# Essays on Innovation in Retail Banking

Carlotta Mariotto

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# Essays on Innovation in Retail Banking

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**COMPOSITION DU JURY :**

Olena HAVRYLCHYK
Université de Lille 1, Président

Fabio MANENTI
Université de Padoue, Rapporteur

Anna CRETÌ
Université de Paris-Dauphine, Rapporteur

Marianne VERDIER
Université Paris 2 Panthéon-Assas, Directrice

Marc BOURREAU
Télécom ParisTech, Co-Directeur

Soutenue par **Carlotta MARIOTTO**
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Dirigée par **Marianne VERDIER**

PSL RESEARCH UNIVERSITY PARIS

MINES ParisTech

# SUMMARY

*“I would trade all my technology for an afternoon with Socrates »*

Steve Jobs

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# Preface

This PhD thesis was funded by the Institut Mines-Télécom and was carried out in the Centre for Industrial Economics, CERNA in the Ecole des Mines. It consists of five articles which have been presented by myself at several conferences and seminars. Some of them have been published and some others are currently under revision.

The first paper, *Innovation and Competition in the Retail Banking Industry: An Industrial Organization Perspective* (with Marianne Verdier ) has been published in the Journal of Communications and Strategies, 99(3):129-146. I presented this work at the European Central Bank - Suomen Pankki conference in Helsinki: Getting the balance right: innovation, trust and regulation in retail payments, in June 2015.

The second paper, *The Role of Merchants' Pass-Through in Payment Platform Markets* (with Marianne Verdier ) is submitted at the Journal of Industrial Economics and I have presented it at the Industrial Organization in the Digital Economy Workshop in Liège in March 2015; at the 13th Annual International Industrial Organization Conference in Boston in April 2015; at the 14th Edition of the European School on New Institutional Economics, May 2015 in Cargèse, where it won the prize for the best accessit paper; at the Conference on the Economics of Information and Communication Technologies in Paris in October 2015.

The third paper, *Competition between a Platform and Merchants for Selling Services* (with Marianne Verdier) circulated under the name "Add-on service, bundling, and exclusive contracts in platform markets". I presented it at the 2nd Industrial Organization conference in the Digital Economy in Louvain-la-Neuve in March 2016; at the 14th Annual International Industrial Organization Conference in Philadelphia in April 2016.

The fourth paper is *What Drives the Expansion of Peer-to-Peer Lending?* (with Olena Havrylchyk, Marianne Verdier and Talal Rahim- May 2016) and I presented it at the CRED Seminar in University Paris II, Panthéon Assas the 26th September 2015, and at the poster session of the 15th International Conference on Credit Risk Evaluation Designed for Institutional Targeting in Finance, in Venise in October 2016.

The fifth paper, *Competition for Lending in the Internet Era: the case of Peer-to-Peer Lending Marketplaces in the USA,* has been published in 2016 in the Journal of Communi-

cations and Strategies, 103(3): 35-58. It has not yet been presented at any conference.

# 1 General introduction

Nowadays, you can pay for your coffee at Starbucks' using a mobile phone app. While taking your coffee, you can connect on the Internet and try to find a shop to buy a present for your best friend's wedding. If you are not sure you have enough money on your account, you can still use your mobile phone to track down your personal finance and check whether you have enough money to make your purchase. And if it is not the case, you still have the option of connecting to a P2P lending platform like Prosper to obtain a personal loan in a couple of days.

During the last years, the finance industry has experienced a proliferation of innovations which may disrupt traditional financial services. They blur the boundaries between banks and financial start-ups, speed up transactions, democratize the access to credit, revise how we can purchase goods and how merchants can sell their products, while imposing regulators the challenge for a new level playing field which balances the trade-off between financial stability, competition and innovation.

According to Frame and White (2009), a financial innovation is something new that reduces costs, risks, or provides an improved product/service/instrument that better satisfies financial system participants' demand. In Table 1 in the next page, I provide a summary of the simplified view of innovative banking services that I will use throughout the thesis.

From table 1, we can see that innovations are proposed both by banks and by non-banks. Banks are the most significant players in the provision of retail banking services and therefore they have a legacy system which favors the development of innovation (e.g., payment systems, historical data on loan performance etc...). Many of these innovations use, as a business model, a platform business model. Platforms act as intermediaries between different groups of users, which exert externalities on each other (see Rysman, 2009 for a definition of platform industries or "two-sided markets") since the utility of users on one side of the platform depends on the number of users on the other side and vice-versa. In order to become profitable, platforms need to reach of a critical mass of consumers. Banks, compared to non-banks, are eased in the process of reaching the critical mass given that they already rely on an installed base of consumer, existing infrastructures, an intra-bank system, and a

**Table 1**: Sectors of innovation, the type of innovation, the benefits and some examples of actors proposing the innovations.

| | **Innovation** | **Technology** | **Benefit** | **Example** |
|---|---|---|---|---|
| **Innovations related to deposits** | 1. SAVINGS | | | |
| | Savings and investments management | Roboadvisors providing algorithm-based portfolio management online services. | Fraction of the costs associated with traditional portfolio managers and investment advisors | Betterment, Charles Schwab, Wealthfront |
| | Online money management advice | They aggregate all bank and savings accounts of the clients | Cost of transport | Mint.com |
| | 2. PAYMENTS | | | |
| | Credit and Debit cards | EMV technology | Cost of cash | Visa, Mastercard |
| | Account-to-account payments | Direct transfer of money from one account to the other. | Speed of procedure | Giffy pay, GoPayment, Serve, Facebook |
| | Mobile payments | SMS or USSD, mobile Internet, with contactless of Near Field Communication technologies | Given the dense network of transaction points, costs are much reduced | M-Pesa |
| | Online shopping | Peer-to-peer payments service that allows people to send and receive money to purchase at an online merchant. | No cost to either sender or receiver, selection of products of interest through machine learning techniques. | Google Wallet, Shopkick, Milo, Paypal, BPAY, ROAM |
| | POS (Contactless payments) | The transaction is done only by bringing the card into proximity ( a few cm) with the POS. | Speed of transaction. | PayPass(MC), Paywave(Visa), Discover |
| | Private money | Block chain technology. | Privacy and speed of transferring money | Bitcoins |
| | 3. WITHDRAWAL | Mobile technology using bar codes. | Speed of withdrawing | CommBank |
| **Innovations related to loans** | 4. PERSONAL LOANS | | | |
| | Crowdfunding | Direct equity funding of projects by investors gathered mostly over the internet. | Speed of gathering a budget for a project; source of information about your work's potentials. | Kisskissbankbank, FundingCircle |
| | P2P lending | Online services who match lenders and borrowers which can be individuals or small businesses. | Lower operative costs, and sometimes lower interest rates for borrowers and high remuneration for lenders. | Zopa, Prosper, LendingClub |

well-developed network.

However, developing innovations can also be costly for traditional banks. This is one reason why they are challenged by non-banks, or financial start-ups (FinTechs). As a matter of fact, notwithstanding the presence of high barriers to entry in this market, new entrants have recently started to propose financial innovations, differentiating from banks by offering primarily technology-enabled business model innovations.

**Why is it important to study innovation in retail banking?** Following Philippon (2016), studying innovation in retail banking can help us understand the cost of financial intermediation. Since the cost of intermediation has remained unchanged in the last 130 years, it is important to understand the mechanisms that increase it or reduce it. In this thesis, I will try to answer to three main issues related to the topic of innovation in retail banking:

1. **How do innovations impact competition in retail banking?** One first issue is to understand why some of these innovative services are offered by non-bank platforms. Is it because they are more efficient? Is it because they offer a better quality? And how can banks compete with entrants that do not perform all the traditional activities, and that do not have the same business model?

2. **What drives the adoption of innovation by consumers in retail banking?** What determines the success of an innovative platform offering financial services? How can an entrant break down barriers to entry? What determines the diffusion of a new financial technology despite all the financial risks related to it?

3. **Is regulation of innovation necessary?** How to create a harmonized level playing field between entrants and incumbents in this particular market? Is it optimal for the society to regulate the providers of innovative retail banking services?

The methodology of my thesis will be both theoretical and empirical. To tackle these issues I use only two examples of innovation with a **platform business model**:

1) Payment card systems

2) Peer-to-peer lending platforms.

I focus mainly on these two examples first of all because they are examples of two tra-

ditional services offered by banks: payment systems and retail lending. When I started the thesis, the revised version of the Second Payment Service Directive (PSD II) of the European Commission was about to be released and the attention of academia and policy makers was catalyzed on the debate on the interchange fee regulation. Nevertheless, despite the trials, it has been impossible to obtain the dataset that is collected the by European Commission on interchange fees in Europe. This is why, in the case of payment card systems, I used a theoretical approach. With respect to peer-to-peer lending platforms, they had just started to become popular especially in the USA and UK, and the two main American platforms, Prosper and LendingClub, publicly provided the full dataset of their borrower clients. This is why I decided to exploit this dataset to analyze financial innovation from an empirical perspective.

In the **first chapter** of the thesis I will try to answer to the issue 1 and I look at firms' incentives to innovate and relate them to the traditional debate on the role of banks in the economy. In particular, I analyze the relationship between the concept of regulation, competition and innovation in the retail banking industry. In the first article, I look at competition between traditional banks and non-banks, while in the second article I look at the competition between two non-bank players, i.e. Lending Club and Prosper. This first chapter is composed by the following articles:

- Mariotto, C. & Verdier, M. (2015). Innovation and Competition in the Retail Banking Industry: An Industrial Organization Perspective. Journal of Communications and Strategies, 99(3):129-146.
- Mariotto, C. (2016). Competition for Lending in the Internet Era: the case of Peer-to-Peer Lending Marketplaces in the USA. Journal of Communications and Strategies, 103(3): 35-58.

In the **second chapter** of the thesis, following the issue 2, I look at the drivers of the adoption and the relationship between adoption and competition in the banking sector by empirically studying the diffusion of the two most successful platforms in P2P lending in the USA (Prosper and LendingClub). In particular, I will test some hypothesis on why non-bank entrants can enter a market. The chapter is composed by the following article:

- What Drives the Expansion of Peer-to-Peer Lending? (with Olena Havrylchyk,

Marianne Verdier and Talal Rahim- May 2016)

In the **third chapter** of the thesis, following the issue 3, I focus on why regulating innovation in retail banking is necessary. In the first article I show that regulation is necessary in a theoretical model of a 4 party payment card system, and derive that the difference between the privately set structure of payment card fees and the socially optimal one depends both on banks' and merchants pass-through of their costs to consumers.

In the second article I more generally study whether the imposition of restrictive rules such as the price parity rule or exclusive arrangements by a platform reduce social welfare. In the case of retail banking, it can be that a marketplace imposes to consumers and merchants only his own means of payment (such as the case of E-bay with the PayPal only policy). This third chapter is composed by the following articles:

o The Role of Merchants' Pass-Through in Payment Platform Markets (with Marianne Verdier ) (submitted at the Journal of Industrial Economics).

o Competition between a Platform and Merchants for Selling Services (with Marianne Verdier).

# 2 Relationship with the literature

The topic of innovation in retail banking is linked to two strands of the literature:

1) Banking: literature on financial intermediation

2) Platform markets: literature on industrial organization

However, my thesis is mainly related to the platform markets literature, namely the two-sided market literature. In the following paragraphs, I will briefly describe these two strands and explain why I use the industrial economics approach.

## 2.1 Banking: literature on financial intermediation

### 2.1.1 The role of banks in the economy

Banks play three important roles for the society: distribution of credits, collection of liquidity, and the management of payment systems, while providing:

1) Production of information through their delegated monitoring role;

2) Liquidity, through deposit contracts.

The entry of start-up firms that offer innovative services raises the issue of whether the entrants can play the same role as banks. In the first chapter, I look at what are the incentives for start-ups, platforms and large retailers to offer innovative means of payment.

Firstly, banks perform delegated monitoring of borrowers, which is according to Diamond (1984) any activity aimed at preventing opportunistic behavior of the borrower, both with respect to moral hazard (screening and preventing) and costly state verification (punishing). The delegated monitoring theory suggests that banks mitigate information asymmetries because of their expertise in screening and monitoring borrowers at reduced costs compared to individual lenders (See Leland and Pyle (1977) and Diamond (1984)). This is because banks are able to perform economies of scale between their deposit and credit activities (See Pyle, (1971) and Kashyp et al., (2002)). Also, banks use the information collected for the deposit accounts to estimate credit risk (See Black, 1975 and Fama, 1985). Nevertheless, there is a lack of empirical evidence supporting the existence of such economies and scale and scope. Moreover, according to Galloway (2009), Herzenstein et al. (2011), and Morse (2015) the mediation of financial institutions is not required. As a matter of fact, in the last years we have observed the growth of crowd-based platforms, in which the screening part of the monitoring process is entrusted to single private lenders. Nevertheless, at the same time, these platforms often rely on information concerning the credit risk of borrowers coming directly from banks.

Secondly banks provide liquidity for the society through their transformation activity. In particular, banks are the only institutions that finance a large part of their loans through the deposits of the public, and transform liquid resources into illiquid long term loans.

Moreover, banks play also a central role in the mechanisms of transmission of the monetary policy via the banking credit (directly through the control of credit, or indirectly through the cost of bank liquidity), and via the channel of the finance and of interest rates (the variation on the interest rates affects the behavior of portfolio selection of non-financial agents).

### 2.1.2 Why are banks regulated?

The banking sector is characterized by the presence of several market failures.

One first market failure is the presence of information asymmetries since the public is not well informed about the soundness of the financial institutions to which he is appointing his money. Information asymmetries can be both *ex-ante* (adverse selection) and *ex-post* (moral hazard).

Secondly, there are externalities in this market. The recent crisis provides an example of how the failure and losses of single financial institutions can impose externalities on the rest of the economy (systemic risk). As a matter of fact, to alleviate this risk, banks have to hold regulatory capital to protect themselves against systemic risk according to the regulation Basel 3. Also the presence of financial risks (liquidity, counterparty, default, etc.) implies externalities on other players. Players may have the incentive to underinvest in the quality of the service because the level of investment and risk-taking is not always observable. For example, they may underinvest in the level of security of an infrastructure such as a payment system. But the level of security of a given payment system may be considered as a public good that depends on the level of investment of all banks and platforms, together with the level of effort exerted by end-users to follow the rules of conduct for their own protection. When one player free rides and underinvests in security, or exerts low effort on data protecting, the incident that may occur due to unprotected exposure to the cited risks causes a negative externality on the other players, through users' perception of security. In fact, if a player underinvests, the aggregate level of security diminishes and consumers' adoption decreases as a consequence. Subsequently, this chain causes a drop in aggregate banks' profits. It is precisely because of asymmetric information and free riding problem that it is strictly necessary for regulators to set standards and minimum security requirements in the industry, and to provide players with incentives for cooperation and coordination.

