such cases. This finding further underscores the idea that lending is a secondary activity to the platform's primary marketplace operations. Finally, we show how the presence of multiple product categories and heterogeneous probability of repayment by innovators would not change qualitatively our results.

The rest of the paper is structured as follows. Section 2 discusses and relates our contribution to the literature. In Section 3, we present the model. Section 4 analyzes the baseline model under the bank lending architecture, where the platform only operates the marketplace and credit is exclusively offered by the bank at a break-even loan rate. In Section 5, we examine platform-bank competition in the credit market and how this affects the equilibrium loan rates and fees. In Section 6, we discuss different regulatory approaches. Section 7 extends the baseline model to consider different market frictions and we discuss the platform's incentive to enter the credit market and its impact on innovation. Section 8 presents the main conclusions. All proofs are in the Appendix.

2 Related Literature

This paper relates and contributes to the literature on big tech lending and platform governance. The extant literature has mostly focused on the economic effect of big tech lending and its relation to the competitive data advantage that big techs have over banks (Frost et al., 2019). This advantage allows the platform to price risk more accurately than banks and tailor credit terms to the characteristics of vendors.[5] In this paper, we present a new and complementary rationale for the platform entry in the credit market, which relates to price discrimination.

Recent works have found positive effects of big tech lending in terms of financial inclusion of credit-worthy borrowers excluded otherwise (Hau et al., 2019; Philippon, 2020). Hau et al. (2019) construct a model where big techs use data from vendors and consumers online trading for credit analysis. Their main prediction is that big tech credit is relatively more attractive for borrowers with low credit scores who are often excluded from banks. This prediction is supported by the empirical analysis based on credit data from Ant Financial, which uses the transaction data on its retail site Taobao to generate credit scores for online vendors. They also find that there are substitution effects between big techs and bank credit, but they vanish for low-quality borrowers without bank access. Liu, Lu and Xiong (2022) examine characteristics of loans offered by big tech to SMEs, finding that these loans are smaller in size, have a higher interest rate, and serve borrowers for short-term financial needs. Chava et al. (2021) contrast the view that big tech platforms have better information than banks, finding that these platforms attract borrowers with a lower credit score, and with higher default rates than banks.[6]

In their theoretical study, Parlour, Rajan and Zhu (2022) explore the ways in which

[5] This is consistent with the Amazon Lending Program for which eligible sellers should have a selling history on the marketplace of at least one year. See Amazon Lending (https://sell.amazon.com/programs/amazon-lending).

[6] Similar results are found by Wang and Overby (2022) who show that in the case of fintech lending, easy access to credit induces borrowers to overextend themselves financially, leading to bankruptcy.

big techs leverage information from payment services to penetrate the credit market. A common theme is that when big techs use consumer payment data to assess credit risk and provide lending, banks' pricing of loans becomes less informative about credit risk, and the quality of bank loans worsens. Consumers with weak bank relationships benefit (from cheaper access to electronic payment services), whereas consumers with strong bank relationships could benefit or lose (depending on the change in banks' pricing of payment services). Dong, Ren, and Zhang (2022) consider a setting in which a platform has superior information relative to banks and focus on the incentives of a platform to lend to sellers that face uncertain demand and compete in quantities. They show that platform lending distorts sellers' inventory upward thereby making sellers competition fiercer and potentially reducing platform's profits.

A recent strand of the literature has studied platform-bank competition. Gambacorta, Khali and Parigi (2021) study the trade-off between privacy and efficiency in the interaction between big tech lending and bank lending. They show that fearing expropriation of their continuation values, firms will not borrow from an all-too-powerful big tech that has superior information as well as superior enforcement. Biancini and Verdier (2023) focus on the impact of platform-bank competition on the average risk of bank loans and the relative level of interest rates. However, all these studies do not consider the incentive of the platform to engage in vendor financing and keep the marketplace activity of the platform unrelated to the lending activity.

A paper close to ours is by Bouvard, Casamatta and Xiong (2022), who study platform lending as a form of price discrimination in the context of vendor's moral hazard in a model à la Holmström and Tirole (1997). Whereas the cross-subsidy is also present in their setting, in the form of a high transaction fee and below-market loan rate, we differ along several dimensions. First, we consider a population of vendors whose heterogeneity arises from investment opportunities not from frictions in credit markets due to information asymmetries and heterogeneous wealth like in Bouvard's et al. Second, whereas the driver of financial inclusion in Bouvard's et al. is information in our model the channel is different. Indeed, a platform may find it profitable to induce the exclusion of a group of vendors not because they are too risky, but because of a standard price discrimination argument whereby it is more profitable to serve only the group with the highest willingness to pay. Platform lending restores financial inclusion because two instruments, fee and interest rate, may allow a finer discrimination strategy.

The interaction of the transaction fee and the interest rate charged by platform on merchants' loans is also studied by Li and Pegoraro (2022). As in our model, superior platform information is not the driver of platform lending that, in their model, arises as a way to segment merchants of different risk. Although in their model the fee is fixed, they also find that the platform engages in the cross-subsidy as the platform uses the fee for borrowing merchants toward loan repayment and to cover potential losses on the loans. However, the nature of the cross-subsidy in their model results as a partial remedy to adverse selection, whereas in our setting inherently arises from the interplay between the two activities of the platform's ecosystem: the marketplace and the lending activity.

Our analysis also relates to a recent stream of the literature that studies the dual role of some platforms, which act both as a marketplace and directly sell to consumers (Anderson and Bedre-Defolie, 2021; Etro, 2021; Hagiu, Teh and Wright, 2022; Zennyo, 2022). In our paper, the platform has a dual role in the sense that it can decide to offer credit to vendors that want to undertake investments, thus fostering or stifling innovation. Our analysis also contributes to the extant literature on digital platforms and, by focusing on innovative expected products being sold by borrowers, on how platforms impact innovation activities of third-party vendors (Belleflamme and Peitz, 2010; Jeon, Lefouili and Madio, 2022).

Furthermore, our paper relates to the literature on price discrimination in two-sided markets (Liu and Serfes, 2013; Jeon, Kim and Menicucci, 2022). Moreover, in the context of e-commerce platforms, the welfare effects of perfect and imperfect fee discrimination in online marketplaces are recently studied by Tremblay (2022a) and Tremblay (2022b) in two companion papers. De Cornière, Mantovani and Shekhar (2023) show that if a two-sided platform engages in third-degree price discrimination of high- and low-type sellers, it can lead to higher participation by users and be Pareto-improving.

Finally, the problem we study is related to vendor financing and trade credits. Vendor financing performs many functions, among which to price discriminate buyers. Brennan, Maksimovics and Zechner (1988) show that a monopolist vendor facing customers whose different financing needs are public information, may find it profitable to discriminate buyers with different demand for credit and different reservation prices. Whereas in Brennan's et al. model the incentive to price discriminate is created by the higher reservation prices of cash customers, in our model vendor financing price-discriminates vendors whose financing needs and innovation opportunities are private information. As the mass of vendors is endogenous in our model unlike in Brennan et al., by subsidizing lending the platform can potentially induce more innovation. Moreover, similar to the literature on trade credits (Biais and Gollier, 1997; Burkart and Ellignsen, 2004), in our setting there is an interplay between the business and the lending activities. However, this interplay comes from the presence of an intermediary — the Big Tech platform — that charges a common fees to heterogeneous vendors. Importantly, in our setting this has a key impact on the level of innovation by vendors and the allocation of surplus across types of vendors.

3 The Model

The market. We model an economy where an online monopolistic platform facilitates transactions between buyers and vendors and charges them an ad valorem fee (the fee, henceforth) based on their output. Ad valorem fees are widely used by e-commerce platforms (e.g., Amazon, eBay).[7] For simplicity, we assume that buyers have a unit demand (i.e., they all buy from all vendors on the marketplace) and their participation in the marketplace is inelastic. We relax this assumption in Section 7.3. Transactions only occur on the platform in exchange for the fee, denoted as $\tau \in [0, 1]$. All players—vendors, bank, and platform— are risk-neutral.

Vendors. There is a mass 1 of vendors, that are monopolistic for their product. We assume that all vendors belong to the same macro-product category (e.g., kitchen, clothing and accessories, etc.). Vendors are of two types: an exogeneously given share λ of vendors, which we label as *innovators*, have the opportunity to innovate and develop a new product by undertaking investment whose cost is normalised to 1 without loss of generality. Innovation is risky and succeeds only with probability $p \in (0, 1)$. Investment output is equal to Y_I in case of success and 0 otherwise. Y_I captures the value of the innovation and we assume that (product) innovation is drastic, meaning that innovators do not face competition from other vendors in the marketplace if they succeed in their investment. We assume that the investment NPV is positive, i.e., $pY_I > 1$. The remaining share of vendors, which we label *non-innovators*, do not have an investment opportunity and sell a non-innovative product.

Note that an alternative interpretation is that vendors that undertake investments are new vendors who are trying to establish their business, and therefore must incur a fixed cost of investment, which is distributed within a support. In contrast, vendors who do not make investments are those vendors who have already passed the initial stage of establishing their business and are now operating in a more mature state.

We assume that innovators have no wealth and have to borrow 1 promising back the rate D. This assumption encompasses the many technical forms of credit for marketplace sales.[8] We assume that all innovators are identical with respect to their probability of success p but are heterogeneous in their outside options, denoted by ω. Because the model becomes computationally challenging despite its simplicity, we assume that the outside options are distributed uniformly within the interval $[0, 1]$. This assumption is particularly relevant in our setting because it generates elastic participation on this side

[7]The economic rationale for the use of ad valorem fees is studied by Wang and Wright (2017; 2018).

[8]For instance, Amazon finances small businesses with factoring, lines of credit, credit cards, and merchant cash advances and engages in revenue-sharing. Source: https://www.americanexpress.com/en-us/business/blueprint/resource-center/finance/amazon-loans/.

of the market.[9]

Innovative vendors that borrow face output risk and, because they have no collateral they default on their debt obligation if the realised output is 0. We assume that the fee is senior to debt so that default occurs if the output net of the fee is less than D. The seniority of the fee can be justified by the fact that the platform controls transactions on its ecosystem and can appropriate part of them before the money is transferred to the vendors. We assume that, following default, the output is lost. This assumption is common in the literature and captures the stylized facts that there are bankruptcy costs.

The expected profit of a vendor that borrows 1 at the rate D is $p[Y_I(1-\tau) - D]$. We also assume that $pY_I < 2$, which guarantees that under a uniform distribution of the innovators' outside option, not all innovators find it optimal to join the platform. This assumption ensures the presence of an extensive margin on the innovators' participation to the platform. The number of innovators is $n_I(\tau, D) = p[Y_I(1-\tau) - D]$ and the total mass of innovators in the marketplace is, therefore, $\lambda n_I(\tau, D)$.[10] Although the fraction of innovators is exogenous, their total mass is endogenous, and it is a function of the choice variables — interest rate and fee — and of the expected output from innovation pY_I.

As discussed, non-innovators do not have an investment opportunity and we assume that their output value is Y_N, with $0 < Y_N < pY_I - 1$.[11] We also assume that these vendors are heterogeneous in their outside option, denoted by ξ, which, for tractability, we assume is distributed uniformly within the interval $[0, 1]$ and independent from ω. Finally, in the baseline model, we assume that non-innovators do not have a storage capacity, which allows us to rule out that these vendors borrow if the repayment is less than the value of the loan even if they do not invest.[12] We relax this assumption in Section 7.4. The number of non-innovators that join the marketplace is denoted by $n_N(\tau) = Y_N(1-\tau)$ and their total mass is, therefore, $(1-\lambda)n_N(\tau)$.

Both banks and platform can offer credit. We assume that banks operate in a perfectly competitive environment and we focus on a representative bank. The bank breaks even and has the same information as the platform and vendors about the probability p about

[9]Rochet and Stole (2002) refer to this elastic participation as *random participation* as each vendor's outside option is drawn from a distribution.

[10]Note that what is important in our analysis is that these vendors face a fixed cost of innovation that is not shared with the platform through the fee, being the latter charged on the basis of the output value (or revenues).

[11]Note that this assumption is not restrictive in any meaning. However, as we distinguish between vendors that invest and vendors that do not invest, it is also reasonable to assume that the (net) expected output resulting from an investment is larger than the output resulting from not investing. Assuming $Y_I = pY_N - 1$ implying that the two populations only differ in their borrowing activity would generate circumstances in which one group of vendors (i.e., those not borrowing) becomes inelastic as it always participates in the marketplace.

[12]Because default on the loan would entail losing the output, lack of storage capacity prevents them from borrowing.

Y_I. In Section 7.2, we relax this assumption and introduce a data-driven informational advantage for the platform. Moreover, we abstract from relationship lending and switching costs which could give the bank a competitive advantage vs the platform. We discuss how relationship lending could affect our results in Section 5.