Thirdly, the banking sector is characterized by oligoposlistic competition due to the presence of high barriers to entry, switching costs and strong brand loyalty (Claessens and Laeven, 2004; Shy, 2002; Kim et al., 2003). Therefore, the presence of market power justifies regulatory action. Several hundreds of M&A operations have been registered in the last

years, and, even if Berger et al. (1999) do not find evidence of cost efficiencies, more empirical evidence is needed. So, one important issue is to understand whether the concentration of the banking market is a signal of inefficiently high barriers to entry or, on the contrary, a signal of efficiency. In the second chapter, I look at the effect of market concentration on consumers' adoption of peer-to-peer lending and find that the more the market is concentrated, the less the population adopts peer-to-peer lending solutions, suggesting that concentration is a symptom of high brand loyalty towards traditional banks and high switching costs.

One question is to understand who should be responsible for regulation in retail banking. An interesting example is the case of payment systems, where public authorities that are involved differ from one country to the other. Payment systems are either regulated by Central Banks (such as in Australia) or are subject to interventions undertaken by competition authorities (such as by the European Commission). Sometimes, Central Banks act as operators in the payments industry, which may sometimes limit their power to intervene as regulators. Authorities intervene with a threefold rationale. On the one hand, Central Banks aim at promoting an efficient use of payment instruments. In particular, since consumers often perceive the use of cash as free, public authorities may decide to provide them with incentives to shift from paper-based to electronic payment instruments. On the other hand, regulators aim at enhancing consumer protection. This is achieved by facilitating the supervision of risks (e.g., by setting mandatory requirements to fight fraud) or by protecting them from the consequences of potential anti-competitive behaviors. Thirdly, regulators sometimes choose to foster innovation and investments in the industry. For example, in 2012, the Reserve Bank of Australia started a strategic review of innovation in the Australian payment system. For this, a public consultation was undertaken, calling for views from all stakeholders, including payment system participants, small and large businesses, consumers and government, with the goal to spur competition and improve payment efficiency. In other realities, such as in the USA, it is true that regulators think that innovation stems from a market process and thus the Central Bank does not intervene to directly promote innovation.

Another example is the regulation of crowdfunding platforms in France. For these platforms, such as Lendix or Younited Credit, there is a double regulation and status. Since October 2014, internet platforms arranging loans must register as a "crowd-financing inter-

mediary" (intermédiaire en financement participatif or IFP) while those arranging securities offerings must obtain a license as a "crowd-sourced investment advisor" (conseil en investissement participatif or CIP) or hold a license as a financial services provider (prestataire de services d'investissement or PSI).

### 2.1.3 How to adapt banks regulation to entrants, and why is regulating banks a difficult task?

According to Philippon (2015, 2016), the existing regulatory framework for incumbents in the financial system is inefficient. After the Great Depression, some efforts have been made to decrease banks' leverage and to make the financial industry safer. However, regulation entails several distortions. The fact that banks have different sizes, for example introduces the problem of the "Too big too fail" mechanism, whereby large banks receive subsidies in case of failure to the detriments of small banks. Furthermore, large banks obtain better funding conditions on financial markets.

Regulating too much can have the counterfactual of shifting activities outside the regulated banking industry, as was the case in the peer-to-peer lending industry, which developed after the Great Recession. Another risk of regulating too much is that of raising barriers to entry with the result of blocking entry and innovation.

Nowadays, it is hard to modify and correct the existing legislation of banks due to their complex environment, and therefore even if, according to Philippon, finance is an industry with excessive rents and poor efficiency, this is going to be hardly changed. It is important therefore to design a new legacy system from scratch for new entrants. In this sense, new entrants may prove to increase efficiency in the financial sector as they do not fully rely on existing set of infrastructure and therefore have the possibility to build the right system from the start. Moreover, their business model is generally more oriented towards cost efficiency and they are ready to take riskier choices.

Nevertheless, these innovations will not automatically increase financial stability and efficiency. There is therefore a need of a regulatory framework which takes into account several aspects:

- **Safeguard entry.** The competition between entrants and incumbents is interesting

as they have different business model as well as different set of compliance rules. To ensure a level playing field is a traditional goal of regulation, but, regulators have to deal with all the distortions and market failures that are specific to the financial market. This issue is descriptively addressed in the first chapter of this thesis.

- **Apply forward-looking regulation.** One important issue is to understand what the instruments to improve regulation are. Do we need a bottom-up approach or a top-down one? Is it better to regulate by entity or by function? What is the optimal level of capital requirements and leverage? These issues are material for future research and are not addressed in this thesis.

- **Consumer protection.** These innovations are meant to increase consumer welfare, both from the point of view of the quality offered and of prices. Is regulation always welfare improving? In the third chapter of the thesis, for example, I analyze how different regulations, i.e. the regulation on interchange fees, and the ban to impose price parity clauses or exclusive contracts, is not always efficient from a welfare perspective.

## 2.2 Platform markets: literature on industrial organization

The industrial economics literature provides a framework to deal with various issues in the economics of banking. Banks are different from other firms as they are able to choose their level of risk, of monitoring, and the level of investment in specific relationships with their customers. The choice of these parameters impacts the functioning of the credit market and, therefore, it is important to correctly model these issues, and to understand the trade-off between competition and stability to guide competition policy in the banking industry.

In industrial organization, the bank is modeled as an economic entity which is rational and efficiently chooses its strategies, having in mind the environment in which it acts (taxes, investments, competition). Various research domains that are treated within the industrial economic framework help study the banking sector, such as the economics of networks, contract theory and the economics of regulation. For example, the theory of networks studies questions regarding competition between agents' networks and questions regarding the "switching costs". Contract theory allows to analyze the optimal pricing of loans in the presence of information asymmetries. The economics of regulation allows to study the

regulation of interest rates and deposits.

The increase of competition coming from non-banks calls for a framework that gives us the tools to analyze competition between traditional and innovative institutions offering these services. As we will see in the following session, the theory of two-sided markets helps to complete the modeling of these interactionq when we look at platform markets, such as payment platforms or online P2P lending platforms.

### 2.2.1 The theory of two-sided markets

The example of payment systems is particularly relevant to describe the notion of two-sided market, and inspired many works in the literature. Visa and MasterCard are payment platforms that act as intermediaries between two groups of users, cardholders on one side and merchants on the other side. Users of a payment platform may exert two different types of externalities on each other: adoption and usage externalities. Adoption externalities refer to the decision to adopt a payment instrument. When a consumer decides to join a payment card platform like Visa, it affects the utility obtained by merchants when they decide to accept Visa cards. Cardholders' adoption of Visa cards increases with merchants' acceptance, and vice-versa. In platform industries, adoption externalities are called crossed externalities, because they relate different groups of users (i.e., consumers and merchants). Usage externalities refer to the decision to use a payment instrument. When a consumer chooses its payment method, it affects the merchant's profit. Think for example of a cardholder who decides to pay a merchant by cash, even though it is more costly for the latter. The cardholder is said to exert a negative usage externality on the merchant.

The presence of crossed network externalities in payment systems impacts platforms' strategies. Platforms try to internalize the (crossed) externalities that consumers and merchants exert on each other in their decision to adopt a payment instrument and to accept it. However, this internalization is often imperfect from the point of view of social welfare maximization because platforms maximize their profits without internalizing the impact of their decisions on consumer and merchant surplus. Armstrong (2006), Rochet and Tirole (2003) show that a monopolistic platform chooses prices that do not maximize social welfare, because it does not internalize the impact of its pricing decision on consumer and merchant

surplus. They also show that monopolistic platforms may subsidize one side, to attract users from the other side.

Also, because of crossed externalities, setting prices at marginal cost for each side is not efficient from the point of view of social welfare maximization, because the platform has to take into account these externalities. For example, Armstrong (2006) shows that consumers should pay a lower price than the marginal cost incurred by the platform for serving them if they exert strong adoption externalities on merchants. Moreover, users of different sides of the two-sided market internalize some of the other's side decisions. It is therefore important to understand what the potential sources of internalization on platform markets are. For example, in Creti and Verdier (2014) consumers internalize investments on the merchants' side in anti-fraud technologies, or consumers with an elastic demand on the product market internalize merchants' transaction fees when they buy a product and pay by card, as in the third chapter of the thesis.

A first strategic decision is pricing of access and use of the platform. Platforms attempt to set fees in such a way to incentivize both sides of the market. Usually the platform sets the fees in an asymmetric way, subsidizing the side which exerts the strongest externalities on the other. For example, as addressed in chapter 1, in the market of P2P lending in the USA, lenders are subsidized with respect to borrowers to access the platform. In the payment platform example, usually cardholders are subsidized and merchants pay higher usage and access fees. In the retail payments industry, the result of Armstrong (2006) and Rochet and Tirole (2003) that monopolistic platforms may subsidize one side, to attract users from the other side, translates into the fact that payment card platforms often subsidize consumers to the detriments of merchants. Indeed, consumers often get rewards for using their cards, whereas merchants often pay fees to accept cards. The same authors show that competition between platforms does not yield to socially optimal prices. When there is competition between payment cards platforms, cardholders (resp. merchants) can multi-home, i.e. they have the ability to own (resp. accept) cards from multiple platforms. For example, Visa cardholders in the United States often hold a card from a different operating system like MasterCard, American Express or Deliver, as investigated in Rysman (2007). Users' ability to single-home or to multi-home impacts the equilibrium fees that result from platform

competition. In this case, authors (such as Armstrong, 2006) find that price asymmetries between consumers and merchants can be even greater than in a monopolistic market structure. Indeed, competition between platforms is fiercer in order to attract the side of the market that exerts the strongest externalities on the other side, and this will increase the asymmetry in the pricing structure.

The pricing structure of payment systems is particularly interesting. The platform is not always able to sign contracts directly with end-users. There are two types of payment platforms: three-party and four-party payment platforms. Three-party payment platforms (closed systems), such as American Express and Diner's Club, are able to set centrally the fees paid by cardholders and merchants (membership, usage fees or both). Four-party payment platforms (open systems), such as Visa and MasterCard, act as intermediaries between consumers' banks (the issuers) and merchants' banks (the acquirers). In this case, the issuers decide on the fees paid by cardholders, whereas the acquirers decide on the fees paid by merchants. These fees paid by consumers and merchants (membership, usage, or both) depend on the terms of contract between their bank and the platform. Banks usually pay membership fees to join a platform, and the platform decides on a level of interchange fee that is paid by the acquirer to the issuer for each transaction. The interchange fee is a fee that is paid by the acquiring bank to the issuing bank each time a consumer pays at the merchant's shop by card. The impact of the interchange fee on the prices paid by consumers and merchants, respectively, depends on the nature of competition on both sides, that is, on the pass-through of costs to consumers. An important issue is to understand the role of merchants' pass-through into higher retail prices for consumers, both from a theoretical and an empirical perspective. This subject is addressed in the third chapter of this thesis from a theoretical perspective.

As in other network industries such as digital music distribution industries or personal computer (e.g. Microsoft or Apple) another strategic decision is the choice on how much to cooperate on compatibility and standards. The degree of cooperation between competing platforms determines the magnitude of networks effects. The presence of multi-homing is not enough to ensure compatibility, and it can be the case that payment platforms do not make their networks compatible –for instance, Google Wallet uses NFC standards and are

thus not compatible with usual payments devices). Compatibility, i.e. when technically compatible products or systems really can interact, is crucial in order for the platforms to benefit from network effects. The need to reach a critical mass leads the platforms to cooperate on the compatibility and on the standards that have to be adopted. This happens only when complementary products or systems operate on the same or compatible standard. Nevertheless, I will not address the trade-off between cooperation and competition in this thesis from a theoretical or empirical perspective, but I describe it in the first chapter in the article on innovation and competition in Internet and mobile banking.

### 2.2.2 What determines the adoption of an innovation?

**Merchants' acceptance** Due to network effects, merchants' acceptance is the main driver and has a direct impact on consumers' adoption in the case of payment systems, whereas in P2P platforms it is unclear which side exerts the most externalities on the other, whether lenders or borrowers. I found as shown in the first chapter, that the servicing fees of Prosper for investors are lower than the borrowers' usage fees, suggesting that the platform subsidizes the lender's side and therefore that it is this side which exerts the most externalities on the other.

Fung, Huynh & Sabetti (2011) find that in Canada the probability of using cash is 32 percent lower at a POS where all payment methods are accepted. As a matter of fact, users can observe the rate of merchants' acceptance of electronic payments and decide in the first place to adopt electronic payments, and, for example in the case of cards, at a later stage to use them at the POS, and not at ATM to withdraw cash.

**Price structure** Secondly, thinking for instance of the cards' market, the fee charged to consumers by the issuer plays a crucial role for incentivizing card adoption. Issuers may charge annual fixed fees –such as the fee per card-and also per-transaction fees to cardholders. According to the European Commission, in the year 2004 Diners Club, with a 57 Euros per card fee was the highest among European Member States. Fees that are charged to "consumer" cardholders may vary significantly from the ones charged to "business" cardholders, and also change significantly within Member States. According to a European Commission

survey in 2006, fees per transaction are only present in 6 out of 25 Member States and vary from 0.1% to 0.7% in the MasterCard network, and from 0.5% to 0.7% in the Visa network. Given the high elasticity of demand of cardholders, they are relatively price-sensitive and their choice to adopt a card is directly linked to the magnitude of the fee. Thus, if the issuers were to set negative fees for cardholders- i.e. a subsidy for their use, as in the USA, it would incentivize consumers' adoption of cards. Cardholders' fees are impacted by the contract between the issuing bank and the platform, and are thus linked to each other. In theory, an increase in the interchange fee corresponds to an equal decrease in the consumers' fee. Empirically, there is not a perfect pass-through to consumers, but still a 1 Euro increase in interchange fee is, on average, associated to a 25 cents direct decrease in cardholders' fee (Interim Report European Commission, 2006). Also Ardizzi (2013) investigates data on 273 issuing banks in the years 2009-2010 and finds that there is a negative correlation between the use of cash and the interchange fees. Thus, interchange fees do have an impact on consumers' adoption. Bourreau and Verdier (2015) show in a theoretical model that the impact of interchange fees on consumer adoption depends on network externalities between consumers and merchants. Indeed, the value of adopting a payment instrument increases with the anticipated number of transactions that can be completed with merchants. In their model, consumers pay fixed fees to adopt a payment instrument and do not pay transaction fees, as is the case in most European countries. Merchants pay a fee to their bank, which is related to the level of interchange fee. When the degree of externality is high, consumer adoption decreases with the interchange fee, whereas when the degree of externality is high, consumer adoption is maximized for a strictly positive value of the interchange fee. However, the model of Bourreau and Verdier does not take into account the fact that interchange fees can be passed through by merchants to consumers through higher prices. This effect could offset the positive impact of interchange fees on consumer adoption. In the third chapter of the thesis, I analyze the role of merchants' pass-through of platform's fees is indeed crucial for the efficient allocation of surplus between the different players. In the case of mobile payments, the usage fee may be set to zero by bundling the payment service with, for instance, advertising. So, while the provider makes revenues out of advertising, users perceive the service as charge-free and are consequently incentivized to adopt.