The platform. The platform operates the marketplace as its core business and from this activity it earns fees. Assuming that the platform sets a common fee τ across vendors, which we show to be optimal in equilibrium, its expected profit from the marketplace, denoted by Π^{mkt}, is

$$\Pi^{mkt}(\tau, D) = \tau \cdot \begin{cases} \lambda n_I(\tau, D) p Y_I + (1-\lambda) n_N(\tau) Y_N & \text{with both innovators and non-innovators} \\ (1-\lambda) n_N(\tau) Y_N & \text{with only non-innovators} \\ \lambda n_I(\tau, D) p Y_I & \text{with only innovators ,} \end{cases}$$

for $D = \{D_B, D_P\}$, where D_B is the loan rate of the bank and D_P is the loan rate chosen by the platform if it lends. If the platform also operates in the lending market and, on top of $\Pi^{mkt}(\tau, D)$, it also earns the following expected profit, denoted as Π^{lend},

$$\Pi^{lend}(\tau, D_P) = \lambda n_I(\tau, D_P) \cdot \begin{cases} D_P p - 1, & \text{if } n_I(\tau, D_P) > 0 \\ 0 & \text{if } n_I(\tau, D_P) = 0 \end{cases}.$$

The first (resp. second) line of the above expression identifies the case in which innovators join (resp. do not join) the marketplace.

Throughout the analysis, we assume that the platform knows the distributions of the vendors' opportunity costs and λ, but it does not recognise each vendor's type and neither can it observe whether it borrowed from the bank.

The timing. The timing of the model is the following.

1. In period 1, loan rates and fees are set. We consider two architectures: in one only a perfectly competitive representative bank is allowed to lend, and in the other one the platform and the bank compete in the credit market. In the former case, the platform sets one (or potentially more than one) fee(s). In the latter case, the platform sets the fee (or potentially more than one) and the loan rate D_P. The bank breaks even and sets the loan rate D_B.

2. In period 2, vendors decide whether to join the marketplace and borrow from the bank or from the platform. If the platform does not lend, innovators borrow from the bank or stay out of the marketplace.

3. In period 3, the output is realised and fee and debt claim are settled.

The equilibrium concept is subgame perfect Nash equilibrium. We assume that the fee is observable by vendors and the bank, and if both the platform and the bank offer loans, the vendor borrows from the cheapest one. Furthermore, in marketplaces such as Amazon.com fees reflect only the type of product being sold in the marketplace and are not affected by the presence of additional services used by the merchants (e.g., Fulfillment Services, Lending Programs, etc.). This assumption combined with the fact that types are not observable implies that a platform that offers a menu of fees with the same interest rate would induce vendors to choose only the lowest fee.

Finally, we also abstract away from another advantage of the platform, which stems from their ability to use its substantial shipping inventory of the vendor as collateral to enforce loan repayment, as defaulting firms can face exclusion from the platform.[13]

4 Baseline model in the bank lending architecture

In this section, we consider the architecture in which the only possible lender is a perfectly competitive representative bank.

Bank's loan rate. The break-even bank loan rate is $D_B^\star = 1/p$. For a given fee τ, innovators default if the net cash flow is less than the promised repayment, i.e., $Y_I(1-\tau) < D_B^\star$. Therefore, if $pY_I(1-\tau) < 1$, or alternatively if $\tau > 1 - 1/(pY_I) \equiv \overline{\tau}$, the bank does not lend because innovators default otherwise. The following lemma summarizes the above discussion.

Lemma 1. *Suppose the platform only operates the marketplace. For a given fee, τ,*

- *if $\tau > \overline{\tau}$, the bank does not lend;*
- *if $\tau \leq \overline{\tau}$, the bank lends at the rate $D_B^\star = \frac{1}{p}$.*

This lemma sheds light on the key role played by the fee in determining whether a bank denies funding to innovators, hence inducing credit rationing. If the platform charges a sufficiently high fee, $\tau > \overline{\tau}$, it would limit the ability of vendors to repay their loans, making it unprofitable for the bank to fund innovation. The only way for the bank to lend to innovators is that the platform sets a sufficiently low fee, $\tau \leq \overline{\tau}$.

Platform's fee. We can now study how the platform sets its fee. The incentive of the platform can be best explained by first assuming that it has full information about each vendor's type. In this case, it could set different fees. Denoting τ_I and τ_N the fees for innovators and non-innovators, respectively, we state the following result.

[13]For a model of the role of collateral in enforcing loan repayment in the platform ecosystem see Gambacorta, Khalil and Parigi (2021).

Lemma 2. *In the bank lending architecture, under full information about vendors' type, the platform sets the following monopoly fees*

$$\tau_N = \frac{1}{2}, \qquad \tau_I = \frac{\overline{\tau}}{2}$$

to non-innovators and innovators, respectively. The bank always funds innovation.

The above lemma states that if the platform can identify vendors' types it would perfectly discriminate them by setting a different monopoly fee for each type. Non-innovative vendors pay the highest fee, $\tau_N > \overline{\tau}$, whereas the innovative vendors pay the lowest fee, $\tau_I < \overline{\tau}$. Intuitively, $\tau_I < \tau_N$ because innovators face the (fixed) investment cost, which is borne entirely by the vendors and, therefore, is not part of the revenue-sharing with the platform. We note that if the platform were to charge τ_N to innovators as well, the latter would lose access to credit because the bank would not fund them.

Under the assumption that the platform only knows the distribution of vendors and does not observe whether a vendor on the marketplace has borrowed from the bank, these differentiated fees are not incentive compatible, i.e., non-innovators would go for the lowest offered fee, i.e., τ_I. This also implies that if the platform aims to attract both types, it needs to charge an intermediate fee between those charged under full information. However, this leads to lower profits for the platform compared to the scenario with full information. As a result, the platform faces a trade-off. It either sets a high fee, which would exclude innovators from access to credit, or set a sub-optimal pooling fee, which attracts both types to the platform.

Denoting τ_F^B the equilibrium fee in the bank lending architecture, with $F = \{P, H\}$ the pooling and high fee, respectively, from the first-order conditions of the platform's profit in the two cases (provided in the Appendix), we have

$$\tau_P^B = \frac{\lambda p Y_I(pY_I - 1) + (1-\lambda)Y_N^2}{2(1-\lambda)Y_N^2 + 2\lambda p^2 Y_I^2}, \qquad \tau_H^B = \frac{1}{2}. \tag{1}$$

Note that $\tau_P^B < \overline{\tau}$ so that the platform attracts both types, whereas $\tau_H^B > \overline{\tau}$ so that the platform induces the bank to deny loans to innovators. Denoting $\Pi(\tau_P^B, D_B^\star)$ the profit obtained by the platform when innovators are funded and $\Pi(\tau_H^B, \emptyset)$ the profit when they are not, in the Appendix we show that $\Pi(\tau_H^B, \emptyset) > \Pi(\tau_P^B, D_B^\star)$ if and only if

$$\lambda < \frac{Y_N^2(2 - pY_I)}{Y_N^2(2 - pY_I) + pY_I(pY_I - 1)^2} \equiv \tilde{\lambda}, \tag{2}$$

that is, at equilibrium the platform sets a high fee if and only if the share of innovators is sufficiently low. Otherwise, if $\lambda \geq \tilde{\lambda}$, the platform finds it optimal to set a pooling fee and induces the participation of both types. The profit of the platform is

$$\Pi(\tau_H^B, \emptyset) = \frac{1}{4}(1-\lambda)Y_N^2, \tag{3}$$

if $\lambda < \tilde{\lambda}$, and

$$\Pi(\tau_P^B, D_B^\star) = \frac{\left(\lambda p Y_I (p Y_I - 1) + (1-\lambda) Y_N^2\right)^2}{4(1-\lambda)Y_N^2 + 4\lambda p^2 Y_I^2} \tag{4}$$

otherwise. We summarize this result in the following proposition.

Proposition 1. *In the bank lending architecture, the platform finds it optimal to set a high fee and gives up on innovators if their share is small enough, i.e., $\lambda < \tilde{\lambda}$. Otherwise, if $\lambda \geq \tilde{\lambda}$, the platform sets a pooling fee and attracts both innovators and non-innovators.*

The above proposition highlights a key finding of the paper. In an economy where banks are the sole source of funding, the platform's incentives to extract monopoly rents via the fee, senior to bank loans, may stifle innovation. This happens if the platform relies heavily on revenues from the large group of non-innovators. That is, if innovators are few to start with, the optimal fee is so high to render unprofitable for the bank to finance them. Counterintuitively, innovation suffers, not because of lack of platform funding, but because the high fee set by the platform deters banks from financing innovators. However, if the share of innovators is large enough such that the platform can generate substantial revenue even with a lower (pooling) fee, then its optimal strategy is to lower the fee and attract all types of vendors. This makes innovators solvent, which is the condition to obtain bank funding. It is important to note that the bank's break-even rate places a constraint on the platform's optimal decision-making process, thereby leading it to suppress innovation and squeeze non-innovative vendors if $\lambda < \tilde{\lambda}$.

This result shows that a platform may find it profitable to induce the exclusion of some vendors not because they are too risky, but because of a price discrimination argument: it is more profitable to serve only the group with the highest willingness to pay.

A graphical representation of the above results is given in Figure 1. The expected value of an innovative product (gross of the investment cost), pY_I is on the x-axis, whose origin is at 1.2, whereas the share of innovators is on the y-axis. The figure normalizes Y_N to 0.2 and presents two regions. In Region I (diagonally shaded area), the platform sets the pooling fee and the bank funds innovators. In Region II (white area), on the contrary, that is for low pY_I and a small share of innovators λ, the bank does not lend as the platform sets a high fee which, in turn, excludes innovators.

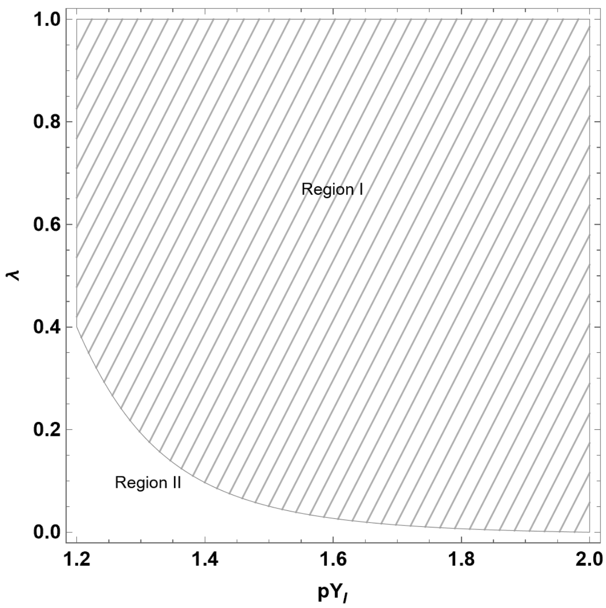


Figure 1: Bank lending architecture ($Y_N = 0.2$).
Region I: the platform sets τ_P^B and the bank finances innovators. Region II: the platform sets τ_H^B and the bank does not finance innovators.

5 Baseline model with platform-bank competition

In this section, we consider the architecture in which the platform and the bank compete for borrowers. We first study the incentive of the platform to enter the credit market by comparing its profits with those obtained in the bank lending architecture. Then, we study how platform lending affects innovation and vendors' surplus.

Conditional on lending, the profit of the platform is

$$\Pi(\tau, D_P) = \tau\Big\{\lambda n_I(\tau, D_P)pY_I + (1-\lambda)n_N(\tau)Y_N\Big\} + \lambda n_I(\tau, D_P)[D_P p - 1] \tag{5}$$

with $n_I(\tau, D_P) = p[Y_I(1-\tau) - D_P]$ and $n_N(\tau) = Y_N(1-\tau)$. Because the fee is the same regardless of whether a vendor borrows from the bank or the platform, a necessary condition for platform lending to happen is that the platform's loan rate is lower than that of the bank, i.e., $D_P < D_B^\star$. This implies that the platform lends at a loss and compensates for these losses by raising the fee on all vendors. To see why, consider the case in which the platform attracts both types of vendors and differentiate the profit of the platform in (5) with respect to τ. Evaluating the first-order condition at the optimal pooling fee τ_P^B set in the bank lending architecture, we obtain

$$\frac{\partial \Pi(\tau, D_P)}{\partial \tau}\Big|_{\tau=\tau_P^B} = \underbrace{\frac{\partial \Pi^{mkt}(\tau, D_P)}{\partial \tau}\Big|_{\tau=\tau_P^B}}_{=0} + \lambda \underbrace{[D_P p - 1]}_{<0} \underbrace{\frac{\partial n_I(\tau, D_P)}{\partial \tau}}_{<0}\Big|_{\tau=\tau_P^B} > 0, \qquad \forall\ D_P < \frac{1}{p}. \tag{6}$$

The first term in (6) is the effect of an increase in the fee on the platform's profit, which is zero at $\tau = \tau_P^B$. The second term captures the change in the platform's profit in the lending market stemming from an increase in the fee that reduces innovators' participation to the marketplace. Because innovators borrow from the platform only if $D_P < 1/p$, the above expression is positive. This means that starting from the equilibrium pooling fee under the bank lending architecture, if the platform offers a below-market rate to innovators it does so by raising the fee on all vendors. As a result, there is a cross-subsidy from the marketplace to the lending activity.