**Price discrimination** Thirdly, we may identify monetary and non-monetary incentives that are used by banks and non-banks instruments to retain consumers. Card loyalty, reward programs, interest-free periods cash-back, reward points redeemable for a selection of merchandise, travel or gift cards, and air miles are all methods that reward loyalty and raise switching costs for consumers. Fung, Huynh & Sabetti (2011) find that above a transaction value threshold of 25 dollars, there is a strong substitution effect from debit cards to credit cards due to credit card rewards. One interesting issue is when a merchant develops its own payment system to bypass the bank's one. The merchant may bundle the payment transaction with the sale of the product and increase brand loyalty of his clients. This issue is going to be treated in a theoretical model in the third chapter. However, most of the rewards effect is due to the change in monetary rewards as they are proportional to the transaction value (e.g. rebates, miles, etc.). Consumers may adopt these instruments in the first place for some immediate gain, such as in the case of interest-free periods. At a later stage they have the incentive to persist on the adoption given the rising switching costs that a loyalty card or a reward program entail. This "lock-in" practice makes consumers dependent from the issuing bank and raises barriers to entry.

**Exogenous factors for consumers' adoption** Beyond these elements, a number of empirical studies have tested the effect of several exogenous drivers in determining payment choice. Bolt and al. (2010) show that surcharging steers consumers away from using debit cards towards cash in the Netherlands case. Schuh and Stavins (2011) find that setup and record keeping are especially important in explaining adoption, while security is important in explaining which methods USA consumers use for transactions, and that cost significantly affects payment use. Fung, Huynh & Sabetti (2011) present estimates of the elasticity of using a credit card with respect to credit card rewards in the Canadian market. Reward elasticities are a key element in understanding the impact of retail payment pricing regulation on consumer payment instrument usage and welfare. First of all they find that cash is the most used for transactions below 25 Euros. Also they find that reveals that a 10 percent increase in dollar incentives raises the likelihood of paying with credit card by about 1.2 to 3.7 percent depending on the transaction value and the rewards plan. Kouyalev, Rysman,

Schuh & Stavins (2012) test several variables such as income, employment, education and ethnicity on the choice for payment instruments and they find that being young, employed and with a higher income positively affects use of credit cards. Most recently, Rysman and Cohen (2013) use demographic explanatory variables - male and female education levels, designated marketing area of the household, employment status of the male and female, household income, household size, whether the house has a pet and race –together with shopping trip explanatory variables.

In the literature on innovation on consumer loans, most studies have focused on users' incentives to adopt innovations according to their individual characteristics. DeYoung et al. (2007) and Hernando et al. (2007) analyze the impact of the adoption of online banking on banks' profitability and find that the Internet channel is a complement to rather than a substitute for physical branches. Nevertheless, there is not yet a lot of empirical evidence on the exogenous variables influencing the adoption of online lending platforms, both on the lenders and on the borrowers' side. The drivers of the adoption of P2P lending are going to be treated in the second chapter of this thesis.

To conclude, in this thesis I will mainly deal with the examples of payment platforms and peer-to-peer lending platforms to stress some of the problematics that were raised in this general introduction.

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# Chapter 1:

# How do innovations impact competition in retail banking?

This chapter is composed by two articles to explain the dynamics of the competition in the innovative retail banking industry.

The first one is a survey of the issues related to innovation and competition in Internet and mobile banking, with several references to possible future research. It explains how the development of Internet banking and mobile banking has had a considerable impact on competition in the retail banking industry, and how in some countries, the regulatory framework has been adapted to allow non-banks to operate in retail payments and compete with banks for deposits. Moreover, the article describes the various actors that offer innovation in the financial sector, the difficulties that they encountered and the reaction of banks to this entry threat.

The second article describes the competitive strategies between two non-banks. In particular, I exploit data obtained by Prosper and LendingClub websites, the two leading peer-to-peer lending platforms in the USA, for the years 2006-2013 in the case of Prosper, while for LendingClub they are for the years 2007 until 2014. Peer-to-peer lending marketplaces are a type of crowdfunding and are increasingly expanding in the USA and Europe. They are interesting from an economic perspective as they build an example of two-sided market. Indeed these platforms attract and match private lenders and borrowers, while facing the trade-off between increasing the volume of intermediated transactions and minimizing the risks.

# Chapitre 1:
# Comment les innovations impactent-elles la concurrence dans le marché de la banque de détail ?

Ce chapitre se compose de deux articles qui expliquent la dynamique de la concurrence dans le secteur innovant de la banque de détail.

Le premier est un sondage sur les enjeux liés à l'innovation et à la concurrence dans les services bancaires Internet et mobiles, avec plusieurs références à d'éventuelles recherches futures. Il explique comment le développement des services bancaires par Internet et de la banque mobile a eu un impact considérable sur la concurrence dans le secteur de la banque de détail et comment, dans certains pays, le cadre réglementaire a été adapté pour permettre aux non-banques d'opérer dans des paiements de détail et de concurrencer les banques pour les dépôts. En outre, l'article décrit les différents acteurs qui offrent l'innovation dans le secteur financier, les difficultés qu'ils rencontrent et la réaction des banques à cette menace d'entrée.

Le deuxième article décrit les stratégies concurrentielles entre deux non-banques. En particulier, j'exploite les données des sites web de Prosper et LendingClub, les deux plates-formes de prêt « peer-to-peer » aux États-Unis, pour les années 2006 à 2013 dans le cas de Prosper, tandis que pour LendingClub, elles se situent pour les années 2007 jusqu'en 2014. Les marchés de prêt « peer-to-peer » sont une catégorie de crowdfunding et se développent de plus en plus aux USA et en Europe. Ils sont intéressants d'un point de vue économique car ils constituent un exemple de marché bi-faces. En effet, ces plates-formes attirent et associent les prêteurs privés et les emprunteurs, tout en faisant face au compromis entre l'augmentation du volume des transactions intermédiées et la réduction des risques.

# Innovation and competition in Internet and mobile banking: an industrial organization perspective*

Authors: Carlotta Mariotto† and Marianne Verdier‡

## Abstract

Over the recent years, the development of Internet banking and mobile banking has had a considerable impact on competition in the retail banking industry. In some countries, the regulatory framework has been adapted to allow non-banks to operate in retail payments and compete with banks for deposits. Several platforms or large retailers have started to offer innovative financial products to their customers. In this paper, we survey the issues related to innovation and competition in Internet banking and mobile banking and discuss some perspectives for future research.

**Keywords:** bank competition; bank regulation; non-banks; payment systems; Internet banking; mobile banking; platform markets.

**JEL Codes:** E42; G21; L96.

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† MINES ParisTech, PSL - Research University; E-mail: carlotta.mariotto@mines-paristech.fr.
‡ Université Paris 2 Panthéon Assas, CRED (TEPP) and MINES ParisTech, PSL - Research University; E-mail: marianne.verdier@u-paris2.fr.

## 1/ Introduction

The banking industry offers an interesting example of a market in which incumbent firms have to compete with new intermediaries that include Internet platforms such as Google or Amazon. Over the recent years, the development of Internet banking and mobile banking services has had a considerable impact on the industrial organization of the retail-banking sector, both in developed and developing countries.[1] Several companies have started to offer innovative financial services such as stored-value payment cards, mobile payment apps providing consumers with tools to manage their accounts, or loans offered through peer-to-peer lending platforms.[2] The emergence of these new entrants raises several challenges for regulators and policy makers.[3]

The purpose of this paper is to survey the issues related to innovation and competition in Internet and mobile banking and to offer perspectives for future research.

Banks offer mainly two categories of services, those related to deposits and those related to loans.[4] Services related to deposits include storing monetary value, withdrawing money, paying, enabling consumers to invest in assets by subscribing to savings products, or to obtain information on their account. Services related to loans include obtaining information on when to pay interests, and intermediation services for customers unable to access financial markets. Table 1 below provides a summary of the simplified view of innovative banking services that we will use throughout our paper.[5]

To our knowledge, our paper is the first to offer a general perspective on the issue of competition and innovation in Internet and mobile banking. Frame and White (2009) review the literature on the impact of financial innovation on commercial banking, in the broad context of the economics literature on innovation. Berger (2003)

[1] In our paper, we define retail banking as the cluster of products and services that banks provide to consumers and small businesses through branches, the Internet, and other channels. Freedman, 2000, defines e-banking as the provision of access devices (ATMs and home banking by computer), stored-value cards and prepaid software products.

[2] Frame and White (2009) define a financial innovation as something new that reduces costs, risks, or provides an improved product/service/instrument that better satisfies financial system participants' demand.

[3] See the Final report on the conference organized by the European Commission in November 2014 on Emerging challenges in retail finance and consumer policy. See also the conference organized by the European Central Bank and the Bank of Finland in Helsinki, June 2015.

[4] In Freixas and Rochet (2008), a bank is defined as an institution whose current operations consist in granting loans and receiving deposits from the public.

[5] For more details about the products and the firms mentioned in table 1, see Appendix 1.

examines the effect of technological changes on the profitability of the banking industry. Our paper distinguishes itself from these two works by focusing specifically on competition and regulatory issues raised by recent innovations in Internet and mobile banking.[6] A number of recent articles have analyzed specific services that emerged on the market, either in developed countries or in developing countries.[7]

**Table 1**. Innovations in Internet and mobile banking

| | **Types of services** | **Examples of entrant firms providing these services** | **Example of innovation** |
|---|---|---|---|
| **Services related to deposits** | Store monetary value | Starbucks, Apple | Stored-value card |
| | Savings | Paypal | Personal finance tools apps |
| | Withdrawal | CommBank | Mobile technologies |
| | Payments | Apple pay, Alipay, Stripe and Square, Transferwise, Forex, Kantox | Touch ID, NFC, and Bluetooth technologies and cross border transactions |
| **Services related to loans** | Account information | Gemalto, mFoundry | Mobile technologies |
| | Intermediation | Supplier pay initiative, Alibaba Small Loans, Lending club, OnDeck, FundingCircle | Online platform |

The rest of the paper is organized as follows. In the first section, we survey the entry costs and barriers to entry faced by entrants. In the second section, we analyze entrants' strategies (start-up companies, large retailers, platforms…). In the third section, we provide an overview of banks' reactions to the competitive threat posed by new entrants and analyze their incentives to innovate. Finally, we conclude.

## 2/ Entry costs in the retail banking sector

- **a/ Regulatory barriers**

[6] Frame and White (2009) in their definition of financial innovation include product, process and organizational innovations. We only focus on service innovations for Internet and mobile banking. Therefore, subprime mortgages, ACH networks and credit scoring innovations are out of the scope of our paper.

[7] See Shy (2012) for a review on account-to-account money transfers in the US, Crowe, Rysman and Stavins (2010) for an analysis of mobile payments in the US. Examples of papers on mobile payments developing countries include Jack et al. (2010).

Regulation of banks' entry and conduct on the market creates a barrier that needs to be overcome by entrants. First, regulators require that banks obtain a license from the relevant authority and that they implement sound risk management procedures. Second, they monitor closely banks' conduct to ensure banks' compliance with regulatory requirements. Table 2 shows the various types of regulations, their scope and the risky activity that they are aimed at regulating.

**Table 2.** Types of bank regulations.

| Type of regulation | Risky activity | Scope |
|---|---|---|
| *Solvency regulations* | | |
| 1) Mandatory insurance of deposits | Transformation activity. | Alleviate liquidity risk, interest rate risk, credit risk, operational risk and systemic risk, and avoid inefficient bank runs. |
| 2) Imposing high franchise values, variable capital requirements | Risky investments on the asset side. | Alleviate information asymmetry and moral hazard. |
| *Non-prudential regulations* | | |
| 1) Conduct of business (set by the regulator or raised *de facto* by the industry itself). | Too high interest rates charged for banking services, disclosure of contractual terms and conditions, fraud, misuse of personal data. | Enhance consumer protection. |

The recent innovations in Internet and mobile banking raise the issue of how to adapt the existing regulatory framework to non-banks, such as Internet Service Providers, platforms or large retailers, both on the deposit and on the loan markets. On the retail payments market, some regulators have designed new categories of licenses to facilitate the entry of non-banks.[8] For example, in Europe, a firm can offer payment services either by becoming a Payments Service Provider (PSP), or an Electronic Money Institution (EMI). As long as a firm does not offer credit to its consumers, it does not need to comply with the full range of regulatory measures applied to banks. In particular, new entrants have to meet lower initial and ongoing capital requirements than banks. Such lighter regulations also exist in other countries and jurisdictions as shown in table 3.[9]

[8] Bradford, Davies, and Weiner (2003) organize non-banks operating in retail payments into six groups: cheque conversion; electronic bill presentment and payment (EBPP); electronic invoice presentment and payment (EIPP); stored-value instruments; person-to–person (P2P) and person to business (P2B); contactless payments.

[9] There are also various examples of regulations of mobile money in developing countries (see for example di Castri, 2013, "Mobile Money: Enabling Regulatory solutions"). Another table in Appendix 2 of the Working Paper version of the paper shows the current minimum capital requirements in France and in Europe for different types of institutions.

Other types of regulatory measures include restrictions on investment in risky assets. Such prudential measures are meant to prevent new players to take on excess leverage and become insolvent. In general, non-banks offering Internet and mobile payment services are not allowed to engage in the transformation activity that is performed by banks. Furthermore, regulators often require entrants to hold liquid assets in a bank account when they issue electronic money to enhance consumer protection and may impose daily transaction limits (e.g., in Kenya and the Philippines).[10] In the loan market, several regulators have started to design rules for the provision of loans by alternative financial services providers operating on the Internet such as Peer-to-Peer Lending platforms.[11]

**Table 3. Regulations of entry with a different license**

| | Law | Resulting regulatory status |
|---|---|---|
| Europe | Payment Service Directive (2007, 2015) | Payment Service Provider (PSP)/ Electronic Money Institution (EMI) |
| USA | Revision of the FinCEN and Financial Action Task Force (2001) | Money Services Businesses (MSBs) |
| Australia | Revision of the Banking Act (2014) | Authorized deposit-taking Institution (ADIs) |

Creating new licenses for non-banks is not the only regulatory option to enhance competition in retail banking markets. Indeed, some countries have recently decided to facilitate entry of new banks by reducing capital requirements for entrants. These reforms have sometimes been accompanied by the design of new rules for the resolution of bank failures. For example, the Financial Service Authority and the Prudential Regulation Authority in the United Kingdom have decided in 2013 to allow new banks to enter with lighter capital and liquidity requirements.[12]

Finally, one last issue concerns the interactions between the regulated and unregulated sectors when an innovation occurs outside the banking industry. In this

[10] This amount may be equal to the exact value of the money issued electronically.
[11] For example, in April 2014, in the United Kingdom, the Financial Conduct Authority published a policy statement on its regulatory approach to firms operating online Crowdfunding platforms (prudential requirements, protections in case of firm failure, disclosure rules, dispute resolutions).
[12] See a review of requirements for firms entering into or expanding in the banking sector, March 2013 by the Financial Service Authority.

case, regulators need to understand the channels through which risks may flow back into the banking system, as may be the case for virtual currencies.[13]

To conclude, regulators face a trade-off between lowering barriers to entry to allow the development of competition and increasing barriers to entry to protect the stability of the financial sector (see Carletti, 2008).[14] The literature on banking regulation and competition could be enriched by analyzing this trade-off in the context of competition between banks and non-banks for the provision of mobile and Internet banking services.

- **b/ Structural barriers**

Economies of scale and scope between deposit and lending activities create another barrier to entry. Banks make economies of scale by bundling both services because they are experts in managing liquidity risk and reducing information asymmetries between depositors and lenders (see Pyle, 1971 or Kashyap et al., 2002). Economies of scope arise if the marginal cost of granting a loan decreases with the volume of deposits and the total cost of producing both services separately is higher than the cost of producing them together. As shown by several authors (Black, 1975, Fama, 1985, or Nakamura, 1984), banks can use the information collected on the deposit account of their customers to evaluate credit risk. The value of this information is particularly important for small firms and customers, which cannot credibly signal their quality on the market. In this context, an important unanswered question is whether entry could occur on the deposit market separately from the loan market. No paper has studied whether non-banks can sustain competition with banks given economies of scale and scope.

Other barriers to entry are created by the presence of switching costs and network effects. According to Degryse and Ongena (2008), switching costs are either due to the fixed technical costs of switching banks[15] or can be explained by the existence of long-

[13] For an interesting introduction about the regulation of Bitcoin, see Brito and Castillo (2013).
[14] The existing literature concludes that the relationship between competition and stability in the banking industry is not clear. On the one hand, a higher franchise value increases' banks' market power and reduces their incentives to take risks (see Hellmann et al., 2000). On the other hand, higher interest rates on loans may induce firms to take more risks, resulting in more risky bank portfolio and less stability (See Boyd and De Nicolo, 2005).
[15] The fixed technical costs of switching banks include the search costs a depositor incurs when looking for another bank branch, the opportunity cost of her time for opening a new account, transferring the funds, closing the old account. Kim and al. (2003) estimate switching costs in the market for Norwegian

term relationships between banks and customers on the loan market (see James, 1987, Sharpe, 1990 and Rajan, 1992).[16] In payment systems, a specific entry cost is related to the presence of crossed externalities and network effects between consumers and merchants, as highlighted by the literature on two-sided markets (see Verdier, 2006 and 2011). To successfully enter the market, entrants need to reach a critical mass of users and to solve the "chicken and egg dilemma" by incentivizing both buyers and sellers to use and accept a payment innovation, respectively. For example, Apple-Pay did not manage to bring many merchants on its platform, as in December 2014, only 220.000 merchant locations were enabled with Apple-Pay.[17]

- **c/ Strategic barriers to entry**

Incumbent banks may also adapt their behavior to the threat of entry and erect strategic barriers to entry (Bain, 1956). There are several strategies that could be used by banks to deter entry, among which overinvestment in ATMs and network capacities (see Dick, 2007), bundling products to offer lower prices, increasing minimum quality standards, investing in reputation, or denying access to facilities shared by a club (such as settlement services). In markets with network effects and switching costs, an incumbent firm can also use its installed base of customers to keep a newcomer with a superior technology out of the market (Farrell and Saloner, 1986).

However, it is not obvious that deterring entry increases banks' profits with respect to entry accommodation. For example, in retail payments, foreclosing access to existing infrastructure may deprive banks from interconnection fees paid by entrants. According to the Financial Times, some banks even agreed to share revenues from card transactions processed through Apple Pay with Apple, which receives a 0.15% fee for each transaction. Indeed, banks' costs of cash can be reduced by an increased use of electronic payment methods.[18] Similarly, overinvestment in ATMs may not be a credible threat since consumers increasingly pay with electronic payment methods. Also, entry

loans at 4.12% of the customer's loan. Shy (2002) argues that the cost of switching between banks varies from 0 to 11% of the average balance in the Finnish market for bank accounts.

[16] In the economic literature, long-term relationships between banks and customers are defined as relational banking (See Freixas and Rochet, 2008).

[17] For the full article see http://www.pymnts.com/news/2014/how-many-consumers-in-apple-pays-bushel-basket/#.VJFnNbQ7V-8.

[18] See the Financial Times 12th, September 2014.

deterrence may be more difficult in an oligopolistic industry than in a market dominated by a monopoly, because multiple incumbents need to coordinate their investment decisions to deter entry (see Kovenock and Suddhasatwa, 2005). Finally, in markets with switching costs like the retail banking industry, larger firms tend to act as less-aggressive "fat cats" (Begg and Klemperer, 1992).[19] Indeed, incumbent banks cannot easily price discriminate between old and new customers. Therefore, they have greater incentives to exploit old locked-in customers by choosing a high price and win fewer new unattached customers.

## 2/ Entrants' strategies

- **a/ Start-up companies**

To reduce entry costs, a first option for start-up companies is to rely on the infrastructure offered by banks to offer complementary or differentiated products. The "partial integration" solution is widely used by start-up companies offering mobile payment services or personal finance management tools. The rationale for building a vertical relationship with incumbent players in the retail-banking sector can be twofold. First, a start-up may decide to target banks' existing customer base by providing additional complementary services. Second, a start-up may decide to serve a niche market that is not served by banks, such as unbanked customers. In both cases, building a vertical relationship with an incumbent firm reduces the risks of failing to reach a critical mass of users. Furthermore, in markets with switching costs, the "fat cat effect" may make small-scale entry very easy when firms cannot price discriminate between old and new customers (Farrell and Klemperer, 2006). Since incumbent firms choose high prices to extract profits from their old customers, this creates a price umbrella under which entrants can profitably win new customers, such as unbanked customers or young consumers who have a taste for technology.

To understand how a vertical relationship can be built between a bank or a group of banks and an entrant firm, we focus on innovations for mobile payment services. Most

[19] In the terminology of Fudenberg and Tirole (1984) firms act as fat cats when there is strategic complementarity between their level of investment and the entrant's investment in case of entry, that is, if the incumbent's investment decreases, the entrant's investment decreases.

innovations in the area of mobile payments rely on an existing payment method that is already accepted by merchants, one exception being PayPal. An interesting example is the case of LevelUp, a solution that enables payments at the Point-Of-Sales via a QR code and a downloadable consumer app on the mobile phone.[20] Level Up relies on a partnership with Bank of America, which receives a fee to process Level Up's transactions and to store financial information. Level Up has dropped the traditional pricing model in which merchants are charged a fee for accepting a payment transaction. Instead, it takes a percentage when consumers see ads through loyalty programs.[21] This is an interesting example of a successful entry with a pricing strategy that differs from the traditional ones used by banks.

Partnerships between banks and entrants are also frequent for personal finance tools. In the United-States, the firm Simple (previously BankSimple) offers online deposit services without holding a banking license. When a consumer opens a checking account, its funds are kept by the Bancorp, which is insured by the Federal Deposit Insurance Corporation, the deposit insurance mechanism that exists in the United-States. The consumer can also withdraw money without paying surcharges thanks to a partnership with the ATM network Allpoint. In contrast with traditional banks, this entrant has no physical branches. Consumers only have access to their bank online through the firm's website or a mobile app. On its website, Simple explains that its revenues come from an agreement with the Bankcorp to split the interest rates collected on the customer's account and the revenues from interchange fees on card payments. [22]

Incumbent firms (banks, financial service providers, telecommunication and Internet companies) may opt for vertical relationships with innovative start-ups or for vertical integration. Several examples in the retail banking industry show that the relationships between start-ups and incumbents are close to vertical integration, because incumbent firms often own a large share of innovative start-ups' capital.[23] For example, the payment card platform Amex decided to invest in a start-up company "Payfone" in order to expand to other markets. Payfone uses a white label for service model in which it

[20] LevelUp was launched in 2011 in Boston and operates in the American mobile payment market.
[21] For example, if a store offers $10 every $100 spent, LevelUp earns 35 cents.
[22] Interchange fees are fees paid by the merchant's bank to the consumer's bank when a consumer uses a payment card.
[23] For examples of vertical relations between incumbents and entrants, see Appendix 3 of the Working Paper Version of the paper.

licenses its mobile payment solutions to merchants. The firm Simple that we mentioned previously has been acquired in 2014 by Banco Bilbao Vizcaya Argentaria, which opted for a vertical merger. As shown by Salinger (1988), vertical mergers may lead to higher wholesale price for competitors. Therefore, vertical mergers can be used as tools to increase the rivals' costs. This implies that banks' or platforms' acquisition of entrant firms can increase their market share.

Lastly, start-up companies are vulnerable to the terms of access designed by incumbent players when the latter remain separated. Incumbent firms can even try to foreclose access to their infrastructure in order to restrict competition on downstream markets. For example, the Reserve Bank of Australia has expressed concern that the requirement to be a deposit-insured institution to access payment card systems like Visa and MasterCard could be too restrictive.[24] The industrial organization literature on market foreclosure is particularly relevant to study banks' incentives to open their infrastructure to entrants (see Salop and Scheffman, 1987, Vickers, 1995 and Economides, 1998). Studying market foreclosure in retail payments amounts to modeling foreclosure in a two-sided market. Finally, no paper has studied whether a regulatory intervention could improve efficiency by forcing incumbent banks to open their infrastructure to entrants, or by regulating the terms of access. Regulators face the same kind of trade-off in the retail banking industry as in the telecommunication industry between service-based and facility-based competition (see Bourreau et al. 2010). If regulators impose mandatory access to incumbent banks' or payment platforms' infrastructure, they run the risk of destroying entrants' incentives to build an alternative infrastructure. While service-based entry promotes competition in the short run, facility-based entry promotes competition in the long run. It is interesting to note that some entrants have started to acquire gradually some elements of the banking infrastructure to improve their services. Leetchi, a company which offers services on the Internet to collect money to make gifts, started as a small start-up in France. Then it decided to build its own transaction platform and to leverage funds to obtain the payment service provider status granted by the Payment Service Directive in Europe. It now uses its platform as a white label service for smaller start-ups like PayPlug in France.

[24] See the consultation document of the Reserve Bank of Australia (2011).

- **b/ Platforms and large retailers**

Technological evolutions have lowered the costs of entering the market for loans and Internet and mobile payment transactions, especially for Internet platforms, large retailers and online merchants. A common point between these non-bank entrants is their ability to rely on network effects.

A first example is the area of Internet and mobile payments. Several merchants such as Internet platforms (Google), large online merchants (e.g., Amazon, Apple) or retailers that already rely on a large physical distribution network (e.g., Starbucks, Wal-Mart) have started to offer payment services as bundles with other goods or services.[25] Because of network effects, online retailers may have incentives to strategically bundle their core product or service to the payment transaction. Furthermore, large online retailers can rely on their installed base of consumers to market innovative payment methods. Both services (product or service and transaction) can be seen as imperfect complements, because without an electronic payment method, the customer is unable to buy online. This explains why Amazon, Google, Apple, Alipay, Groupon and many more online retailers issue their own payment methods. The purpose of bundling, in this case, is to increase consumer loyalty and to increase the firm's market share. According to the leverage theory, a dominant firm may have incentives to bundle its core product to a secondary market in order to extend its market power when some precise conditions are met.[26] Edelman (2014) argues that Google used "Google Checkout" to bundle advertising and payment transactions and increase its market share.[27] This business model differs from the strategy used by banks, which charge merchants with fees for transaction processing. Banks cannot reply to this strategy by selling consumers' data to advertisers, because such practices are forbidden in many countries by existing regulations on consumer protection.

[25] Bundling is often mixed bundling, because consumers are not forced to use the payment method offered by the merchant. Mixed bundling refers to a situation in which consumers can buy the products either bundled or separated.

[26] In particular, bundling has a strategic effect on entry if i) it is irreversible and products are not perfect complements (Whinston, 1990), entry is uncertain on the secondary market (Choi and Stefanadis, 2001), iii) there are cost externalities between both markets (Carlton and Waldman, 2002). One could argue that some of these conditions could be satisfied in the market for retail payments.

[27] Google Adwords advertisers who agreed to use Google Checkout can obtain free credit card processing if they spend 10% of their gross revenues on Adwords, an advertising service offered by Google.

Bundling of payments and products by merchants is also a common practice used by brick and mortar retailers that own a large distribution network (e.g., Starbucks, Wal-Mart, Abercrombie & Fitch Stores). Indeed, retailers have developed mobile payments apps and prepaid cards to offer rewards to loyal consumers and economize on the cost of bank fees. In that case, bundling can help merchants price-discriminate between heterogeneous consumers (see Adams and Yellen, 1976 or Schmalensee, 1984). Furthermore, several mobile payment solutions enable merchants to bundle advertising with payments, which can also increase merchants' ability to price discriminate between consumers.[28]

Finally, several peer-to-peer lending platforms (P2P) have started to exploit social network effects to compete with banks on lending intermediation services, i.e. matching lenders and borrowers. Examples include Zopa in the UK, Smava in Germany, Boober in the Netherlands, Trustbuddy in Sweden, Pret d'Union in France, Prosper and Lending club in the US and Alibaba Small Loans in China. An unanswered issue is how competition between P2P platforms and banks impacts loan rates for individuals and small firms. Both types of firms do not rely on the same monitoring technology. According to Diamond (1984), banks have a comparative advantage in monitoring loans that is, screening projects, preventing opportunistic behavior of a borrower, or punishing or auditing a borrower who fails to meet contractual obligations.[29] The micro-finance literature argues that social networks are able to efficiently select borrowers and estimate their risk level (Freedman and Jin, 2008). Essentially, social networks are informative either because friends on the social platforms are also able to observe the type of borrowers ex ante or because the monitoring of these networks provides a stronger incentive and increases the probability to pay off loans ex post (Freedman and Jin, 2014). In some cases, P2P lending platforms offers lower interest rates than banks and thus represents an alternative service for the unbanked population.[30]

[28] Varian (1980) and Robert and Stahl (1993) see advertising as a substitute to costly information acquisition by consumers. It generates a differentiation between informed and an uninformed consumer, which enables firms to price discriminate.