The following proposition summarizes this result and provides the equilibrium loan rate and fee resulting from the platform maximizing (5) with respect to D_P and τ.

Proposition 2. *Conditional on the platform being active in the lending market, the platform cross-subsidizes its lending activity through revenues on its marketplace. The optimal fee and interest rate are*

$$D_P^\star = \frac{1}{2p}, \qquad \tau^P = \frac{1}{2}.$$

This states that if the platform enters the credit market, it sets the fee equal to 1/2 and subsidizes innovators by lowering the interest rate to a level that is half of the bank's rate. Remarkably, this fee is (weakly) higher than the one set by the platform in the bank lending architecture. Specifically, it is higher than the pooling fee τ_P^B but it is the same fee that the platform sets when attracting only non-innovators or perfectly discriminating them (i.e., $\tau^P = \tau_H^B = \tau_N$).

Indeed, by lending, the platform engages in a form of price discrimination. The platform sets the highest fee for the non-innovators, who do not borrow and uses the interest rate to reach the intended goal of subsidizing the innovators.[14] By subsidizing loans the platform increases the range of innovators that find it optimal to apply for loans as opposed to enjoying their outside options. The profit for the platform is

$$\Pi(\tau^P, D_P^\star) = \frac{1}{4}\left(\lambda(pY_I - 1)^2 + (1-\lambda)Y_N^2\right). \tag{7}$$

A direct implication of the above result is that the platform always finds it optimal to lend in this setting. This can be observed by comparing the profit of the platform in (7) with its profit in the two scenarios under a bank lending architecture in (3) and (4).

[14] Note that the platform has no incentive to tie the fee to the loan and provide a menu of contracts where a given fee is associated with a given interest rate. This is because it charges the maximum fee $\tau = 1/2$ and the rate $D_P^\star = 1/(2p)$. Even if the platform could set a menu of two contracts $\{\tau_i; \text{no loan}\}$ and $\{\tau_j; D_P\}$ and let the vendors choose which one they like, it would not be able to set a fee larger than 1/2, hence it would not benefit from separating the types.

The rationale is the following. If the platform sets a pooling fee in the bank lending architecture, it uses only one instrument over two types of vendors. Because platform lending does not entail any distortion, the platform obtains a second instrument that guarantees a strictly higher profit. Differently, if the platform sets a high fee and only attracts non-innovators under the bank lending architecture, it extracts the highest profit from this group of vendors. By entering the lending market, the platform keeps the same high fee but now also attracts innovators, resulting therefore in strictly higher profit as well. This suggests that absent market frictions the platform has always a strictly positive incentive to enter the credit market. This result is presented in the following proposition.

Proposition 3. *Absent market frictions, the platform always has a strictly positive incentive to enter the credit market.*

5.1 Welfare effects of platform lending

In this section, we provide a discussion of the welfare effects of platform lending.

First, an implication of platform lending is financial inclusion, that is funding projects with a positive NPV that would not be funded otherwise by the bank. This result has been found in previous papers (Hau et al., 2019).[15] Yet, the mechanism is starkly different and arises from the fact that absent platform lending, the platform has the incentive to raise the fee for all vendors when innovators account for a limited share and this, reducing the cash flow available for debt repayment, induces the bank not to lend. This distortion is fully internalized by the platform when it lends because the cross-subsidy leads to a lower interest rate. Formally, platform lending leads to financial inclusion in the circumstance summarized in the following lemma.

Lemma 3. *Platform lending leads to financial inclusion if* (2) *holds, i.e.,* $\lambda < \tilde{\lambda}$.

We can now study the welfare impact of platform lending on the participants in the marketplace. The welfare here is simply the sum of the payoffs of all actors, net of the outside option cost paid by innovators and non-innovators.

First, we note that platform lending exerts a (weakly) negative externality on non-innovators. Because platform lending implies setting a (weakly) higher fee for everyone, non-innovators are (weakly) worse off relative to when only the bank lends. Specifically, if (2) holds ($\lambda < \tilde{\lambda}$), non-innovators pay the highest fee $\tau^P = \tau_H^B = 1/2$ in both architectures and, therefore, platform lending is welfare-neutral to them. Otherwise, if (2)

[15] In Hau et al. (2019), the fintech firm, using data on vendors on an e-commerce platform, generates financial inclusion by operating on the extensive margin of the borrowers and serving, therefore, borrowers not served by banks.

does not hold ($\lambda \geq \tilde{\lambda}$), non-innovators pay a higher fee under platform lending than the pooling fee in the bank lending architecture, i.e., $\tau^P = 1/2 > \tau_P^B$ and, therefore, platform lending harms them.

Second, the effect of platform lending on the surplus of innovators may be ex ante ambiguous and we have to distinguish once again the counterfactual scenario that occurs if the platform does not lend. If (2) holds ($\lambda < \tilde{\lambda}$), innovators are not funded by the bank under the bank lending architecture, whereas they are funded by the platform under platform-bank competition. As a result, the lending activity of the platform has a positive effect on innovation. This, combined with the fact that the platform always finds it profitable to lend under platform-bank competition, and non-innovators pay the same fee, makes the lending activity of the platform welfare-enhancing. This also means that a sufficient condition for platform lending to be socially desirable is that the bank would not lend to innovators in the bank lending architecture.

If (2) does not hold, the platform sets a pooling fee in the bank lending architecture and subsidizes innovators if lending. The impact on innovators' surplus depends on whether losses from a higher fee are offset by (or offset) gains from a lower loan rate. Denote the surplus of the innovators for any given τ and D as

$$IS(\tau, D) = \lambda \int_0^{p[Y_I(1-\tau)-D]} [p(Y_I(1-\tau) - D) - \omega] d\omega. \tag{8}$$

Let $\triangle IS = IS(\tau^P, D_P^\star) - IS(\tau_P^B, D_B^\star)$ be the difference in the innovators' surplus in the platform-bank lending architecture and in the bank lending architecture. In the Appendix, under the maintained assumptions of uniform distributions of the outside options, we show that the reduced interest rate benefits innovators more than how much the higher fee lowers their surplus. As a result, also in this case, platform lending is beneficial to innovators. However, as discussed, non-innovators are worse off because the fee is distorted upward.

In the Appendix, we compare the total vendors' surplus in the bank lending architecture with that in the platform-bank competition architecture under the condition that $\lambda \geq \tilde{\lambda}$. We show that the total vendors' surplus decreases with platform lending. Therefore, platform lending in this case spurs innovation but overall harms vendors because losses for non-innovators offset gains for innovators. Whether platform lending is socially desirable in this scenario depends on whether aggregate vendors' losses are offset by the platform's gains. We summarize this discussion in the following proposition.

Proposition 4. *A sufficient condition for platform lending to be (weakly) beneficial to innovators, non-innovators, and the platform is that in the bank lending architecture, the bank does not fund innovation, that is* (2) *holds. Otherwise, if* (2) *does not hold, platform* *lending harms non-innovators, and benefits innovators and the platform's profit, but the net effect on vendors' surplus is negative.*

Table 1 summarizes the main results in our baseline model both in the presence of a bank lending architecture and in the platform-bank architecture.

Note that throughout our analysis we made the simplifying assumption that both the platform and the bank treat borrowers the same way. In reality, however, banks can also build relationships with their clients, implying that the vendors face an opportunity cost from borrowing from the platform. Under the assumption that this cost is homogeneous across borrowers, our main results would hold qualitatively in several circumstances. Moreover, for the sake of tractability, we have abstracted from the fact that the platform controls additional instruments (e.g., prioritization on search results, better ranking position) that can impact sales on its marketplace. Our model is qualitatively robust to extensions that introduce additional advantages that borrowing from the platform can entail.

	Only bank allowed to lend (1) Proposition 1			Bank, platform compete (2) Proposition 4			Change in surplus from (1) to (2)		
% of innovators	Fee	Lending	Int. rate	Fee	Lending	Int. rate	Innovators	Non-Innovators	Total surplus
Low	High	No		High	Yes	Below mkt	Increases	Constant	Increases
High	Middle	Yes	Mkt rate	High	Yes	Below mkt	Increases	Decreases	Decreases

Table 1: Summary of the main results in the baseline model

6 Regulation

In this section, we discuss the effect of three regulations: (i) a cap on the fee that the platform can charge; (ii) the outright prohibition of platform lending; (iii) a structural separation between the marketplace and the lending unit of the platform.

Cap on the fee. Regulation of fees is currently discussed by policymakers to avoid platforms engaging in excessive pricing.[16] Recent studies have also examined the effects of a cap on fees (Gomes and Mantovani, 2020; Bisceglia and Tirole, 2023). Suppose there is a cap on the fee, denoted as $\hat{\tau}$. We focus on the scenario where $\hat{\tau}$ is lower than the fee that excludes innovators from the marketplace, denoted by $\overline{\tau}$.

A cap has two effects on the platform's strategy in both lending architectures. First, in the bank lending architecture, where the rate $D_B^\star = 1/p$, the equilibrium fee τ_P is

[16]For example, in 2020, the city of San Francisco imposed a cap on the fees for order delivery platforms.

constrained by the cap. If the cap is binding, the platform's equilibrium fee is set to the cap, $\hat{\tau}$. Otherwise, the platform's equilibrium fee remains τ_P^B as defined in equation (1). It is important to note that in the bank lending architecture, the platform may have an incentive to raise the fee and attract only non-innovators. However, the cap now prevents the platform from doing so, resulting in the platform attracting both groups. As a result, relative to an unregulated regime, with a cap on the fee it is (weakly) more likely that the bank funds innovators. This implies that if the share of innovators is so low that the platform prefers to set a high fee inducing the bank not to lend, i.e., $\lambda < \tilde{\lambda}$, then a cap on the fee would spur innovation.

Second, let us consider the bank-platform lending architecture. In this case, the introduction of a cap on the fee lowers the extent to which the platform can engage in cross-subsidies, as losses on the credit side are compensated to a lesser extent by the higher fee on the marketplace. As a result, the platform has a lower incentive to enter the credit market than in an unregulated regime. Suppose the constraint binds under bank lending, so that the fee is equal to $\hat{\tau}$. Then, under platform lending, the fee is again equal to $\hat{\tau}$. This makes it impossible for the platform to out-compete the bank and engage in a cross-subsidy because any undercutting of the bank will only result in losses in the credit market and no gains in the marketplace. Since innovators benefit from below-market interest rates offered by the platform, the cap on the fee has a negative effect on innovation while benefiting non-innovators.

Now suppose the constraint is slack in the bank lending architecture. The platform faces a trade-off between operating sub-optimally with a pooling fee, without being constrained by regulation (because the pooling fee in the bank lending architecture is $\tau_P^B < \hat{\tau}$), and being constrained in the fee when lending because the resulting fee is higher than the cap (i.e., $\tau^P > \hat{\tau}$). This reduces the incentive for the platform to lend, which may have a negative impact on innovation given that innovators benefit from the lending activity of the platform. We conclude the following.

Proposition 5. *A cap on the fee has a (weakly) positive effect on innovation in the bank lending architecture. Moreover, under platform-bank competition, it has a (weakly) negative effect on the incentive of the platform to enter the credit market and on innovation.*

Outright prohibition of platform lending. In our setting, an outright prohibition of platform lending is equivalent to the emergence of a bank lending architecture and this architecture entails a possible trade-off for the authority. From the baseline model, we know that a sufficient condition for platform lending to be socially desirable is that, in a bank lending architecture, innovation is not funded.

In the parameter range identified by $\lambda \in [0, \tilde{\lambda})$ the outright prohibition of platform lending is socially undesirable because it lowers aggregate vendors' surplus and negatively impacts the platform's profit. The reversal of the platform-bank competition architecture to a bank lending one will lead the bank to deny credit to innovators (Lemma 1), which will be worse off. However, non-innovators would obtain the same surplus in either scenario.

However, in the parameter range in which innovators receive funding from the bank in the bank lending architecture (i.e., $\lambda \geq \tilde{\lambda}$), the outright prohibition of platform lending will have contrasting effects. On the one hand, it benefits non-innovators because the platform will lower the pooling fee in this parameter range. However, it harms innovators, which will be funded by the bank at a higher interest rate. Ultimately, it also reduces the platform's profit. Because in this parameter range overall vendors' surplus is lower if the platform lends, the outright prohibition of lending will benefit overall vendors' surplus.

Structural separation. In our setting, imposing a structural separation between the platform's marketplace activity and the lending activity neutralizes fully the incentive of the platform to operate the lending market. Under structural separation either the platform finds it profitable to charge a higher fee so that the bank does not lend, or if the platform lends it must break even like the bank. Moreover, even if innovators borrow from the platform, the outcome would be identical to the one in which only the bank is allowed to lend as no cross subsidy would take place.

7 Extensions

In this section, we relax some of the baseline model's assumptions and introduce several frictions that can mitigate or amplify the platform's incentive to engage in price discrimination of vendors through its lending activity as well as its social desirability. First, we consider the case in which the platform has a funding cost disadvantage relative to the bank. Second, we introduce platform information advantage relative to the bank. Third, we introduce cross-group network effects and consider the case in which there is elastic buyer participation. Fourth, we allow non-innovators to borrow even if they do not have funding needs. Fifth, we consider the case in which some vendors borrow from the platform but do not operate in its marketplace. Finally, we consider the case in which the marketplace has multiple product categories and, therefore, the probability that innovators repay their loan can differ across product categories.

7.1 Costly funding for the platform

In this section, we assume that the bank has a cheaper funding cost than the platform. This is because platforms do not have access to deposits because they lack a banking licence. To this end, we normalize the funding cost of the bank to zero and denote the funding cost of the bank as $r > 0$. We assume that $pY_I > 1 + r$, which means that the NPV of the investment is still positive. Under the bank lending architecture, the analysis in Section 4 holds in full and it is unchanged.

With a slight abuse of notation for the interest rate and fees, if the bank and the platform compete in the credit market, the platform's fee and interest rates are now given by

$$D_P^\star = \frac{1+r}{2p}, \qquad \tau^P = \frac{1}{2}. \tag{9}$$

There is a partial pass-through of the funding cost onto the loan rate, which remains lower than that of the bank (i.e., $D_B^\star = 1/p$) as $1 + r < pY_I < 2$ by assumption. The cross-subsidy continues to be present but the platform cannot raise further the fee. Because the platform bears part of the funding cost there is a friction that renders the price discrimination strategy of the platform more costly. The profit of the platform is

$$\Pi(\tau^P, D_P^\star) = \frac{1}{4}\Big(\lambda(pY_I - (1+r))^2 + (1-\lambda)Y_N^2\Big). \tag{10}$$

Comparing it with the profit obtained under the bank lending architecture, we first verify that if under bank lending innovators are not funded, (2) holds, then platform lending is always profitable for the platform. This is done by comparing (3) with (10). The rationale is quite simple. The fee is the same as when the platform focuses only on non-innovators (i.e., $\tau^P = \tau_H^B$) in the bank lending architecture. Because now the platform also attracts innovators and can make strictly positive profits from them, $(pY_I - (r+1))^2$, by lending it can increase its profit. Therefore, it always has an incentive to enter the credit market.

However, if under the bank lending architecture (2) does not hold, in the platform-bank competition the platform weighs the cost of funding innovators against the benefit of discriminating vendors. Comparing profits in (4) with those in (10), it is immediately clear that the platform finds it optimal to lend if and only if

$$\lambda < \max\left\{0, \frac{Y_N^2\,(2prY_I - (1+r)^2)}{r(2 - 2pY_I + r)(pY_I - Y_N)(pY_I + Y_N) - Y_N^2}\right\} \equiv \tilde{\lambda}^r \tag{11}$$

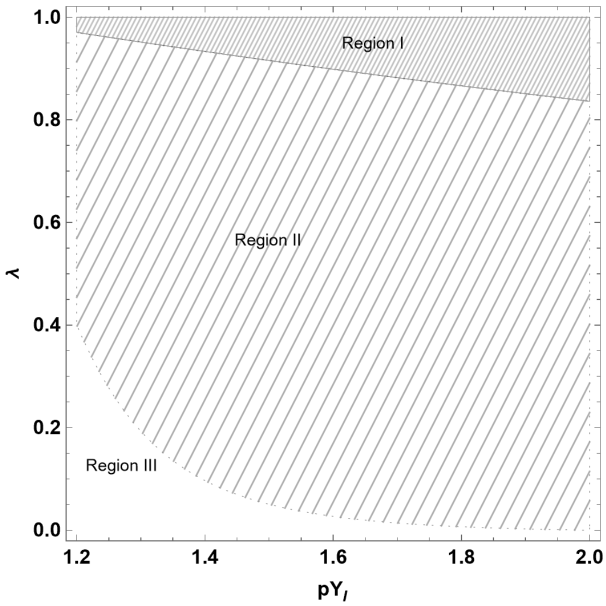
Otherwise, the platform does not lend and only operates the marketplace. Unlike in the baseline model, the platform might not enter the credit market. We conclude the following:

Proposition 6. *Under the maintained assumption that* $1+r < pY_I$*, a sufficient condition for the platform to find it optimal to lend is that in the bank lending architecture, the bank does not fund innovation, that is* (2) *holds. Otherwise, if* (2) *does not hold, the platform finds it optimal to enter the credit market if and only if the portion of innovators is not "too" large, i.e.,* (11) *holds.*

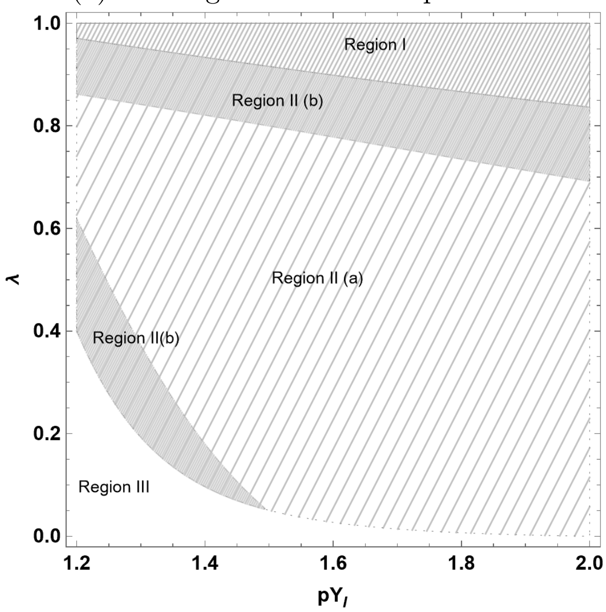
The rationale for the second part of the above proposition is that if the bank would lend to innovators, the platform behaves sub-optimally both when it does not lend (because of the pooling fee) and when it lends (because of the funding cost). As a result, its incentives to lend depend on how costly it is for the platform to lend. If the innovators are few (or the expected net value of the innovation is small), the platform can afford the costly funding and enable price discrimination. However, when the share of innovators grows larger, the funding cost of the platform grows as well and because the funding cost is partially passed onto innovators, the gains from discrimination decrease. As a result, the platform would not find it optimal to lend to a large share of innovators.

Figure 2 graphically summarizes the above findings under some parameter constellations. In Region I, the platform does not find it optimal to lend, meaning that the outcome is the same as in the bank lending architecture in this parameter range and innovators are always funded because the platform sets a fee that attracts both innovators and non-innovators. Regions II and III represent the areas in which the platform finds it optimal to lend. They differ with respect to their counterfactual in the bank lending architecture. Region III is the area in which the bank would not find it optimal to lend because (2) holds (i.e., the fee is too high). In Region II, the bank offers credit to innovators because the platform sets the pooling fee, i.e., (2) does not hold.

The welfare effects of platform lending are more complex than in the baseline model. Figure 2 (panel a) shows that it continues to hold that platform averts credit rationing and platform lending is socially desirable. This is because if (2) holds, the platform lends and innovators are better off, whereas non-innovators always face the same fee $\tau^P = \tau^B_H$. This occurs in Region III. However, if (2) does not hold and there is platform-bank competition (Region II), non-innovators are worse off because of the higher fee whereas innovators can either be better off or worse off depending on the relationship between the reduced interest rate and the higher fee. However, relative to the baseline the interest rate is now higher because of the funding cost pass-through. This implies that not only platform lending can reduce total vendors' surplus as in the baseline model, but it can now harm innovation in some circumstances. Figure 2 (panel b) shows that, within Region II, there exist two areas (gray areas) in which the platform lends to innovators but innovators are worse off relative to when only the bank lends. This is because innovators' gains from the reduced loan rate do not compensate for the high fee relative to the bank lending



(a) Lending decision of the platform



(b) Impact of platform lending on innovation

Figure 2: Bank-platform lending architecture ($Y_N = 0.2, r = 0.1, pY_I > 1 + r$)
In Region I, innovators are funded by the bank both in the bank lending architecture and under platform-bank competition. In Region II, innovators are funded by the platform under platform-bank competition and by the bank in the bank lending architecture. In Region (II a), innovators are worse off under platform-bank competition relative to the bank lending architecture, whereas in Region II (b) innovators are better off. In Region III, innovators are funded by the platform under platform-bank competition whereas they are not funded by the bank in the bank lending architecture; the platform lending activity is welfare-enhancing.

architecture. On the contrary, Region II (a) is consistent with the baseline setting and therefore in this area, innovators benefit from platform lending whereas non-innovators are worse off. Moreover, the total vendors' surplus is lower with platform lending for the same reasons we discussed in the baseline setting.

A key message from this section is that there exists a non-empty set in which platform lending occurs at equilibrium but this harms innovators and non-innovators.[17] A sufficient condition for this to happen is that innovators are better off under the bank lending architecture. The following proposition summarizes this result.

Proposition 7. *Under the maintained assumption that the platform incurs a positive funding cost, a sufficient condition for platform lending to be (weakly) beneficial to innovators, non-innovators, and the platform is that in the bank lending architecture, the bank does not fund innovation, that is* (2) *holds. If* (2) *does not hold and the platform finds it optimal to lend, i.e.,* $\lambda < \tilde{\lambda}^r$*, platform lending may have a negative effect on innovation and harm all vendors.*

7.2 Platform information advantage

A significant by-product of the platform's e-commerce business is its vast data accumulation. These data are used as input to offer various services. These services exploit natural network effects, leading to increased user activities. This creates what is termed as a "virtuous Data, Network, Activities (DNA) feedback loop" (Frost et al., 2019). As a result, the platform can price risk more accurately than traditional banks. Additionally, it can tailor credit terms based on vendor characteristics.

To this end, we modify the baseline model by assuming that the population of the λ innovators is of two types, high (H) and low (L), with exogeneously-set proportions α and $1 - \alpha$, respectively. Both types produce output Y_I, but high-type innovators succeed with probability p_H whereas low-type innovators succeed with probability p_L. We assume that the NPV of the investment by high-type innovators is positive whereas that of low-types is negative, i.e., $p_L Y_I < 1 < p_H Y_I$. Moreover, we assume that $p_H Y_I < 2$ in order to have elastic participation of high-type innovators and that α is independent from the outside option of joining the platform ω, which ensures tractability in our analysis.

We proceed as follows. First, we consider the equivalent of the baseline setting in Section 4, which focuses on a bank lending architecture. Within this setting, the bank is aware that a fraction α of the innovators belong to the "H" category, with the residual fraction

[17] Analytical details are provided in the Appendix. However, as a direct computation is unfeasible, we provide a proof by (graphical) example.

falling under the "L" category. Second, we consider the platform-bank competition and assume that the platform perfectly identifies the innovators' type, whereas the bank only their proportions.

Bank Lending Architecture. Given that innovators are aware of their type, type-H would join the platform under the condition $p_H[Y_I(1-\tau) - D_B] \geq \omega$. Similarly, low-type innovators would join if $p_L[Y_I(1-\tau) - D_B] \geq \omega$. While we slightly deviate from the standard notation, we will continue to use the notation from Sections 4 and 5 to represent the interest rate and fees, provided it doesn't lead to ambiguity. Under the maintained assumption that ω is uniformly distributed within the range $\omega \in [0,1]$, the bank's break-even loan rate is now represented as:[18]

$$D_B^\star = \frac{p_L + \alpha(p_H - p_L)}{p_L^2 + \alpha(p_H^2 - p_L^2)}. \tag{12}$$

Because the bank lends if and only the realised net cash flow is larger than the promised repayment, as in Lemma 3, there is a critical threshold of the fee, denoted as $\overline{\tau}$, such that the bank does not lend if $Y_I(1-\tau) < D_B^\star$ for any $\tau > \overline{\tau}$ and lends otherwise.

The other results hold true qualitatively as well: the platform sets either a sufficiently high fee, denoted as $\tau_H^B = 1/2 > \overline{\tau}$, so that no innovator joins the marketplace, or sets τ to maximize the following profit function

$$\Pi(\tau, D_B^\star) = \lambda\tau Y_I\Big[(1-\alpha)n_L(\tau, D_B^\star)p_L + \alpha n_H(\tau, D_B^\star)p_H\Big] + (1-\lambda)n_N(\tau), \tag{13}$$

subject to $\tau < \overline{\tau}$, where n_L and n_H, which are defined in the Appendix, are the numbers of low- and high- types entering the marketplace, respectively. Consistently with the baseline model, the platform induces the bank not to lend if the share of innovators is low. Otherwise, the platform lowers the fee so that the bank lends to both types of innovators. Therefore, the platform collects a fee also from those vendors that should not have been funded because of their negative NPV.