[29] The presence of banks generates an economy in the monitoring costs, provided that i) there are scale economies in monitoring, ii) investors have small capacities, iii) the cost of delegation is low (i.e., the cost of monitoring the bank itself is less than the surplus gained from exploiting scale economies in monitoring projects).

[30] Lending Club's website (one of the leading P2P lending platforms in the United-States) claims the rate offered is 6.78% as against an average of 11.41%.

- **c/ Entry as banks**

The last option for entrants is to enter the market as banks. A first strategic choice pertains to the degree of differentiation with respect to other competitors (see chapter 3 of Degryse et al., 2009 for an analysis of differentiation in banking retail markets). An entrant firm can choose to compete with existing banks in a horizontal dimension. For example, METRO Bank decided to establish itself in the United Kingdom and to open bank branches. It outsourced its IT system to a Swiss Banking system provider to lower its entry cost. However, this entrant bank did not manage to reach profitability.[31] Possible explanations for the difficulties encountered by horizontally differentiated entrants are the presence of adverse selection and existing price regulations. For instance, because of adverse selection, consumers who switch banks are likely to be less loyal, less valuable, or more risky than other customers.[32] Furthermore, the optimal number of banks in a free-entry equilibrium depends on deposit rates regulation (see Chiappori, Perez-Castrillo and Verdier, 1995).

Another option for entrants is to offer vertically differentiated services. Several authors argue that vertical differentiation between banks is due to reputation and network effects. For example, depositors exhibit a higher willingness to pay for banks with a larger ATM network (Knittel and Stango, 2004). However, banks' reputation on the loan market is not necessarily impacted by the size of the ATM network (Kim, Kristiansen and Vale, 2004). While reputation can be a barrier to entry for financial intermediaries (Jeon and Lovo, 2011), entrants may also differentiate themselves from banks by offering a better technology. When consumers have heterogeneous tastes for technology, entrants can successfully enter by selling high quality services to consumers who have a high valuation for technology. This strategy has been used by Fidor Bank, which obtained a banking license from the German regulator.

To conclude, entrants have to trade off between competing with banks or competing with other entrants that have the same regulatory status. An interesting question is the timing at which a firm should acquire a banking license on the market. A firm can decide

[31] According to The Telegraph of July 2014, 23rd, METRO Bank is not yet profitable despite holding £1.7 trillion of deposits and £1.8 trillion of loans.
[32] Ausubel (1991) or Calem and Mester (1995) have found empirical evidence of adverse selection on the credit card market.

to start as a platform, and then to obtain the status of bank when it has gained significant experience and reputation on the market, as was the case for PayPal.[33]

## 3/ Banks' reactions to entry threats

There are several sources of rents in the banking industry that impact banks' incentives to innovate. First, banks have market power. Therefore, their incentives to innovate depend on the classical trade-off identified in the industrial organization literature between the replacement effect and the efficiency effect (see Arrow, 1962 and Gilbert and Newberry, 1982).[34] Second, the banking industry exhibits network effects, which are the source of specific trade-offs (Farrell and Klemperer, 2007).

- **a/ The role of switching costs**

Because of switching costs, a bank must design a strategy that balances the profits earned on its installed base and the profits earned on new customers. Therefore, it faces a trade-off between customer retention and customer acquisition, which is often referred to as the "harvesting versus investing dilemma" (Klemperer, 1995).[35] An incumbent firm can decide to charge a high price to its installed base to recoup its investment expenditure. However, this harvesting strategy must be balanced against the opportunity cost of losing new customers who will make valuable repeat-purchase in the future (investing). For example, when Bank of America launched the BankAmericard, it made a $20 million loss. However, this innovation became profitable in the long run (investing). The issue of whether large banks with a higher installed base innovate more than small banks has not been investigated in the empirical literature. A second choice for banks is whether to innovate by themselves or to outsource innovation to entrants and start-ups. From a theoretical perspective, Good (2006) shows

[33] PayPal started as a platform in 1998 on the American market of online payments and was acquired in 2002 by eBay. It settled in 2007 in Europe and received a license to operate as a credit institution from the Commission de Surveillance du Secteur Financier (CSSF) in Luxembourg. In 2014, PayPal split from eBay.
[34] The replacement effect means that monopolistic banks have fewer incentives to innovate than competitive firms because they "replace themselves" when they innovate. The efficiency effect implies that, when competition reduces profits, a monopolist's incentive to remain a monopoly is greater than an entrant's incentives to enter a market as a duopoly.
[35] A firm must balance the incentives to charge a high price to "harvest" greater current profits against the incentives to lower its price to invest in market share and future profits (see Farrell and Klemperer, 2007).

that switching costs may lead an incumbent firm to prefer to delay innovation and instead rely on new entrants to introduce new products which the incumbent can then imitate. From an empirical perspective, Chakravorti and Kobor (2003) find from the interviews they performed to market participants that the choice to rely on in-house development of innovative payment solutions is different for small and large banks.

### b/ Compatibility and cooperation decisions

Network effects may provide banks with incentives to make their products compatible when they innovate. For example, Matutes and Padilla (1994) show that banks trade off between competition and network effects when they choose to share their ATM networks. On the one hand, banks are able to offer lower deposit rates when their ATMs are compatible because depositors can withdraw cash more easily in a larger network. On the other hand, a large ATM network increases competition (and thus deposit rates), because banks become more substitutable. Incentives to make products compatible depend on firms' installed base of customers. In particular, Katz and Shapiro (1986) show in a Cournot duopoly setting with network externalities that the firm that has the largest installed base of customers has fewer incentives to choose product compatibility than the firm that has initially no customers. However, a firm may let rivals into its network, trading-off the higher value of its network due to its increased size against the sharing of the profits with its rival (Katz and Shapiro, 1985).

The trade-off between competition and network effects is also present in banks' incentives to coordinate in joint ventures and alliances. In the area of Internet and mobile payments, there are two types of joint ventures: between banks, and between banks and entrants. Cooperation for both entrants and incumbents is crucial to raise acceptance and usage of the innovative product, and thus to reach a critical mass of users to exploit network effects. One example of joint ventures between banks can be found with the French company Paylib, a new payment system that three French banks created for Internet transactions. Joint ventures between banks and entrants are also frequent.[36] As a matter of fact, entrants do not always offer traditional bank functions, such as cash management, risk control or short-term loans, which involve significant

[36] See Appendix 4 of the Working Paper version of the paper for examples of joint ventures between platforms, banks and other firms in order to provide a more customized service.

fixed costs. On the other side, banks do not always have the know-how to develop innovations in their core business and may benefit from a partnership with entrants (see Bourreau and Verdier, 2010, for an analysis on the mobile payments market). Specific issues about cooperation arise in retail payment systems because of externalities between consumer and merchant adoption. In an extension of d'Aspremont and Jacquemin (1988), Bourreau and Verdier (2014a) relate the social benefits of cooperation in R&D in two-sided markets to the degree of externalities between the two sides. Bourreau and Verdier (2014,b) also study whether interchange fees can improve banks' incentives to cooperate.

- **c/ The impact of risks on banks' strategies**

Banks' strategies are also impacted by the presence of risks, which can be classified into two broad categories: risks associated to the transformation activity, and risks occurring at the transaction level for payments or loans.

Innovations offered by entrants can have an impact on banks' liquidity risk. Indeed, since entry impacts competition for deposits, it may affect banks' reserve management strategies. An interesting direction for future research would be to analyze how competition with a non-bank entrant affects the interest rates on loans and deposits, according to the various liquidity requirements that can be imposed on an entrant. For example, Prisman, Slovin and Sushka (1986) study how the cost of reserve management affects the interest rate on deposits and the interest rate on loans in a setting where a bank is a monopoly. Shy and Stenbacka (2007) have studied the impact competition between banks offering different types of accounts (perfectly liquid or partially liquid) on interest rates. However, no paper has studied competition for deposits between banks and non-banks, subject to different liquidity requirements.

Risks occurring at the transaction level can provide banks with incentives to invest in security standards. For example, Weiner et al. (2007) identify several risks associated to the provision of innovative payment services (credit risk, settlement risk, liquidity risk, and operational risk). Banks have incentives to invest in security standards to protect their reputation from the negative externalities that could be triggered by entry

(e.g., in case of fraud risk, human errors…).[37] The report of a study conducted by the World Bank reveals that 63% of innovative payment services are subject to operational security standards and data integrity. These standards can be set either by a regulator, or by a collective self-regulatory agreement between incumbent banks. The issue of whether banks set inefficiently high security standards to discourage entry of non-banks on the market for retail payment services has not yet been studied in the literature. In its seminal paper, Leland (1979) shows that minimum quality standards can increase welfare in markets with asymmetric information when set by a regulator. However, if quality standards are set by an industry itself, it is likely that the standards will be too high. This issue is a policy concern for antitrust authorities and financial regulators. For example, in 2011, the European Commission opened an antitrust investigation into the standardization process for payments over the Internet undertaken by the European Payments Council. The Commission undertook a careful examination of the standardization process to ensure that competition was not restricted, for example, through the exclusion of new entrants who are not controlled by a bank.[38]

**Conclusion**

In our paper, we have surveyed the issues related to innovation and competition in Internet and mobile banking. We have shown how the existing models of the industrial organization literature could be enriched by designing tools, that will help policy makers find the right balance between competition and financial stability on the retail banking market.

Further research on the impact of innovations on competition in retail banking is essential from a policy perspective. The recent creation of a Payments System Regulator in the United-Kingdom in 2013 to oversee competitiveness in the United-Kingdom payments industry shows that financial regulators consider this issue as a priority.

[37] Data security risk involves unauthorized modification or disclosure of sensible data. Fraud risk occurs when, for example, the payee does not have a legitimate claim on the payer because a wrongful or a criminal deception is in place (such as cloning of cards), and may be a consequence of data security risk. Risk of counterfeit refers to the risk of incurring in a false payment instrument (such as currency reproduced without authorization).
[38] See press release IP/11/1076 on the website of the European Commission.

## Appendix 1. Examples of innovations in retail banking

### DEPOSITS AND TRANSACTIONS

| | Types of services | Description | Website |
|---|---|---|---|
| **Services related to deposits** | Stored- value products | Often closed system prepaid cards that may be used exclusively at the merchant's shop. As it is for the Starbucks prepaid card, usually customers must own one of these cards to accede loyalty programs and favorable treatments. | https://www.starbucks.com/card |
| | Savings products | Paypal offers to its customers the possibility to deposit and save money on a PayPal account and to reinvest these deposits into risky assets. Also the online payment affiliate of Alibaba, Alipay, now allows users with money stored online to invest in a fund fixed to corporate debt and government bonds. | https://www.paypal.com/fr/webapps/mpp/home |
| | Withdrawal | Cardless Cash is Australia's first cardless cash service, and enables customers to use the CommBank app to withdraw cash without a card across CommBank's national ATM network. | https://www.commbank.com.au |
| | Payments | The new Apple Pay, for example, permits customers to make a payment transaction with their mobile phones exploiting NFC, Touch ID and Bluetooth technologies. Apple Pay technology is also meant to decrease fraud risk as for each payment a unique Device Account Number will be automatically assigned and encrypted, avoiding customers to write online their actual credit and debit card numbers. | https://www.apple.com/apple-pay/ |
| **Services related to loans** | Account information | With a banking apps users can manage several accounts and cards, review transactions, check their account balances, transfer funds, pay bills and find the closest banks and ATMs without having to go to the different banking sites. | http://www.fisglobal.com/products-mobilefinancialservices |
| | Intermediation | With the Peer-to-peer lending, intermediation takes place on virtual marketplaces where individuals or companies invest in small businesses. | https://www.lendingclub.com/ |

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**Competition for Lending in the Internet Era:**

**The case of Peer-to-Peer Lending Marketplaces in the USA**

Author: Carlotta Mariotto*

## Abstract

Peer-to-peer lending marketplaces are a phenomenon in great expansion in the USA and Europe. These Online platforms build an example of two-sided market as they try to attract and match lenders and borrowers, while facing the trade-off between increasing the volume of intermediated transactions and minimizing the risks. In this article, we provide a descriptive analysis on the competitive strategies used by these platforms, in a two-sided market environment, and we try to find whether these two platforms differentiate from each other or from banks. To provide evidence on this comparison, we exploit data obtained by Prosper and LendingClub websites, the two leading peer-to-peer lending platforms in the USA, for the years 2006-2013 in the case of Prosper, while for LendingClub they are for the years 2007 until 2014. We deduce that these platforms are substitutes with one another and that they are frontally competing.

**Keywords:** peer-to-peer lending; two-sided markets; crowdfunding; bank competition; non-banks; platform competition; Internet banking.

**JEL Codes:** E42; G21; L96.

* MINES ParisTech, PSL - Research University; E-mail: carlotta.mariotto@mines-paristech.fr.

## 1. Introduction

Peer-to-peer lending marketplaces are a phenomenon in great expansion in the USA and Europe and represent one of the main successful innovations in the FinTech movement of the last decade. They match lenders seeking alternative investment possibilities and borrowers who are left out of the traditional credit or that are impatient to have a loan, or that are just heterogeneous in their taste for technology. It is debated whether these platforms could be as disruptive in the banking industry as Uber was for the taxi market or Booking.com, Experia and Airbnb for hotel reservations[1],and one unanswered question is whether this form of consumer lending is a substitute or a complement of the traditional banking system. Moreover, peer- to-peer lending platforms build an example of two sided-markets, and try to properly exploit network effects to attract borrowers and investors on both sides to reach the critical mass of users. On the other side, these platforms have to moderate the presence of financial risks and to assure the financial solvability of their users.

In this article, we provide a descriptive analysis on the competitive strategies used by these platforms, in a two-sided market environment, and we try to find whether these two platforms differentiate from each other or from banks. To provide evidence on this comparison compute this comparison, we exploit data obtained by Prosper and LendingClub websites, the two leading peer-to-peer lending platforms', for the years 2006-2013 in the case of Prosper, while for LendingClub we have data available from the year 2007 until 2014.