Platform-bank competition. We assume that the platform perfectly identifies types. Quite intuitively, the platform excludes the low types from loans given their negative NPV. Yet, they can try to borrow from the bank but the latter, anticipating that these vendors did not secure a platform's loan, will not offer credit to them as well. As a result, the fact that the platform denies them credit eliminates the adverse selection problem otherwise present.

[18] Note that $D_B^\star = 1/p$ as in the baseline model if $p_H = p_L = p$.

After excluding the innovators with negative NPV, the platform faces a decision: either to exclusively lend to the high-type innovators or to abstain from lending altogether. As demonstrated in the Appendix, the platform consistently deems it optimal to participate in the lending market. In this case, the profit of the platform is

$$\Pi(\tau^P, D_P^\star) = \tau^P \Big\{ \lambda\alpha n_I(\tau^P, D_P^\star)Y_I + (1-\lambda)n_N(\tau^P)Y_N \Big\} + \lambda\alpha n_I(\tau^P, D_P^\star)[D_P^\star - 1] \quad (14)$$

with $n_I(\tau^P, D_P^\star) = p_H[Y_I/2 - 1/(2p_H)]$ and $n_N(\tau^P) = Y_N/2$ because $\tau^P = 1/2$ and $D_P^\star = 1/(2p_H)$, which are the same as in Proposition 2 once replacing p_H by p.

This result is consistent with the baseline model but carries out a new effect: within the parameter spectrum where the bank lending architecture funds both low- and high-type innovators, the platform opts to finance only the high-type innovators. Consequently, the interest rate for these high-type innovators is reduced compared to the rates offered in the baseline bank lending model because of two factors: (i) the cross-subsidy mechanism and (ii) the avoidance of being pooled with low-types. Therefore, when the platform possesses superior information compared to the bank, a "cream skimming" phenomenon emerges. Since the platform excludes innovators with negative NPV, these innovators turn to the bank. However, the bank, foreseeing the potential adverse selection, refrains from financing them as well. As the bank no longer lends to those negative NPV types to whom it would have lent under symmetric information, better information will result in an improvement of the quality of the pool of projects financed and in lower rates.

In summary, the key finding of this section reinforces the insights obtained from the baseline model and confirms their qualitative validity. We conclude the section by stating the following proposition.

Proposition 8. *Suppose the platform can identify innovators with positive and negative NPV investments, whereas the bank cannot. Then, the platform always finds it optimal to enter the lending market and exclude negative NPV innovators and the bank does not lend anticipating the adverse selection problem.*

7.3 Network effects

In this section, we relax the assumption that buyer participation is inelastic. We assume that buyers have an opportunity cost of joining the platform, which we denote as $\gamma \in [0, 1]$, and they enjoy a cross-group network benefit $\phi > 0$ from vendors on the marketplace, regardless of whether they are innovators or not. In other words, we assume that buyers have a taste for variety and their decision to join the marketplace depends on the amount of sellers on the marketplace (see Rochet and Tirole 2006). Formally, we denote the utility of a consumer as

$$u(n_I(\cdot), n_N(\cdot)) = \phi\Big(\lambda n_I(\cdot) + (1-\lambda) n_N(\cdot)\Big) - \gamma,$$

and we drop the arguments for better readability. We also assume that once on the platform they consume all available output. Assuming a uniform distribution of γ, buyer's participation in the marketplace, which we denote as $M(n_I(\cdot), n_N(\cdot))$, is simply $M(n_I(\cdot), n_N(\cdot)) = \phi[\lambda n_I(\cdot) + (1-\lambda) n_N(\cdot)]$. The mass of innovators and non-innovators changes as follows

$$n_I(M(n_I(\cdot), n_N(\cdot)), \tau, D) = p[Y_I M(n_I(\cdot), n_N(\cdot))(1-\tau) - D],$$

$$n_N(M(n_I(\cdot), n_N(\cdot)), \tau, D) = Y_N M(n_I(\cdot), n_N(\cdot))(1-\tau).$$

Consider first the bank lending architecture. Because the bank breaks even it continues to set $D_B^{\star} = 1/p$. As in the baseline model, the platform can decide to focus on the non-innovators only, setting a high fee τ_H^B, or attract innovators as well with a pooling fee τ_P^B. To understand incentives, let us start with a scenario where the platform chooses τ_H^B and lowers it to τ_P^B. This reduction in the fee brings about two main effects. First, as in the baseline model, the platform can extract surplus from innovators now funded by the bank. Second, and more importantly, the platform boosts consumer participation because $M(\cdot)$ is decreasing in the fee because $n_N(\cdot)$ and $n_I(\cdot)$ are both decreasing in the fee. This in turn implies that in the bank lending architecture, the platform is less likely to induce a scenario in which innovators do not receive funding.

Consider now the platform-bank competition. As in the baseline model, the platform can enter the lending market conditional on offering a below-market interest rate. First, let us consider the parameter range in which in the bank lending market only non-innovators join the marketplace. Because platform lending implies that innovators join the marketplace, this increases $M(\cdot)$ and, as a result, it has a strictly positive effect on the surplus of both innovators and non-innovators as well as on the platform's profit. Therefore, it continues to hold that platform lending is welfare-enhancing if innovators would not receive funding otherwise. However, cross-group network effects amplify the positive impact of platform lending in this parameter range.

Second, let us consider the parameter range in which innovators are funded under the bank lending architecture. It is intuitive that it continues to hold that the platform engages in a cross-subsidy for the same rationale provided in the baseline model. Because lending to innovators implies a below-market interest rate, due to $n_I(M(n_I(\cdot), n_N(\cdot)), \tau, D_P)$, which is decreasing in τ, the equilibrium fee must be higher under platform-bank competition than under the bank lending architecture. However, buyer participation now plays an important role in understanding whether lending is profitable for the platform. In the baseline model, platform lending leads to fewer non-innovators and more innovators in the marketplace. Because of cross-group network effects, it is not straightforward that the platform would always prefer to lend. The reason is that if buyer participation decreases (because non-innovators' reduction in participation makes buyers also reduce their activity) under platform lending, innovators can be harmed (and reduce their participation) because losses from the reduced demand and a higher fee relative to the bank lending architecture would offset gains from subsidized credit. On the other hand, if buyer participation increases with platform lending, innovators and non-innovators may increase their participation, amplifying the platform's incentive to lend and its social desirability.

In summary, this section emphasizes that the primary motivation behind the platform's lending activity remains unchanged. However, the presence of cross-group network effects can either weaken or strengthen this motive. Nevertheless, a crucial finding is that lending consistently takes place at a below-market rate, resulting in increased welfare in situations where banks would not provide loans.

7.4 Non-innovators can borrow

In this section, we relax the assumption that non-innovators do not have storage capacity and do not borrow even when the promised repayment is less than the loan, 1. If non-innovators also borrow at a below-market rate from the platform, the incentives of the latter to lend by cross-subsidizing innovators may decrease.[19] To this end, we consider the case in which non-innovators may borrow 1, store it in a safe asset, and repay $D = \{D_P, D_B\}$. Because the bank's break-even rate is larger than 1, non-innovators may only borrow if loans are offered by the platform. More precisely, a non-innovator has an incentive to borrow from the platform if, and only if,

$$D_P^\star = \frac{1}{2p} < 1,$$

which turns out to be the case if, and only if, $p > 1/2$. Therefore, our analysis of the baseline model continues to hold for any $p \leq 1/2$. However, if $p > 1/2$, the platform faces a new force that goes in the direction of reducing its incentives to lend because vendors different from its intended target can also borrow. As a result, the platform can follow three alternative strategies: (i) set $D_P = 1$, thereby rendering non-innovators indifferent between borrowing or not; in this case, under the assumption that non-innovators do not

[19]Note that we continue to assume that the platform is not in the condition to distinguish innovators and non-innovators.

borrow when they are indifferent between two alternatives, the profit of the platform is

$$\Pi(\tau, D_P) = \tau \cdot \Big\{\lambda n_I(\tau, D_P)pY_I + (1-\lambda)n_N(\tau)Y_N\Big\}, \tag{15}$$

and we denote as $\tilde{\tau}^P$ the optimal fee that maximizes (15); (ii) accept that non-innovators would also borrow and set $D_P < 1$; in this case, the profit of the platform is

$$\begin{aligned}\Pi(\tau, D_P) =& \tau \cdot \Big\{\lambda n_I(\tau, D_P)pY_I + (1-\lambda)n_N(\tau, D_P)Y_N\Big\} \\ &+\lambda n_I(\tau, D_P)[D_P p - 1] + (1-\lambda)n_N(\tau, D_P)[D_P - 1]\end{aligned}$$

(iii) do not lend and obtain profits as in (3) (if $\lambda < \tilde{\lambda}$) or as in (4) (if $\lambda \geq \tilde{\lambda}$). In the latter case, the profit of the platform is the same as in the baseline model of the bank lending architecture and depends on whether it finds it optimal to have a high fee (and give up innovators) or lower the fee to allow innovators to borrow from the bank. In the Appendix, we show that option (ii) is never a feasible strategy for the platform as this would lead to a loan rate above 1.

To identify the optimal choice of the platform we compare its profit when lending sub-optimally (alternative (i)), because of the constraint on the loan rate, with its profit when it does not lend (alternative (iii)). Suppose that under bank lending, the platform sets a pooling fee so that both innovators and non-innovators join the platform. In this case, the platform obtains the profit in (A-4). Denoting $\Delta\Pi = \Pi(\tilde{\tau}^P, 1) - \Pi(\tilde{\tau}^B_P, D^\star_B)$ the difference between the profit of the platform when it lends and when it does not (where $\Pi(\tau^B_P, D^\star_B)$ is the same as in (4)), in the Appendix we show that $\Delta\Pi > 0$. Therefore, the platform always finds it optimal to lend to innovators in the parameter range in which, in the bank lending architecture, the bank would lend (i.e., (2) does not hold). The intuition is the following: if only the bank lends, the platform sets a pooling equilibrium fee that is sub-optimal for the platform because it is not able to discriminate vendors. Under platform lending, however, the platform can *partially* cross-subsidize innovators and, therefore, discriminate vendors. Even if the latter strategy is sub-optimal for the platform because of the constraint on the loan rate, it can still increase its profit relative to when only the bank lends. Therefore, platform lending occurs at equilibrium.

Suppose now that, in the bank lending architecture, the platform sets a high fee so that only non-innovators join the platform, that is (2) holds and $\lambda < \tilde{\lambda}$. In this case, the platform obtains the same profit as in (3). Denoting $\Delta\tilde{\Pi} = \Pi(\tilde{\tau}^P, 1) - \Pi(\tau^B_H, \emptyset)$ the difference between the profit of the platform when it lends and when it does not (where $\Pi(\tau^B_H, D^\star_B)$ is the same as in (3)), in the Appendix we show that $\Delta\tilde{\Pi}$ can either be positive or negative depending on the value of λ. Specifically, there may exist a threshold, denoted as $\hat{\lambda}$, above which $\Delta\tilde{\Pi} > 0$ and below which $\Delta\tilde{\Pi} < 0$. This implies that platform lending occurs in equilibrium provided that $\tilde{\lambda} > \hat{\lambda}$ if and only if there exists a $\lambda \in [\hat{\lambda}, \tilde{\lambda}]$. Otherwise, the platform does not lend.

The intuition of this result is the following. If the platform does not lend it only attracts non-innovators and uses one instrument, the fee, over one homogeneous mass of vendors, thereby leading to the maximum profit to be extracted by the platform. However, if the platform lends, it attracts both types but with an imperfect cross-subsidy, which is sub-optimal. Therefore, it is more profitable not to lend if there are few innovators and more profitable to lend otherwise.

Proposition 9. *Suppose non-innovators have storage capacity. If $p \leq 1/2$, the analysis of the baseline model holds. If $p > 1/2$, a sufficient condition for platform lending to occur is that the bank funds innovators in the bank lending architecture, i.e., $\lambda \geq \tilde{\lambda}$. Otherwise, if $\lambda < \tilde{\lambda}$, platform lending occurs if and only if $\tilde{\lambda} > \hat{\lambda}$ and $\lambda \in [\hat{\lambda}, \tilde{\lambda})$. If $\hat{\lambda} \geq \tilde{\lambda}$, platform lending never occurs.*

The proposition posits that the presence of non-innovators who can benefit from the platform's loan, coupled with a high probability of success for innovators' investments, may weaken the platform lending system. This, in turn, can negatively impact innovation, as we know from Proposition 4 that a sufficient condition for platform lending to be socially desirable is that banks do not fund innovators in the bank lending architecture.

7.5 Lending outside the platform

Credit to e-commerce vendors is only a part of the credit offered by big techs. Big tech offers loans to firms working outside the e-commerce platforms (offline firms), whose credit scoring is calculated using machine learning techniques applied to big data collected via QR code-based payment systems (Beck et al., 2022). In this section, we discuss how the incentive of the platform changes if innovative vendors can have access to cheap credit from the platform and sell outside (i.e., own direct channel, offline). A similar argument would also apply in the presence of a competing platform. We discuss this in detail in what follows.

First, suppose there exists a fixed mass of vendors that sell outside the marketplace whereas other innovative vendors and all the non-innovative sell in the marketplace like in the baseline model. Assume that these vendors require 1 unit of investments and the output is again Y_I with probability p, else it is zero, with $pY_I > 1$. In the bank lending architecture, these vendors only borrow from the bank at $D_B^\star = 1/p$. Because these vendors do not sell on the marketplace, the platform sets the fee as in the baseline model depending only on the share of innovators in the marketplace (see (1)). As a result, Proposition 1 holds in full.

In the bank-platform lending architecture, the platform can potentially discriminate vendors that operate in the marketplace from those that do not. The reason is that the platform observes whether a loan request is made by one of its clients. Because vendors outside the platforms do not bring about any additional value to the marketplace via the fee, the platform does not have any incentive to subsidize their loans. As a result, it would set the fee and the loan rate as in the baseline model for the innovators operating in the marketplace (Proposition 2) and offer a rate equal to its break-even rate for those that are outside the marketplace. As we assume that for the same loan rate vendors prefer the bank to the platform, it follows that these vendors never borrow from the platform.

Suppose now that the platform cannot discriminate vendors on the marketplace from those outside the marketplace and for any given p, a vendor should be offered the same loan rate. For example, tying loans to access to the marketplace may be considered anti-competitive if put forward by a dominant platform.[20] Thus, in contrast to the baseline model, the platform's incentives to enter the credit market would be reduced since lending is a loss-making activity (due to the cross-subsidy), and outside vendors would not offset the platform's costs by paying the fee.

We have shown that in the baseline model, the platform would not have the incentive to lend to those vendors that operate outside the marketplace because the cross-subsidy motive would not be operative. The fact that we do observe platform lending to offline vendors must therefore arise from other sources e.g. the platform information advantage arising from processing payments, or a long-term *platform envelopment strategy* (Eisenmann, Parker and Van Alstyne, 2011) where a platform tries to expand its business to adjacent markets leveraging its rich network. This discussion highlights the relevance of the cross-subsidy in generating the incentive of the platform to enter the credit market.

Second, let us now examine a scenario where a platform (platform A) faces competition from another marketplace (platform B). For instance, Amazon.com competes with Walmart.com in the US. We hypothesize that platform A's motivation to provide loans would decrease if the output of those investments can also be sold on the rival platform. To understand this, let us assume that platform B does not offer credit to innovators, and for simplicity let us take the heterogeneous fee and the loan rate as given. If innovators start participating on platform B due to the subsidized credit from platform A, and vendors have limited inventory, platform A would only capture a portion of the resulting output. This would reduce the effectiveness of the cross-subsidy, as platform A's ability to capture surplus decreases, leading to a lower incentive for expanding its rival marketplace.

[20] In the specific case, a platform would tie its interest rate (the tying product) conditional on the vendors joining the marketplace and using intermediation services of the platform (the tied product).

In other words, by lending to innovators, platform A indirectly benefits its rival platform by providing credit to vendors who also sell outside of platform A's environment.

To address this potential issue, the provision of credit to innovators can be limited, similar to the approach taken by the Amazon Lending program. Specifically, credit could be restricted to innovative activities that directly impact the marketplace of the platform that is offering credit, such as investments in marketing, inventory management, and other related areas.

7.6 Multiple product categories

In the baseline model, we have assumed that all vendors belong to the same product category, and that innovative vendors share the same probability of success (p). However, our results are also applicable to marketplaces with multiple product categories that host both innovators and non-innovators. To illustrate this, let us consider a scenario where there are two product categories (e.g., automotive and office supplies), one with a high probability of success for innovators (denoted as p_h) and one with a low probability of success (denoted as $p_l < p_h$). In this situation, since a product category is observable, the platform can set category-contingent fees based on the percentage of innovators and non-innovators within each category and the probability of success for innovators.

In the context of bank lending architecture, the platform is responsible for deciding the fee to set for each product category. From simple comparative statics, because the pooling fee outlined in equation (1) increases with the probability of success (p), the platform is more likely than in the baseline model to set a higher pooling fee for product categories with p_h. Conversely, for product categories with lower probabilities of success, such as p_l, the platform may set a high fee, which would discourage the bank from lending. In the absence of frictions, the platform may opt to lend in both categories by setting a high fee for all vendors and compensating innovators with a loan rate that depends on p_h and p_l, respectively. This approach is more likely to be socially desirable in product categories with low p, given that the platform is more likely to induce the bank not to lend in product categories with lower probabilities of success.

However, when frictions are present, the platform's incentives to lend may be asymmetric, leading to loans being offered only to vendors in a specific product category. The targeted category will depend on the type of frictions present in the market. For instance, the platform may have lower incentives to lend in product categories with high p, where loan rates are expected to be low, and non-innovators with storage capacity may also borrow (as Proposition 9 suggests). If the platform faces a higher funding cost than the bank, Proposition 6 suggests that the platform is more likely to enter the credit market in product categories with lower probabilities of success for innovators. This strategy aims to encourage innovators to access the credit market, while the platform is less likely to enter product categories with many successful innovators. In these cases, the platform would incur higher total funding costs to finance innovators, and the bank is more likely to fund them instead.

8 Conclusion

Several big tech platforms have broadened their business scope beyond just e-commerce, which traditionally generates revenue through transaction fees. These platforms have now ventured into offering financial services, including credit provisions. This paper delves into the intricate relationship between the financial and operational aspects of a platform's ecosystem. Specifically, it examines the influence of platform-based lending on innovation and the surplus of vendors.

Our analysis reveals that prohibiting platforms from lending can stifle innovation, not because of lack of platform funding, but because the high fee of the platform deters banks from financing innovators. By contrast, when the platform is allowed to engage in lending, it can optimize its decisions by also setting interest rates, thereby internalizing the effects on innovation outcomes.

When the population of vendors possesses privately known and heterogeneous innovation opportunities, leading to diverse funding needs, the platform has the ability to leverage both the access fee to its marketplace and the interest rate on loans to extract surplus from its vendors more effectively. By offering a below-market interest rate, it attracts vendors with innovation opportunities while offsetting these losses by charging higher fees, which are also paid by those without funding needs. We show that a sufficient condition for platform lending to be welfare-enhancing is that the bank would not fund innovators in the absence of platform lending. Conversely, if the bank does fund innovators, the negative impact on non-innovators resulting from the higher fee outweighs the benefits gained by the innovators through the lower loan rate. As a result, under these conditions, platform lending has an adverse effect on vendors' surplus.

This paper shows that e-commerce platforms may have an additional rationale to lend to the vendors in the marketplace besides the well-known exploitation of the information advantage from their ecosystem. When the platform, unlike the bank, can distinguish positive from negative NPV loan applicants, the platform always finds it optimal to lend but it lends only to the first group. Anticipating the adverse selection problem, the bank would not fund applicants rejected by the platform. Quite intuitively, better information improves efficiency as platform lending leads to the rejection of negative NPV projects otherwise funded by the bank.

Furthermore, we emphasize that several frictions might diminish the motivation for big tech platforms to venture into the lending market. Our analysis reveals that their incentives are significantly shaped by elements such as their higher funding costs in comparison to banks, the presence of vendors who operate outside the platform's marketplace, and the potential for non-innovators to capitalize on the platform's subsidized rates. Under these circumstances, the platform might find it more profitable to abstain from lending.

Our analysis provides some testable predictions. Firstly, in jurisdictions where platforms are prevented from lending or following a structural separation between financial and e-commerce activities, we should observe fewer innovative activities being funded overall (Proposition 1). Secondly, e-commerce fees are expected to be (weakly) higher in economies where the potential of innovation is limited than in economies where the potential of innovation is high (Proposition 1). Thirdly, when the cost of lending is high, platforms tend to lend less frequently, particularly in scenarios where the proportion of innovators is high. In these cases, it is more likely that the platform only run the marketplace and banks lend (Proposition 7). Consequently, platforms may choose to limit their lending operations and let banks lend, particularly during periods of high interest rates. Fourthly, when comparing loans issued by platforms to those exclusively provided by banks, interest rates are generally lower for the same risk level when a platform is part of the loan offer (Proposition 1). Finally, as the probability of success for an investment or product increases, the interest rate set by the platform tends to decrease. This relationship implies that even non-innovators may express interest in borrowing funds. As a result, we may observe lower entry by platforms in the credit market (Proposition 9) or the implementation of lending restrictions on specific activities of vendors within the marketplace (e.g., Amazon Lending Program).

Our model offers insights into the potential consequences of different regulatory policies designed to address platforms' forays into banking territories. Such policies encompass setting a cap on the platform's fees, outright bans on platform lending, and enforcing a structural separation between the marketplace and the platform's lending divisions. However, it is crucial to approach these interventions with prudence. Our findings indicate that these regulatory measures might inadvertently stifle innovation and adversely impact social welfare.

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Appendix

Proof of Lemma 1

The proof is omitted as it follows from the discussion in the main text.

Proof of Lemma 2

The platform maximizes the following profit function

$$\Pi(\tau_N, \tau_I, D_B^\star) = \tau_I \lambda n_I(\tau_I, D_B^\star) p Y_I + \tau_N (1-\lambda) n_N(\tau_N) Y_N \tag{A-1}$$

subject to the condition that $\tau_I < \overline{\tau}$ (by Lemma 1).

Differentiating (A-1) with respect to τ_N yields

$$\begin{aligned} & (1-\lambda) n_N(\tau_N) Y_N + \tau_N (1-\lambda) \frac{\partial n_N(\tau_N)}{\partial \tau_N} Y_N \\ \Leftrightarrow \ & (1-\lambda) Y_N^2 (1-\tau_N) + \tau_N (1-\lambda)(-Y_N) Y_N. \end{aligned}$$

Dividing by $(1-\lambda)Y_N^2$, τ_N solves

$$1-\tau_N-\tau_N=0.$$

Therefore, $\tau_N=1/2(>\overline{\tau})$ because

$$\frac{1}{2}-\left(1-\frac{1}{pY_I}\right)>0,$$

which holds under our assumption that $pY_I<2$ (which guarantees that $n_I(0,D_B^{\star})<1$).

Differentiating (A-1) with respect to τ_I yields

$$\begin{aligned}&\lambda n_I(\tau_I,D_B^{\star})pY_I+\tau_I\lambda\frac{\partial n_I(\tau_I,D_B^{\star})}{\partial \tau_I}pY_I\\ \Leftrightarrow\ &\lambda pY_I\Big(pY_I(1-\tau)-1-\tau_I Y_I\Big).\end{aligned}$$

Therefore, τ_I solves

$$pY_I(1-\tau_I)-1-\tau_I pY_I=0,$$

which implies that $\tau_I=\frac{1}{2}-\frac{1}{2pY_I}$. Moreover, note that $\tau_I<\overline{\tau}$ because

$$\tau_I=\frac{1}{2}-\frac{1}{2pY_I}<1-\frac{1}{pY_I}=\overline{\tau}, \tag{A-2}$$

which is satisfied because $1<pY_I$.

We conclude that under full information, the platform sets the following monopoly fees:

$$\tau_N=\frac{1}{2},\qquad \tau_I=\frac{1}{2}-\frac{1}{2pY_I}\equiv\frac{\overline{\tau}}{2}$$

to non-innovators and innovators, respectively. The bank always funds innovation.

Proof of Proposition 1

We distinguish two cases. If $\tau>\overline{\tau}$, the platform only attracts non-innovators and maximizes

$$\Pi(\tau,\emptyset)=(1-\lambda)\tau Y_N(1-\tau).$$

Differentiating with respect to τ yields

$$(1-\lambda)Y_N(1-\tau)-\tau(1-\lambda)Y_N=0.$$

Therefore, the equilibrium fee is $\tau_H^B = \frac{1}{2} > \overline{\tau}$ and the associated profit is the same as in (3). If $\tau < \overline{\tau}$, the platform attracts both innovators and non-innovator so it maximizes

$$\Pi(\tau, D_B^\star) = \tau \lambda n_I(\tau, D_B^\star) p Y_I + \tau_N (1-\lambda) n_N(\tau_N) Y_N. \tag{A-3}$$

Differentiating it with respect to τ yields

$$\lambda p Y_I (p(Y_I - 2\tau Y_I) - 1) + (1-\lambda)(1-2\tau) Y_N^2 = 0,$$

which gives the optimal pooling fee, τ_P^B, in (1). The associated profit is

$$\Pi(\tau_P^B, D_B^\star) = \frac{\left(\lambda p Y_I (p Y_I - 1) + (1-\lambda) Y_N^2\right)^2}{4(1-\lambda) Y_N^2 + 4\lambda p^2 Y_I^2}. \tag{A-4}$$

We can now compare the profits of the platform in the two scenarios. From (3) and (4), we have that

$$\Pi(\tau_H^B, \emptyset) \equiv \frac{1}{4}(1-\lambda) Y_N^2 > \frac{\left(\lambda p Y_I (p Y_I - 1) - (1-\lambda) Y_N^2\right)^2}{4(1-\lambda) Y_N^2 + 4\lambda p^2 Y_I^2} \equiv \Pi(\tau_P^B, D_B^\star)$$
$$\Leftrightarrow \; \lambda < \frac{Y_N^2 (2 - p Y_I)}{Y_N^2 (2 - p Y_I) + p Y_I (p Y_I - 1)^2} \equiv \tilde{\lambda}.$$

Otherwise, the opposite holds and, therefore, the platform finds it optimal to attract both innovators and non-innovators.