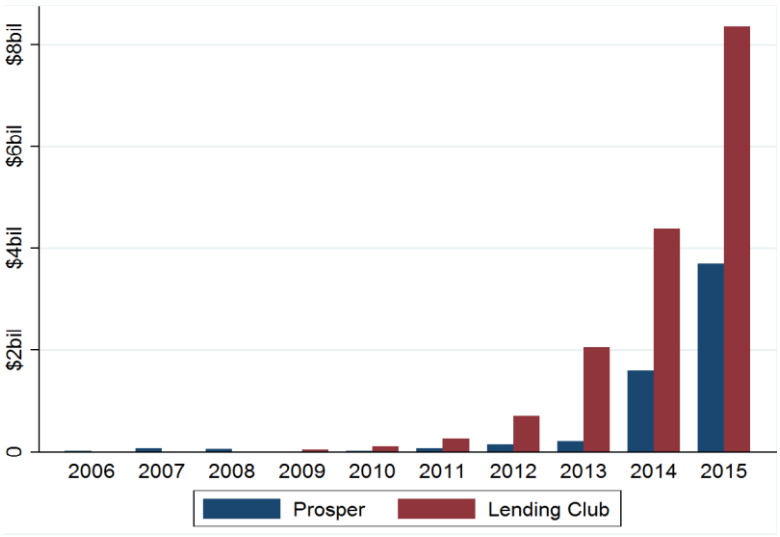
Peer-to-peer lending is a form of lending-based crowdfunding[2] where platforms act as brokers between borrowers and lenders: each borrower requests a sum of money -a loan- which ranges from about $1000 to $350003, then the platform issues a series of unsecured notes for each

[1] See the Economist, 2015: http://www.economist.com/news/special-report/21650289-will-financial-democracy-work-downturn-people-people.

[2] Other crowdfunding forms are donation, rewards, and equity based crowdfunding. (See Neiss, Best and Cassady-Dorion, 2012.

loan, which are sold to multiple investors putting a minimum of $25 on each note. Peer-to-peer lending started out in the UK in 2005 with the launch of the platform Zopa. In 2006 it landed in the United States with the marketplace Prosper. At the end of 2008, the Securities and Exchange Commission (SEC) issued a "cease and-desist" order against Prosper since the sale of unregistered securities represented a violation of Section 5 of the Securities Act of 1933. A month earlier, LendingClub, which started its activity in 2007, came forth after a six-month quiet period during which, by its own strategic initiative, registered the loans as securities with the SEC and induced the latter to impose on all other platforms to register their loans. LendingClub took advantage of the period during which Prosper and the other platforms were inactive while registering the loans as securities, and won the majority of the American market share. At the end of 2014, LendingClub went public on the New York Stock Exchange and declares as today $18.7 billion of loans borrowed to US citizens, while Prosper has issued, as today, $6 billion loans, about one third of its rival's volume.

**Figure 1:** Peer-to-peer lending growth in the US (in billions of dollars)




As figure 1 shows, this technology grew slowly until 2013 and then rose dramatically. The "take-off period" of about six years is consistent with the predictions of the Bass (1969) model of technology diffusion (Renana *et al*. for a review of the literature on technology diffusion, and Havrylchyk *et al.* (2016) for an analysis on the drivers of the expansion of peer-to-peer lending in the USA) and with the fact that in two-sided markets it takes time to reach the critical

mass of users. Given the high potential of this market, since 2013 other actors, such as UpStart or SoFi, entered the market differentiating in the risk profiling of borrowers[4].

This article belongs to different strands of literature. First of all, it is linked to the literature on innovation and competition in retail banking. Viotto (2015) explores the competition and regulation of crowdfunding in general, but does not focus on lending-based crowdfunding. Mariotto and Verdier (2015) look at the issues in competition and regulation in the retail banking industry, however the focus is not on peer-to-peer platforms. Frame and White (2009) survey the literature on the impact of financial innovation on commercial banking. Northcott (2004) analyzes the trade-off between economic efficiency and stability in the banking system in a review of the literature.

Secondly, this paper is linked to the literature of platform competition inspired by the pioneering work of Caillaud and Jullien (2003), who look at the chicken and egg problem in the presence of competition among intermediation service providers such as Amazon, Rochet and Tirole (2003, 2006) and Armstrong (2006) who look at competition in two-sided markets. Furthermore, Damiano and Li (2009) show that the coexistence of platforms may occur when the platform charges more for access to agents of higher quality.

The reminder of the paper is as follows: in the first section we describe the peer-to-peer lending market as a two sided market, the role of indirect network externalities, the price structure, and the strategies of quality differentiation. In the second section we describe the institutional and competitive environment in which these platforms act. In the third section we look at the role of market failures, that is information asymmetries and risks. Finally we conclude.

## ▪ Peer-to-peer lending Platforms as a two-sided market

### a. The Role of Indirect Network Externalities

[4] Upstart and SoFi, for example, are more focused on young borrowers and look at their academic performance to estimate the future potential earnings of the candidate. Their risk estimation strategy is therefore based on predictions of the future income of the candidate borrower, rather than on their credit history, and the main purpose is to fund student loans.

The lending market faces the trade-off between increasing the volume of transactions by exploiting network externalities to attract lenders and borrowers, and managing the presence of risks.

In markets with network externalities, the utility of users on each side of the market is determined partly by how many users are on the other side (Rochet and Tirole, 2003, 2006). The more lenders there are in the platform, the higher the probability for borrowers to have their loan funded. Vice versa, the more borrowers are in the platform, the higher the probability to finance a loan involving the desired level of risk. Therefore, the higher the number on each side, the higher the probability of a successful match between a borrower and a lender and the higher the volume of transactions.

Both platforms adopt the same selection process for borrowers , and any U.S. resident aged at least 18 with a U.S. bank account and a social security number may apply and request a loan, provided that the platform is authorized in her/his state[5]. Nevertheless, LendingClub minimum required credit score is slightly higher than the Prosper one (i.e. a Fico score of 660 with respect to 640). Viceversa, on the lender side, the two platforms have slightly different requirements. LendingClub imposes minimum gross income ($70000) and net worth requirements ($70000) for all lenders, while Prosper only for those lenders who are resident in states with suitability requirements[6].

Therefore, one element of differentiation between the platforms is that Prosper acceptation policy both on borrower and investor side is wider, and Prosper is more competitive than LendingClub for investors with higher propensity to risk.

Nevertheless, an increase in the number of potential matches does not only have a positive impact because of the increase in the transaction volume (choice effect), but it may entail a negative effect due to the higher competition between agents on the same side (competition

5 For borrowers, LendingClub is admitted in 49 states, while Prosper in 47. For investor, LendingClub is opened to 45 states, while Prosper only in 32 states.

6 Alaska, Idaho, Missouri, Nevada, New Hampshire, Virginia and Washington, have financial eligibility requirements of a $70,000 annual gross income and a $70,000 net worth, and investors in peer-to-peer lending may not invest more than 10% of their net worth.

effect) (See Halaburda et al., 2015[7]) on the borrowers' side, and to the higher probability to run into riskier profiles on the investors' side. In particular, when borrowers and investors are heterogeneous on their outside option, that is the possibility to get or finance a loan elsewhere, their reaction to strong network effects may differ. For those borrowers who receive a strong disutility from not getting the loan, the presence of a high number of users on their side may discourage them from asking a loan in that platform, because of their expectation of not getting it. Therefore, for these types of users the competition effect may be stronger and a platform with a lower number of users may be preferred. Vice versa, for borrowers whose disutility is not as strong, the choice effect prevails. In the same way, for those lenders with high risk aversion, the presence of riskier borrowers may incentivize them to move to another platform.

To conclude, with respect to the trade-off between volume and risk, Prosper prefers to expand its mass of users, while LendingClub prefers to minimize risks by adopting higher quality standards.

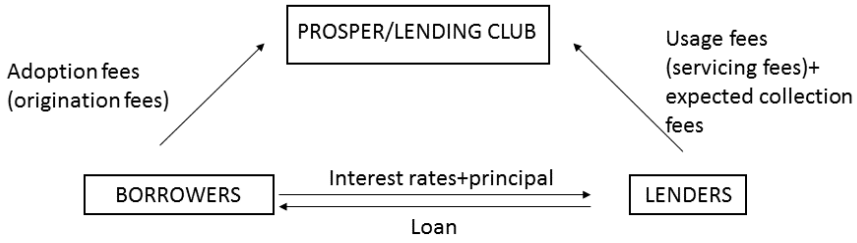
**b. The Price Structure**

As in many two-sided markets (Rysmann, 2009), platforms try to attract borrowers and lenders with the proper fee structure. The role of the price structure in this specific two-sided market is to ensure that the risk is correctly tariffed. So, on one side the price structure must assure that borrowers are correctly penalized if they entail a high default risk. On the other side, platforms have to correctly repay investors.

Both platforms set an origination fee, which is paid upfront by the borrowers when they request the loan and depends on the level of risk of the borrower, and a usage fee, which is the servicing fee, paid by lenders on the interest rates received from borrowers annually. This fee is also composed by the uncollected interests on charge-off borrowers and by collection fees. Figure 2 shows a simplified representation of the peer-to-peer lending platform.

**Figure 2:** Peer-to-peer lending as a two-sided market

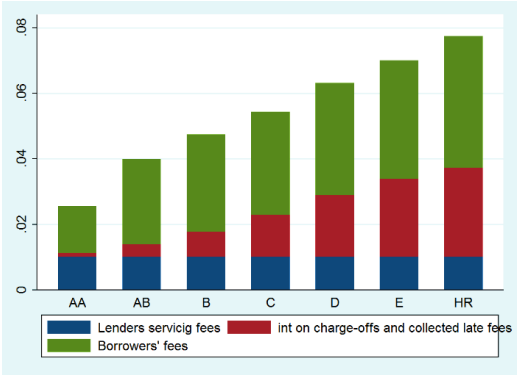
[7] Halaburda et al. (2015) analyse the market of Search Platform in the USA and find that aside the positive, opposite-side choice effect, there is also a negative same side competition effect, and study how the trade-off between these two effects allows for the coexistence of platforms with different business models.




Following theoretical predictions (see Armstrong, 2006 and Rochet and Tirole, 2006), the platform subsidizes the side of the market which releases the strongest externalities on the other side, and where competition is fiercer. Figure 3 shows Prosper origination fees for investors and borrowers, with respect to the degree of risk of the borrower. Since peer-to-peer lending developed mainly after the financial crisis, when the banking sector was weak and mistrusted, the regulation stricter, and banks have deleveraged (Atz and Bholat, 2016), consumer lending experienced an increase on the credit demand side of a wider range of creditworthy borrowers looking for a loan. In order to reach the critical mass, lending marketplaces had to incentivize lenders to join the platform by setting low fees while recording high returns in terms of interest rates. Figure 3 shows that Prosper borrowers' and lenders' fees are increasing with risk and that borrowers' fees are higher than investors' fees.

**Figure 3**: Fees paid by Prosper investors versus borrowers' net cost of borrowing in the year 2013[8].

[8] Unfortunately, LendingClub does not provide this data at micro-level.

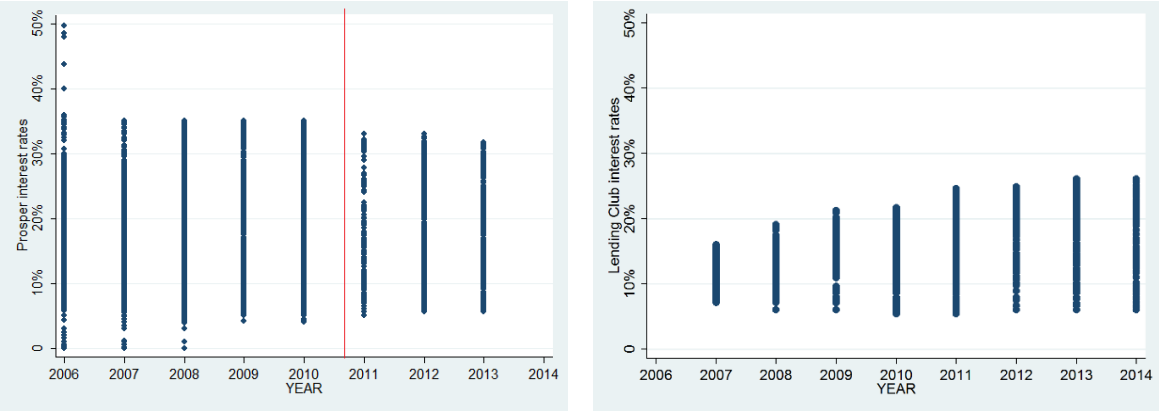



From data on the LendingClub website (See LendingClub.com), also LendingClub subsidizes investors with respect to borrowers, by setting higher fees for the latter. Therefore, the fee structure is not an element of differentiation between the platforms.

Lastly, both platforms pre-assign the interest rate that the borrowers have to pay, based on their credit score and grade of risk. The platforms claim that their added-value is to have more efficient profiling algorithms than the traditional banking system. They rely nevertheless on banking information and on Experian, a global information service group which calculates the FICO score of borrowers, an index of solvability based on credit history, payments history and amounts owed. Based on Expedian information, on the debt-to-income ratio and on some offline verifications (such as the employment status) the platform divides consumers into several rating segments, which correspond to different fixed interest rates ranging from 6% to 26% for LendingClub and from 6 to 30% for Prosper in 2014. The higher are the interest rates, the lower the demand for loans on the borrowers' side, but the higher the supply for loans on the lenders' side. Nevertheless, due to network externalities, if the demand on the borrowers' side decreases, the supply of loans on the investors' side is going to decrease, with a subsequent decrease in the overall transaction volume. Figure 4 shows the distribution of interest rates throughout the years 2006-2014. LendingClub's interest rates are on average lower than Prospers'. First of all, this may be explained by the fact that Lending Club selection process is stricter, as already seen in Section 1a: LendingClub's minimum admission score is 660, against the 640 of Prosper. Secondly, it may arise by the fact that Prosper is more remunerative for higher level of risk (see Figure 5), and therefore it attracts lenders with a higher propensity to risks. But, while on one side higher interest rates increase lenders' profits, on the other they cause a drop in low-risk borrowers, worsening credit risk through adverse selection and eventually overall profit. Moreover, the interest rate may influence the subsequent behavior of

borrowers towards riskier income prospects (See Durkin and Elliehausen, 2010). This may reduce the expected profit of lenders and therefore the presence of moral hazard may lead lenders to look for other sources of investments other than Prosper.

**Figure 4**: Prosper and LendingClub interest rates in the years 2006-2014.

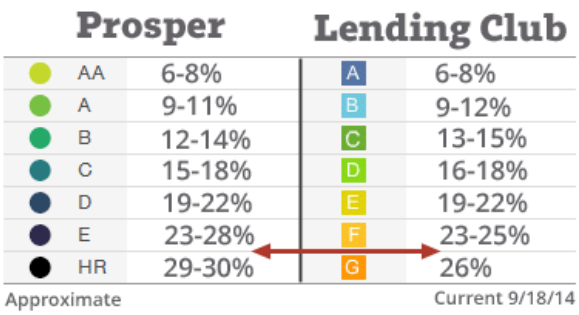



Source: elaboration on data available for investors on LendingClub.com

Back in 2006, as a first mover in the American peer-to-peer lending market, Prosper was admitting borrowers with a FICO score lower than 600 and yet setting really low interest rates to signal its competitiveness to potential entrants. Nevertheless this aggressive strategy lead the platform to have a high default rate and was obliged to close by the SEC. Moreover, before December 20th 2010, Prosper had an auction mechanism to determine the price of each loan[9]. Borrowers used to post the maximum interest rate they were willing to pay and then lenders could bid it to fund a part of it, with winning bids going to those who offered the best terms. After this date, Prosper adopted the same score-based mechanism as LendingClub.

**Figure 5**: Table of conversion of Prosper vs. LendingClub solvency rating and respective interest rate in the year 2014.

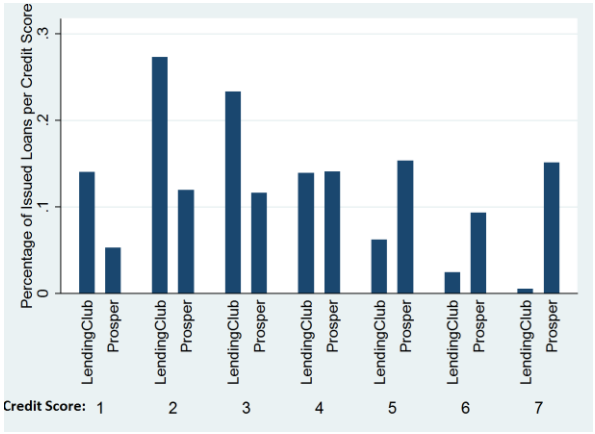
[9] The auction mechanism process was similar to an eBay auction. Wei and Li (2013) study this business change and find that under pre-set prices loans are funded at a higher probability at a higher price, with a higher default rate.




Source: lendingmemo.com

Figure 6 shows the distribution of issued loans with respect to the credit risk. LendingClub and Prosper have opposite trends: while LendingClub issues the majority of its loans to low risk borrowers, Prosper tends to assign more risky loans. Therefore, one clear differentiation strategy is that Prosper attracts lenders with a higher propensity to risk.

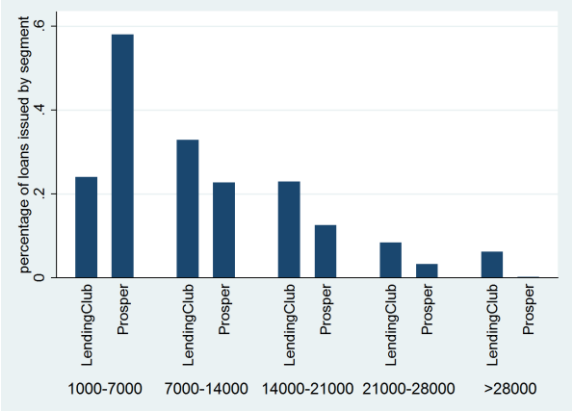
**Figure 6**: Distribution of Percentage of issued loans with respect to the credit score assigned by the platform[10].




To mitigate the default risk, Prosper on average issues lower value loans. Almost 60 per cent of loans are in the range between $1000 and $7000, while very few loans are higher than $28000. LendingClub's majority of loans is in the range from $7000 to $14000.

[10]See Appendix 1 for the table of conversion of credit scores.

**Figure 7**: Percentage of loans issued by segment of loan.




To conclude, LendingClub differs from Prosper on the fact that it issues on average higher level loans, but Prosper is more remunerative on risky loans.

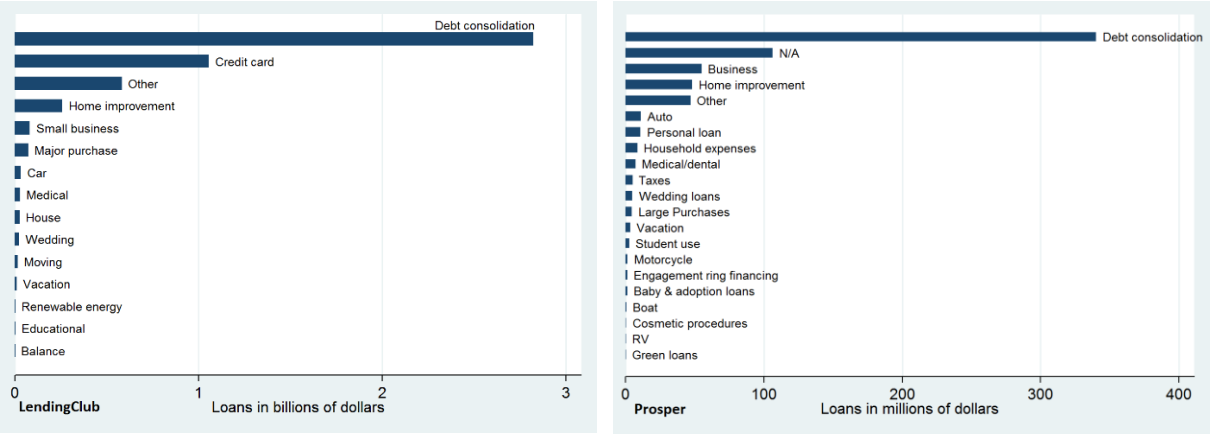
### c. Quality differentiation strategies

In two sided markets with networks effects, users on one side care not only about the number of users on the other side, but also on their quality (Filistrucchi and Klein, 2015). Given the presence of a trade-off between the volume of transactions and the presence of risks in this market, the platform has incentives to select the users by adopting quality and solvability criteria.

Therefore, one of the first criteria in which the platform may differentiate is the quality of borrowers that they attract. After being selected by the platform, when applying for a loan, users have to declare a purpose for their loan request, within a list of choices. LendingClub has a list of 15 purposes, while Prosper proposes 20 different categories. Figure 8 shows the distribution of declared purposes of borrowers who passed the screening of the platform and obtained the loan. For both platforms, most borrowers apply for debt consolidation reasons. Home improvement, personal loans and medical expenses are some of the other purposes. These purpose may not be completely trustful as borrowers may use this tool to trigger altruism behaviors on lenders. Nevertheless, while for other types of crowdfunding the main motivations to invest for lenders are altruism, social connections, participation on a project and access to exclusive rewards (Burtch, et al.2013, Mollick 2014, Agrawal et al.2015), in lending-based crowdfunding only monetary gains stimulate the investors to participate. But, there is a vast

literature on how borrowers' characteristics may affect lenders' choices. For example, Ravina (2012) finds that beauty, age, race and personal characteristics affect lenders' behavior. As figure 8 shows, the two platform are competing mainly on the very same market that is for debt consolidation. Therefore, the platforms are in frontal competition with one another on the market where they act.

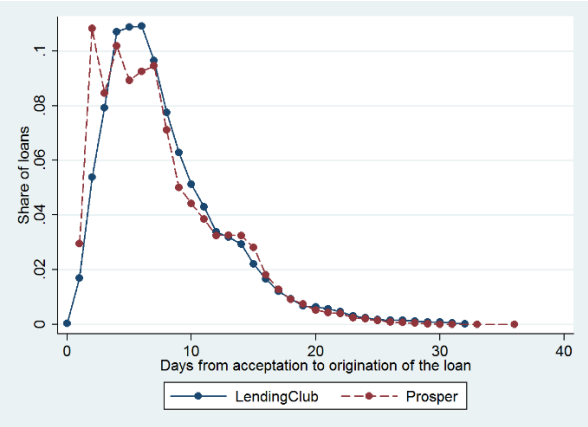
**Figure 8 :** declared purposes of borrowers to lenders when applying for a loan.

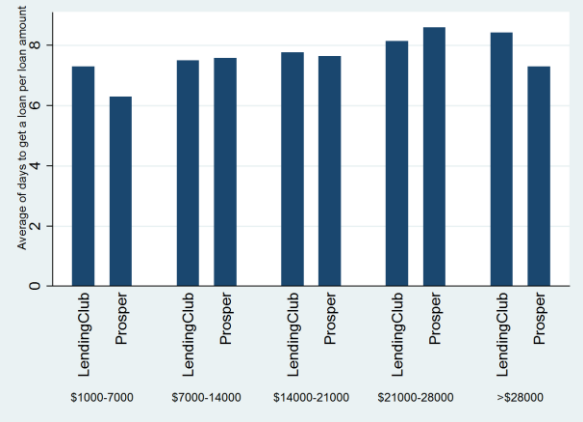



Moreover, borrowers have to declare their gross annual income. Prosper's borrowers declare on average $65130 of annual gross income, while LendingClub borrowers are slightly richer and declare $75190. Therefore, both platforms serve middle-class citizens. One unanswered question so far is whether peer-to-peer platforms will move beyond this niche of middle-class credit card borrowers (See http://bruegel.org/2014/12/the-economics-of-p2p-lending).

Furthermore, borrowers may have heterogeneous taste on the speed of loans issuing (See Meier and Sprenger, 2010), and therefore can be more or less impatient to be financed. Figure 9 shows the days from the moment when the loan is accepted by the platform, to the moment when it is originated. Prosper seems to be particularly efficient until day 4, but, later on, LendingClub is slightly faster in originating loans. Nevertheless, these differences are really small. Therefore also on this characteristic, the two platforms do not differentiate significantly and face a frontal competition one another.

**Figure 9**: days from acceptation to origination of the loan, and origination speed with respect to the magnitude of the loan.




Secondly, platforms attract different sorts of lenders. Lenders are mainly divided into two categories: retail investors and institutional investors. Institutional investors, which include community banks and money managers, have generally higher expected return from investing, as well as a higher cost of delaying (Chamley, 2004), and therefore they tend to enter earlier in the funding process. Moreover, due to their know-how, they are usually more efficient in selecting the loans with the lowest default rates because they are better able to monitor borrowers and mitigate information asymmetries. The problem is that institutional investors crowd out retail investors by winning the best loans (Lin and Sias, 2015). To partially solve this issue, both LendingClub and Prosper offer as a bundle with their core matching service some automated investing tools in order to help retail investors to efficiently allocate their portfolio. Nevertheless, at the same time, LendingClub in 2012 followed by Prosper in 2013, incentivize the participation of institutional investors by launching a program named "whole loans" in which institutional investors can purchase the loans in their entirety[11]. By the end of 2013, two thirds of LendingClub total loan volume had been provided by institutional investor, and probably this ratio will continue to grow, leaving room for competition on the retail loan supply.

To conclude, Prosper and LendingClub do not differentiate significantly on the quality of the borrowers and lenders they attract on their platforms: on the borrowers' side, the purpose to obtain a loan is mostly similar and there is a negligible difference on the speed of loan origination. On the lenders' side, both retail and institutional investors are admitted and both platforms offer similar tools to efficiently allocate the investment portfolios.

[11] In December 2013, 12843 Prosper loans, for a total of $137,490,880 where financed with the "Whole Loan" program since its launch in January 2013.

## ▪ Section 2. Institutional environment

### a. Cooperation vs. Competition with banks and other platforms

Online peer-to-peer lending platforms face the trade-off between competition and the presence of network effects in the market, which may incentivize cooperation. Both on the borrowers and on the investors' sides, LendingClub and Prosper face competition coming from banks. On the borrower side of the market, both platforms compete with banking institutions, credit unions, credit card issuers, payday loan companies, student loans companies and other consumer finance companies[12]. They also compete with each other and with other online marketplaces such as Sofi or Upstart. On the investor side, the relevant market is composed by investment vehicles and asset classes such as equities, bonds and commodities.

On one hand, banks have a comparative advantage in monitoring loans that is, screening projects, preventing opportunistic behavior of a borrower, or punishing or auditing a borrower who fails to meet contractual obligations (Diamond, 1984)[13]. Moreover, banks exploit economies of scale and scope between the lending and the deposit activity in the sense that they are experts in managing liquidity risk and in reducing information asymmetries between depositors and lenders. Another barrier to entry for lending platforms is the presence of switching costs and network effects (See Mariotto and Verdier, 2015 for a description of barriers to entry in the Internet banking).

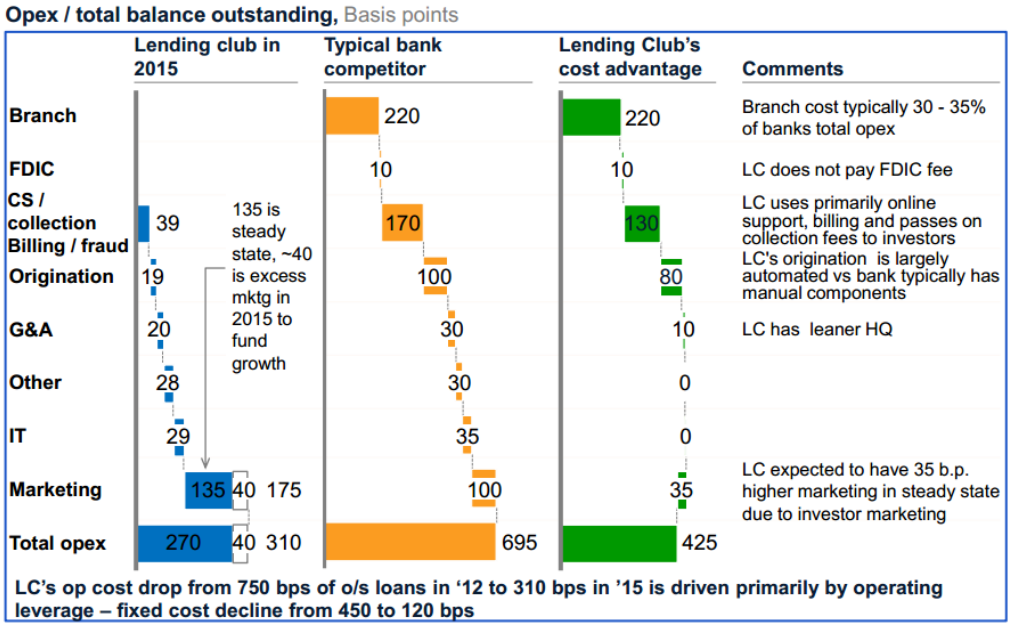
Nevertheless, both LendingClub and Prosper have lower fixed and operative costs with respect to banks. Above all, they do not need capital requirements, and they rely on the existing payment infrastructure in order to process money exchanges. Moreover, their business model is characterized by lower operating expenses, also due to the absence of costs coming from

[12] Laplanche (former CEO of LendingClub) told Forbes in April 2015 that LendingClub would expand into car loans and mortgages.