Proof of Proposition 2

The first part of the proof is omitted as it follows from the discussion in the main text.

The second part requires identifying the optimal loan rate of the platform and the optimal fee, which are defined by $D_P^\star$ and $\tau^\star$, respectively. Differentiating the profit of the platform with respect to τ and D_P yields

$$\frac{\partial \Pi(\tau, D_P)}{\partial \tau} = \lambda p Y_I (p(Y_I - 2D_P - 2\tau Y_I) + 1) + (1-\lambda)(1-2\tau) Y_N^2 = 0,$$

and

$$\frac{\partial \Pi(\tau, D_P)}{\partial D_P} = \lambda p (p(Y_I - 2D_P - 2\tau Y_I) + 1) = 0.$$

The equilibrium loan rate and fees, are

$$D_P^\star = \frac{1}{2p}, \qquad \tau^P = \frac{1}{2}.$$

Note that $D_P^\star < D_B^\star$. Plugging these into the profit of the platform and letting τ^P identify the fee when the platform lends, then the profit of the platform at equilibrium is as in (7).

Proof of Lemma 3

The proof is omitted as it follows from the discussion in the main text.

Proof of Proposition 4

If (2) holds, innovators' surplus increases (by revealed preferences) and non-innovators' surplus remains constant. This combined with the result that the platform finds it optimal to lend makes platform lending socially desirable.

If (2) does not hold, we have to determine the surplus of innovators and non-innovators. First, it is immediate that non-innovators are worse off because of the higher fee under platform lending. Non-innovators' surplus is denoted as

$$NS(\tau, D) = (1-\lambda)\int_0^{Y_N(\tau)} [Y_N(1-\tau) - \xi] d\xi$$

which is equal to

$$NS(\tau_P^B, D_B^\star) = \frac{1}{8}(1-\lambda)Y_N^2, \quad NS(\tau^P, D_B^\star) = (1-\lambda)\frac{\left((1-\lambda)Y_N^3 + \lambda p Y_I Y_N (pY_I 1)\right)^2}{8\left((1-\lambda)Y_N^2 + \lambda p^2 Y_I^2\right)^2},$$

with $NS(\tau_P^B, D_B^\star) > NS(\tau^P, D_B^\star)$.

Innovators' surplus under bank lending only is

$$IS(\tau_P^B, D_B^\star) = \lambda \frac{\left(\lambda p^2 Y_I^2 (pY_I - 1) + (1-\lambda)Y_N^2(pY_I - 2)\right)^2}{8\left((1-\lambda)Y_N^2 + \lambda p^2 Y_I^2\right)^2} \tag{A-5}$$

whereas under platform lending is

$$IS(\tau^P, D_P^\star) = \lambda \frac{1}{8}(pY_I - 1)^2. \tag{A-6}$$

Comparing the two, we obtain that

$$IS(\tau^P, D_P^\star) - IS(\tau_P^B, D_B^\star) = \frac{(1-\lambda)Y_N^2\left((1-\lambda)Y_N^2(2pY_I - 3) + 2\lambda p^2 Y_I^2 (pY_I - 1)\right)}{8\left((1-\lambda)Y_N^2 + \lambda p^2 Y_I^2\right)^2},$$

which is always positive in the relevant parameter range for which platform lending occurs (i.e., if (2) does not hold).

Comparing the total vendors' surplus, we have

$$IS(\tau^P, D_P^\star) + NS(\tau^P, D_P^\star) - IS(\tau_P^B, D_B^\star) - NS(\tau_P^B, D_B^\star) = -\frac{3(1-\lambda)\lambda Y_N^2}{8\lambda p^2 Y_I^2 + 8(1-\lambda)Y_N^2} < 0.$$

Therefore, total vendors' surplus decreases with platform lending relative to bank lending if (2) does not hold.

Proof of Proposition 5

The proof is omitted as it follows from the discussion in the main text.

Proof of Proposition 6

We compare the profit of the platform when it enters the market with costly funding with the profits obtained when it does not enter. If the platform enters the lending market, it sets the loan rate and the fee as in (9), resulting in the following profit

$$\Pi(\tau^P, D_B^\star, r) = \frac{1}{4}\left(\lambda(pY_I - (1+r))^2 + (1-\lambda)Y_N^2\right). \tag{A-7}$$

We compare this profit of the platform in the bank lending architecture. There are two cases:

(i) Suppose (2) holds and the platform obtains $\Pi(\tau_H^B, \emptyset)$. Comparing it with (A-7), the platform finds it optimal to lend if $\Pi(\tau^{\star,PL}, D_B^\star, r) > \Pi(\tau_H^B, \emptyset)$, that is

$$\frac{1}{4}\left(\lambda(pY_I - (1+r))^2 + (1-\lambda)Y_N^2\right) > \frac{1}{4}(1-\lambda)Y_N^2$$

which is always the case.

(ii) Suppose (2) does not hold and the platform obtains $\Pi(\tau_P^B, D_B^\star)$. Comparing it with (A-7), the platform finds it optimal to lend if $\Pi(\tau^P, D_B^\star, r) > \Pi(\tau_P^B, D_B^\star)$, that is

$$\frac{1}{4}\left(\lambda(pY_I - (1+r))^2 + (1-\lambda)Y_N^2\right) > \frac{\left(\lambda pY_I(pY_I - 1) + (1-\lambda)Y_N^2\right)^2}{4(1-\lambda)Y_N^2 + 4\lambda p^2 Y_I^2}$$

which is the case if and only if

$$\lambda < \max\left\{0, \frac{Y_N^2\left(2prY_I - (1+r)^2\right)}{r(2 - 2pY_I + r)(pY_I - Y_N)(pY_I + Y_N) - Y_N^2}\right\}, \tag{A-8}$$

which is decreasing in r. Otherwise, the platform does not lend and only operates the marketplace.

Proof of Proposition 7

The first part of the proof follows from the discussion in the main text.

The second part of the proof is as follows. First, the surplus of innovators if the platform does not lend is as in (A-5), whereas the surplus of innovators under platform lending is

$$IS^{PL} = IS(\tau^P, D_P^\star) = \frac{1}{8}\Big(pY_I - (1+r)\Big)^2.$$

Let $\triangle IS = IS^{PL} - IS^{BL}$ be the difference in the innovators' surplus under platform lending and bank lending

$$\triangle IS = IS^{PL} - IS^{BL} = \frac{1}{8}\left((pY_I - (1+r))^2 - \frac{\left(\lambda p^2 Y_I^2 (pY_I - 1) + (1-\lambda) Y_N^2 (pY_I - 2)\right)^2}{((1-\lambda)Y_N^2 + \lambda p^2 Y_I^2)^2}\right). \tag{A-9}$$

As direct computation is unfeasible, we provide proof by example. By graphical simulation, we show that there exists a non-empty set in which (A-9) is negative in the same parameter range in which the platform finds it optimal to lend, i.e., (A-8) holds. An example is provided in Figure 2.

Proof of Proposition 8

We provide details on the proof distinguishing between the case in which the platform is not active in the lending market and the case in which its competes with the bank.

Bank lending architecture. The conditional probability that the bank receives a loan request from a high-type innovator is given by

$$\frac{\alpha n_H(\tau, D_B)}{\alpha n_H(\tau, D_B) + (1-\alpha) n_L(\tau, D_B)},$$

where, assuming $\omega \in [0,1]$ uniformly distributed, $n_H(\tau, D_B) = p_H[Y_I(1-\tau) - D_B]$ and $n_L(\tau, D_B) = p_L[Y_I(1-\tau) - D_B]$. Similarly, the conditional probability that the bank receives a loan request from a low-type innovator is given by

$$\frac{(1-\alpha) n_L(\tau, D_B)}{\alpha n_H(\tau, D_B) + (1-\alpha) n_L(\tau, D_B)}.$$

The bank solves the following

$$D_B\Big(p_H \frac{\alpha n_H(\tau, D_B)}{\alpha n_H(\tau, D_B) + (1-\alpha) n_L(\tau, D_B)} + p_L \frac{(1-\alpha) n_L(\tau, D_B)}{\alpha n_H(\tau, D_B) + (1-\alpha) n_L(\tau, D_B)}\Big) = 1,$$

which determines the loan rate in (12). Because the bank lends if and only the realised net cash flow is larger than the promised repayment, as in Lemma 3, there is a critical threshold of the fee, which with slight abuse of notation we continue to denote as $\overline{\tau}$, such that the bank does not lend if and only if

$$Y_I(1-\tau) < D_B^\star \implies \tau > \overline{\tau} \equiv \frac{\alpha p_L^2 Y_I + p_L^2(-Y_I) - \alpha p_L + p_L - \alpha p_H^2 Y_I + \alpha p_H}{Y_I\left(\alpha p_L^2 - p_L^2 - \alpha p_H^2\right)}, \quad \text{(A-10)}$$

and lends if $\tau \leq \overline{\tau}$.

As in the baseline model, the platform has two choices. On the one hand, it can set a fee that excludes innovators from access to bank's credit and it only focuses on non-innovators. In this case, the optimal fee is $\tau_H^B = 1/2$ and the profit of the platform is the same as in (3). Otherwise, the platform sets τ to maximize the profit function in (13) subject to $\tau \leq \overline{\tau}$. Differentiating (13) with respect to τ and solving the related first-order condition yields

$$\tau_P^B = \frac{\lambda Y_I\left(p_L(p_L Y_I - 1) + p_H(p_H Y_I - 1)\right) - 2(1-\lambda)Y_N^2}{4(1-\lambda)Y_N^2 + 2\lambda Y_I^2\left(p_L^2 + p_H^2\right)}.$$

Note that there are conditions for which $\tau_P^B > \overline{\tau}$. Formally, $\tau_P^B < \overline{\tau}$ if

$$\lambda > \max\left\{0, \frac{Y_N^2\left((\alpha-1)p_L^2 Y_I + 2(1-\alpha)p_L + \alpha p_H(2 - p_H Y_I)\right)}{\Psi + (\alpha-1)p_L\left(\alpha p_H^2 Y_I^2 - 2Y_N^2\right) + \alpha p_H\left(\alpha p_H^2 Y_I^2(p_H Y_I - 1) + Y_N^2(2 - p_H Y_I)\right)}\right\} \equiv \dot{\lambda} \quad \text{(A-11)}$$

where $\Psi \equiv (1-\alpha)^2 p_L^4 Y_I^3 - (1-\alpha)^2 p_L^3 Y_I^2 - (1-\alpha)p_L^2 Y_I\left(\alpha p_H Y_I(1 - 2p_H Y_I) + Y_N^2\right)$. In such a case, the constraint on the fee binds and the platform can set the fee as high as $\overline{\tau}$.

Therefore,

- If $\tau_P^B < \overline{\tau}$ (or $\lambda > \dot{\lambda}$), the profit of the platform is

$$\Pi(\tau_P^B, D_B^\star) = \frac{\lambda Y_I\left((1-\alpha)p_L^2 Y_I + p_L(1 - \alpha p_L) + \alpha p_H(p_H Y_I - 1)\right) + (1-\lambda)Y_N^2}{2\left(\lambda Y_I^2\left((1-\alpha)p_L^2 + \alpha p_H^2\right) + (1-\lambda)Y_N^2\right)}.$$

- If $\tau_P^B \geq \overline{\tau}$ (or $\lambda \leq \dot{\lambda}$), the profit of the platform is

$$\Pi(\overline{\tau}, D_B^\star) = \frac{(1-\lambda)Y_N^2((1-\alpha)p_L + \alpha p_H)\left((1-\alpha)p_L^2 Y_I - p_L(1-\alpha) + \alpha p_H(p_H Y_I - 1)\right)}{Y_I^2\left((1-\alpha)p_L^2 + \alpha p_H^2\right)^2}.$$

As a result, under the bank lending architecture, we can determine the equivalent result contained in Proposition 1. Specifically, consider the parameter range for which $\lambda \leq \dot{\lambda}$

(so that $\tau_P^B \geq \overline{\tau}$). Comparing $\Pi(\overline{\tau}, D_B^\star)$ with $\Pi(\tau_H^B, \emptyset)$ in (3), we have that

$$
\begin{aligned}
&\Pi(\tau_H^B, \emptyset) > \Pi(\overline{\tau}, D_B^\star)\\
\Leftrightarrow &\frac{1}{4}(1-\lambda)Y_N^2 > \frac{(1-\lambda)Y_N^2((1-\alpha)p_L + \alpha p_H)\left((1-\alpha)p_L^2 Y_I - p_L(1-\alpha) + \alpha p_H(p_H Y_I - 1)\right)}{Y_I^2\left((1-\alpha)p_L^2 + \alpha p_H^2\right)^2}\\
\Leftrightarrow &\frac{(1-\lambda)Y_N^2\left(\alpha p_H(2-p_H Y_I) - (1-\alpha)p_L(p_L Y_I - 2)\right)^2}{4Y_I^2\left((1-\alpha)p_L^2 + \alpha p_H^2\right)^2}\\
\Leftrightarrow &\left(\alpha p_H(2-p_H Y_I) - (1-\alpha)p_L(p_L Y_I - 2)\right)^2 > 0,
\end{aligned}
$$

which is always the case. As a result, if the platform is constrained in setting the fee because $\tau_P^B \geq \overline{\tau}$, then it always gives up innovators and sets $\tau_H^B = 1/2$.

Consider now the parameter range for which $\lambda > \dot{\lambda}$ so that $\tau_P^B < \overline{\tau}$. Comparing $\Pi(\tau_P^B, D_B^\star)$ with $\Pi(\tau_H^B, \emptyset)$ in (3), we have that

$$
\begin{aligned}
&\Pi(\tau_H^B, \emptyset) > \Pi(\tau_P^B, D_B^\star)\\
\Leftrightarrow &\frac{1}{4}(1-\lambda)Y_N^2 > \frac{\lambda Y_I\left((1-\alpha)p_L^2 Y_I + p_L(1-\alpha p_L) + \alpha p_H(p_H Y_I - 1)\right) + (1-\lambda)Y_N^2}{2\left(\lambda Y_I^2\left((1-\alpha)p_L^2 + \alpha p_H^2\right) + (1-\lambda)Y_N^2\right)}\\
\Leftrightarrow &\lambda < \max\left\{0, \frac{Y_N^2\left((\alpha-1)p_L^2 Y_I + 2(1-\alpha)p_L + \alpha p_H(2-p_H Y_I)\right)}{\Omega + \Lambda + \alpha p_H\left(\alpha p_H Y_I(p_H Y_I - 1)^2 + Y_N^2(2-p_H Y_I)\right)}\right\} \equiv \tilde{\lambda},
\end{aligned}
$$

where $\Omega \equiv (1-\alpha)^2 p_L^4 Y_I^3 - 2(1-\alpha)^2 p_L^3 Y_I^2 - (1-\alpha)p_L^2 Y_I\left(\alpha - 2\alpha p_H^2 Y_I^2 + 2\alpha p_H Y_I + Y_N^2 - 1\right)$, $\Lambda \equiv 2(1-\alpha)p_L\left(\alpha p_H Y_I(1-p_H Y_I) + Y_N^2\right)$. Therefore, we have $\Pi(\tau_H^B, \emptyset) > \Pi(\tau_P^B, D_B^\star)$ if and only if $\lambda \in [\dot{\lambda}, \tilde{\lambda})$ and $\Pi(\tau_H^B, \emptyset) < \Pi(\tau_P^B, D_B^\star)$ if $\lambda > \max\{\dot{\lambda}, \tilde{\lambda}\}$. Note that these results are qualitatively similar to those in Proposition 3.

Platform-bank competition. Consider now the case in which the platform can compete with the bank. Note that the platform never funds low-types as any low-type entails a loss because of negative NPV investment. As a result, the profit of the platform when lending is given by (14), which leads to the following optimal fee and loan rate

$$
\tau^P = \frac{1}{2} \qquad D_P^\star = \frac{1}{2p_H},
$$

which are the same as in Proposition 2 once replacing p_H by p. The equilibrium profit of the platform is

$$
\Pi(\tau_P, D_P^\star) = \frac{1}{4}\left(\alpha\lambda(p_H Y_I - 1)^2 + (1-\lambda)Y_N^2\right).
$$

Decision of the platform. We are now interested in identifying the incentives of the platform. Because of the number of parameters, we consider the optimal choice of the platform in the different parameter ranges identified in the bank lending architecture.

First, let us consider the case in which the bank does not fund innovation. This case occurs if $\tau_P^B \geq \overline{\tau}$ or if $\tau_P^B < \overline{\tau}$ and $\lambda < \tilde{\lambda}$.[21] Comparing $\Pi(\tau^P, D_P^\star)$ with $\Pi(\tau_H^B, \emptyset)$ in (3), we have that

$$
\begin{aligned}
&\Pi(\tau_H^B, \emptyset) < \Pi(\tau_P, D_P^\star) \\
\Leftrightarrow &\frac{1}{4}(1-\lambda)Y_N^2 < \frac{1}{4}\left(\alpha\lambda(p_H Y_I - 1)^2 + (1-\lambda)Y_N^2\right) \\
\Leftrightarrow &\frac{\alpha}{4}\lambda\Big(p_H Y_I - 1\Big)^2 > 0
\end{aligned}
$$

which is always the case. As a result, the platform always finds it optimal to enter the lending market, aligning with the results in the baseline model.

Consider now the other case in which the bank funds innovation. This case exists if and only if $\lambda > \max\{\dot{\lambda}, \tilde{\lambda}\}$. In this case, the platform has two options: (i) lend to high-type innovators only, or (ii) not to lend but free-ride on the bank's lending activity to both types of innovators. To see why the platform may possibly have an incentive not to lend and free-ride on bank lending note that if the platform lends and excludes low-types, it gives up collecting a share of their ex post revenues on the marketplace if they succeed in their innovation, namely τY_I. However, lending allows the platform to better price discriminate the high-type innovators and the non-innovators, subsidizing the former and raising the fee for all vendors. By choosing not to lend when the bank would, the platform faces the following trade-off. On the one hand, the platform extracts surplus using a single instrument, τ_P^B, without engaging in price discrimination among vendors. On the other hand, the platform still manages to capture a portion of the output from low-types without incurring the lending costs associated with negative projects.

Thus, comparing $\Pi(\tau^P, D_P^\star)$ with $\Pi(\tau_P^B, D_B^\star)$, we have that

$$
\begin{aligned}
&\Pi(\tau_P^B, D_B^\star) < \Pi(\tau_P, D_P^\star) \\
\Leftrightarrow &\frac{\lambda Y_I\left((1-\alpha)p_L^2 Y_I + p_L(1-\alpha p_L) + \alpha p_H(p_H Y_I - 1)\right) + (1-\lambda)Y_N^2}{2\left(\lambda Y_I^2\left((1-\alpha)p_L^2 + \alpha p_H^2\right) + (1-\lambda)Y_N^2\right)} < \frac{1}{4}\left(\alpha\lambda(p_H Y_I - 1)^2 + (1-\lambda)Y_N^2\right), \\
\Leftrightarrow &\lambda > \frac{Y_N^2\left(\alpha - (1-\alpha)p_L^2 Y_I^2 + 2(1-\alpha)p_L Y_I\right)}{\Theta + 2(1-\alpha)p_L Y_I\left(\alpha p_H Y_I(1-p_H Y_I) + Y_N^2\right) + \alpha Y_N^2} \equiv \lambda^L,
\end{aligned}
$$

where $\Theta \equiv (1-\alpha)^2 p_L^3 Y_I^3(p_L Y_I - 2) - (1-\alpha)p_L^2 Y_I^2\left(\alpha\left(2 - p_H^2 Y_I^2\right) + Y_N^2 - 1\right)$. Computationally-demanding analysis shows that $\lambda^L < \dot{\lambda}$ meaning that in this parameter range the platform always finds it optimal to lend.

[21] Formally, this case exists provided that $\lambda < \max\{\dot{\lambda}, \tilde{\lambda}\}$ where $\dot{\lambda}$ is defined in (A-11).

Proof of Proposition 9

In this section, we relax the assumption that non-innovators do not borrow even when the promised repayment is less than the loan, 1. This case only exists if the platform lends under the condition that

$$D_P^\star = \frac{1}{2p} < 1,$$

which is the case if, and only if, $p > 1/2$. The analysis in the baseline model, therefore, holds in full for any $p \leq 1/2$. However, if $p > 1/2$, the platform faces a new force that goes in the direction of reducing the incentives to lend.

More specifically, under bank lending, there is no change in the decision of the platform. Under platform lending, if $p > \frac{1}{2}$ also the non-innovators would borrow because $D_P^\star = \frac{1}{2p} < 1$. Recall that the platform does not distinguish between innovators and non-innovators.

The platform can follow three alternative strategies:

(i) set $D_P = 1$, thereby rendering non-innovators indifferent between borrowing or not; in this case, the profit of the platform is

$$\Pi(\tau, D_P) = \tau\Big\{\lambda n_I(\tau, D_P)pY_I + (1-\lambda)n_N(\tau)Y_N\Big\} + \lambda n_I(\tau, D_P)[D_P p - 1] \qquad \text{s.t.} D_P = 1;$$

with $n_I(\tau, 1) = Y_I(1-\tau)p - p$ and $n_N(\tau) = Y_N(1-\tau)$. Differentiating it with respect to τ and solving for the optimal fee, which we denote as $\tilde{\tau}^P$, we have

$$\tilde{\tau}^P = \frac{\lambda p Y_I(p(Y_I - 2) + 1) + (1-\lambda)Y_N^2}{2\lambda p^2 Y_I^2 + 2(1-\lambda)Y_N^2},$$

resulting into

$$\Pi(\tilde{\tau}^P, 1) = \frac{\lambda^2 p^2 Y_I^2 (pY_I - 1)^2 - 2(\lambda - 1)\lambda p Y_N^2 \left(p\left(Y_I^2 - 2\right) - Y_I + 2\right) + (1-\lambda)^2 Y_N^4}{4\lambda p^2 Y_I^2 - 4(\lambda - 1)Y_N^2}. \tag{A-12}$$

(ii) accepting that non-innovators would also borrow and set $D_P < 1$; in this case, the profit of the platform is

$$\begin{aligned}\Pi(\tau, D_P) =& \tau\Big\{\lambda n_I(\tau, D_P)pY_I + (1-\lambda)n_N(\tau, D_P)Y_N\Big\} \\ &+ \lambda n_I(\tau, D_P)[D_P p - 1] + (1-\lambda)n_N(\tau, D_P)[D_P - 1].\end{aligned}$$

Differentiating it with respect to τ and D_P and solving simultaneously, we obtain

$$D_P = \frac{2pY_I - Y_N}{2p(Y_I - Y_N)} \qquad \tau = \frac{1 - p(2 - Y_I + Y_N)}{2p(Y_I - Y_N)}.$$

Recall that $D_P < 1$ is necessary for non-innovators to borrow when $p > 1/2$. It is straightforward to see that

$$\frac{2pY_I - Y_N}{2p(Y_I - Y_N)} < 1$$
$$\Leftrightarrow 2pY_N - Y_N < 0,$$

which is a contradiction given that $p > \frac{1}{2}$ in this case. Therefore, $D_P > 1$ violates the constraint that non-innovators would borrow. As a result, this case never occurs at equilibrium.

(iii) not to lend. In this scenario, the decision of the platform is either to set a low fee and attract both innovators (who borrow from the bank) and non-innovators, or to set a high fee and attract only non-innovators. As a result, the strategy of the platform depends on whether (2) holds and results are as in Proposition 1.

Comparing profits in the different scenarios, we observe the following.

First, let us consider the interval $\lambda \in [\tilde{\lambda}, 1]$. Denoting $\Delta\Pi = \Pi(\tilde{\tau}^P, 1) - \Pi(\tau_P^B, D_B^\star)$ the difference between the profit of the platform when it lends and when it does not, then

$$\Delta\Pi = \frac{(1-\lambda)\lambda(1-p)pY_N^2}{\lambda p^2 Y_I^2 + (1-\lambda)Y_N^2} > 0.$$

Second, let us consider the interval $\lambda \in [0, \tilde{\lambda})$. Denoting $\Delta\tilde{\Pi} = \Pi(\tilde{\tau}^P, 1) - \Pi(\tau_H^B, \emptyset)$ the difference between the profit of the platform when it lends and when it does not, then is

$$\Delta\tilde{\Pi} = -\frac{\lambda p\left((1-\lambda)(2-Y_I)Y_N^2(p(Y_I+2)-2) - \lambda p Y_I^2(pY_I-1)^2\right)}{4[\lambda p^2 Y_I^2 + (1-\lambda)Y_N^2]},$$

which is positive if

$$\lambda > \frac{(2-Y_I)Y_N^2(p(Y_I+2)-2)}{p^3Y_I^4 - 2p^2Y_I^3 - pY_I^2\left(Y_N^2-1\right) + 4pY_N^2 + 2(Y_I-2)Y_N^2} \equiv \hat{\lambda}.$$

Therefore, if $\hat{\lambda} < \tilde{\lambda}$, platform lends in equilibrium if and only if $\lambda \in [\hat{\lambda}, \tilde{\lambda})$ and does not otherwise. On the contrary, if $\hat{\lambda} > \tilde{\lambda}$, then the platform never finds it optimal to lend.

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