[13] The presence of banks generates an economy in the monitoring costs, provided that i) there are scale economies in monitoring, ii) investors have small capacities, iii) the cost of delegation is low (i.e., the cost of monitoring the bank itself is less than the surplus gained from exploiting scale economies in monitoring projects).

running physical branches,[14]as figure 10 shows in the case of LendingClub.

**Figure 10**: Operating expenses of LendingClub in the year 2015 with respect to a typical bank competitor.




Source: Lending Club presentation of Renaud Laplanche, CEO of Lending Club

However, peer-to-peer lending platforms cooperate with banks in joint ventures. Both Lending Club and Prosper, in order to avoid obtaining the banking license, do not originate loans themselves. Interestingly, they both rely on the same online bank, WebBank, whose main activity is to finance peer-to-peer lending platforms. Moreover, LendingClub partnered with several financial institutions: it acquired Springston Financial in 2014, it formed a partnership with Union Bank and with Opportunity Fund, to provide $10 million to small businesses in areas of California that are underserved by lenders, and with several community banks (BancAlliance). Prosper announced in April 2015 its collaboration with Credit Swiss. Furthermore, like LendingClub, it started a partnership with Western Independent Bankers, which is a consortium of 160 Community Banks. In addition, in 2015 Citibank signed an agreement with Prosper which gave the financial group access to loans to securitize.

[14] 30 to 40% of retail banks costs in the come from running physical branches (Napier and Lock 2014).

Secondly, peer-to-peer platforms collaborate with platforms and marketplaces to exploit network effects and reach a larger mass of consumers. For example, at the beginning of 2015, LendingClub announced a partnership with Google, where eligible Google partners can access low interest loans without added fees. Moreover, they can extend the credit funded up to $600000 for smaller companies who use Google's business service. Furthermore, LendingClub partnered with Alibaba, the Chinese e-commerce platform[15]. With this partnership, LendingClub borrowers can obtain loans of a value up to $300000 if they want to purchase items on the Alibaba e-commerce platform. Also Prosper in March 2016 partnered with HomeAdvisor, an home service digital marketplace to provide borrowers the possibility to access home improvement financing through this platform.

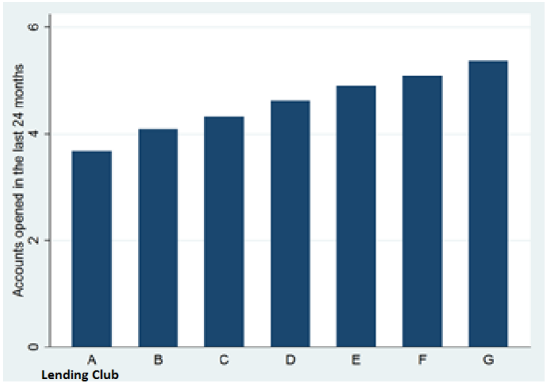
To conclude, as the market expanded, banks have started more and more to finance loans and to build partnerships with these online platforms. Through these partnerships, LendingClub is stepping into the market for small-business loans, differentiating from Prosper and moving beyond the market for debt consolidation.

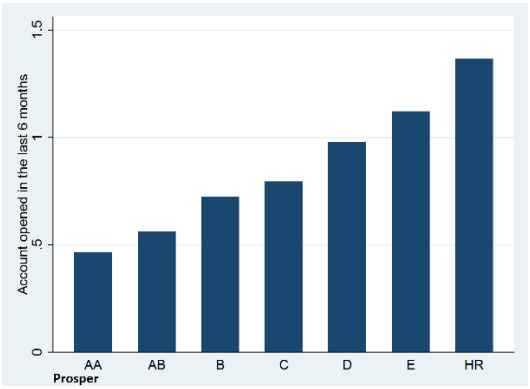
**b. Multihoming and switching costs**

The banking industry is characterized by the presence of switching costs due to fixed technical costs of switching bank and to information and search costs. Peer-to-peer lending platforms may provide an easier and quicker access than physical banks and therefore may reduce switching costs. However, their algorithms to formulate scores takes negatively into account the fact that the borrower is "multihoming", i.e. that the borrower is asking several loans at the same time. While on one side this mechanism is justified by the platforms as a signal of worsening of the debt-to-income ratio of the borrower, on the other side it may trigger a lock-in mechanism by discouraging borrowers to switch bank. Figure 11 shows the positive correlation between the number of open accounts in the last 24 months in traditional banks and other online platforms with respect to the credit score assigned by the platform. The higher the number of accounts opened, the higher the risk beard by the borrower.

[15]See http://www.bloomberg.com/news/articles/2015-04-23/lending-club-expands-into-business-loans-with-google-alibaba-help.

**Figure 11**: LendingClub accounts opened in the last 24 months by the credit score and Prosper accounts opened in the last 6 months.




Hence, both Prosper and LendingClub negatively take into account the fact that borrowers are multi-homing in their definition of risk.

## ▪ Market failures

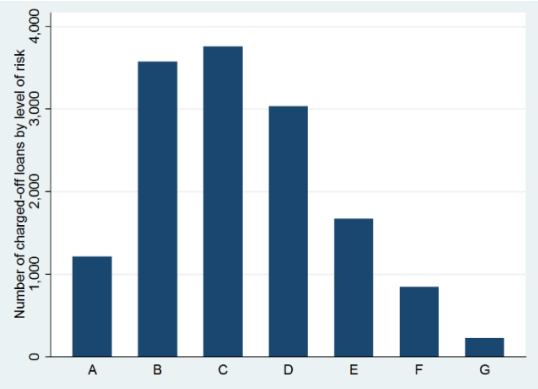
### a. Reaction to risks

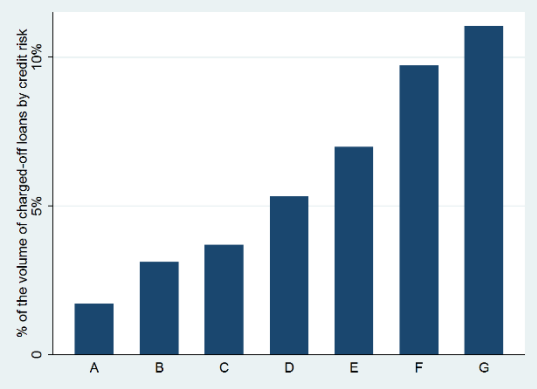
The presence of risks in this specific two-sided market, as already mentioned, influences the selection process of the platforms and, as a consequence the volume of matches. As a matter of fact, the presence of risks may discourage lenders from joining the platform, and therefore impede the platform to reach the critical mass of users. Indeed, unlike traditional banks providing loans, these platforms issue un-securitized loans that are not insured by the FDIC, and are therefore exposed to default risk, i.e. the risk that borrowers default and do not repay their loan back[16]. Figure 12 shows the number of borrowers who did not pay back and were

[16] Both Prosper and LendingClub have developed a strict collection process. Prosper charges $15 for a 15 days delay, then it resorts to an in-house collection agency. If this is not successful, Prosper engages a third party collection agency to collect the amount due and the penalty fees, and notifies the scoring agencies Experian and Transunion about the delinquency status, with a subsequent decrease of borrowers' credit score. After four months the loan is charged-off, put on sale and the borrowers' credit score experiences a big decrease. Moreover, he is disqualified from taking other loans with Prosper in the future. Lenders bear all collection fees. LendingClub uses in the first period of delay its own collection team which tries to contact the defaulting borrower. Later on, also LendingClub uses an external collection agency, and eventually starts a legal action against the borrower. After four months, the loan enters the default status and later on the loan is charged-off. Both platforms collection practices need to comply with the Federal Fair Debt Collection Practices Act.

subsequently charged-off, by credit risk. The volume of loans that were charged-off is increasing with the level of risk, suggesting that Lending Club is efficiently predicting the risk of borrowers.

**Figure 12**: Number of LendingClub charged-off loans by level of risk, and percentage of the volume of charged-off loans.




Secondly, they bear the risk that the marketplace itself goes bankrupt[17]. To mitigate this risk, Prosper has split his headquarter into two: Prosper Funding, the administrative headquarter and Prosper Market Place, which manages the loans. Moreover, investors may incur inflation risks when inflation rate is higher than the net interest rates they earn. Lastly, they are subject to changes in the platform management and may experience increases in the adoption fees from one year to the other.

For these reasons, the market of consumer lending in the United-States is subject to many regulations, which are in continuous progress (e.g., State Usury Laws, State Securities Laws, Dodd-Frank Wall Street Reform and Consumer Protection Act, Truth-in-Lending Act…). In 2008, the Securities and Exchange Commission (SEC) required that peer-to-peer companies register their offerings as securities, in compliance with the Securities Act of 1933. Since then, online lending platforms must obtain a license to operate in a given state and comply with all existing regulations on consumer lending of that state. For example, currently, LendingClub does not facilitate loans to borrowers in Idaho, Iowa, Maine, Nebraska and North Dakota, but

[17] The Swedish peer-to-peer lending company Trustbuddy, for example, declared bankruptcy in October 2015.

has obtained a license in all other jurisdictions. Furthermore, state and local government authorities may impose additional restrictions on their activities (such as a cap on the fees charged to borrowers), mandatory disclosure of information, and some further requirements such as a minimum gross income, gross worth to be lenders and a maximal percentage of the net worth to be invested in peer-to-peer lending platforms. In some states, platforms are opened to borrowers and not to investors, or vice versa. Authorizations can also differ for Prosper and LendingClub. Another set of regulation they have to comply with is states' usury laws, which impose a cap on the maximum interest rate a borrower can pay. This cap is not binding only in 7 states in the USA, while for all other jurisdictions the maximum interest rate is lower than the maximum interest rate set by the platform.

Moreover, these platforms are starting to self-regulate. In April 2016, LendingClub and Prosper, together with Funding Circle, launched the Marketplace Lending Association, a U.S. non-profit membership organization created to promote responsible business practices and established the Marketplace Lending Operating Standards, which is a code of business conduct promoting transparency for investors, and a sound policy to protect borrowers and investors[18]. To conclude, these platforms not only have to comply with regulatory standards imposed by the state legislation, but also, in order to signal their solvability, they have started to self-regulate.

### b. The role of information asymmetries

Peer-to-peer lending platforms face the trade-off between lowering information asymmetries and assuring consumer privacy. In general, in consumer lending markets, lenders' information about borrowers may be imperfect and the terms of a loan may affect borrowers' choices regarding risk or performance, due to information asymmetries. In particular, lenders observe only the expected income but not the risk associated with income. In contrast, borrowers know their expected value and risk. Due to these asymmetries, Stiglitz and Weiss (1981) prove that adverse selection and moral hazard may cause credit rationing. Moreover, in this particular online market, online anonymity may exacerbate the problem of information asymmetry and

[18] https://s3-us-west-2.amazonaws.com/marketplacelendingassociation/MLA+-+the+Marketplace+Lending+Operating+Standards.pdf

adverse selection. Especially in the first phase of these marketplaces development, the problem of adverse selection was even higher relative to offline markets.

Prosper tried to alleviate this problem by instituting social networking features. Prosper members, when submitting their loan request, may identify each other as friends and can join pre-set groups[19]. Especially during the first year of Prosper, borrowers used the membership to one of these groups as a signaling device to lenders. On average, loans accorded to borrowers that are identified in a group were usually higher than those originated to single borrowers in the first years (See Appendix 2). Freedman and Jim (2014) find that borrowers with social ties are consistently more likely to have their loans funded and receive lower interest rates, even if the majority of them does not perform better ex-post. Interestingly, LendingClub started its company in 2007 as one of Facebook applications. Therefore, though differently from Prosper, also LendingClub exploited social network ties in order reduce information asymmetries and reach a critical mass of lenders and borrowers.

Moreover, to partially solve the problem of information asymmetries, both platforms used to provide a complete dataset with historical data of all the loans, showing their characteristics (amount, interest rate, personal characteristics of the borrower, etc.). Nevertheless, since 2014, these datasets are no longer publicly available and the platforms share them only upon request and for investors' use due to privacy issues.

To conclude, both Prosper and LendingClub have adopted similar measures against the problems of information asymmetries and adverse selection. But, one source of differentiation comes from the fact that Prosper borrowers can identify in a group of users to signal their solvability.

[19] There can be also borrower-initiated social networking.

## Conclusion

In conclusion, in this article we investigated how the two main consumer-centered peer-to-peer lending platforms in the USA compete. In general, LendingClub seems to attribute more weight to the presence of risks and therefore adopts a stricter selection process, while Prosper panders the expansion of possible matches. Nevertheless, they offer a very similar product: the loan amount per borrower, the interest rates, the individual characteristics of the users, the speed to process the origination are very similar. Moreover, these platforms use similar strategies to exploit network effects, to reduce information asymmetries and to manage risks. Therefore these two platforms are facing a frontal competition with each other.

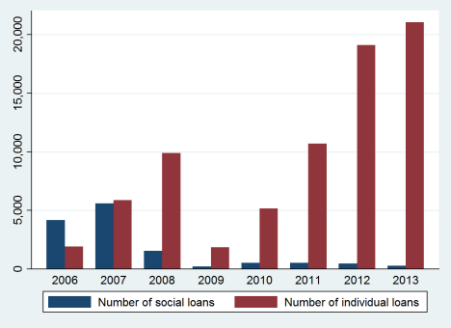
Even though, at the moment, the volume of originated loans is still not comparable to those traditionally issued by banks, the American peer-to-peer lending market is shifting from a consumer-centered to a small-business centered market for lending, and is therefore transitioning from being a complement to potentially being a substitute of bank's consumer lending. One unsolved question remains to understand why these two platforms coexist, despite the fact that they are offering a very similar product.

- **Appendix**

**Appendix1:** Table of conversion of credit scores

| **Figure 6** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Prosper | A | B | C | D | E | F | G |
| LendingClub | AA | A/AB | B | C | D | E | HR |

**Appendix2:** Number of social loans and individual loans in the Prosper dataset in the years 2006-2013.

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# Chapter 2:

# What drives the adoption of innovation by consumers in retail banking?

This chapter is composed by one empirical article on the diffusion of peer-to-peer lending platforms in the USA by using data from the two leading online lenders, Prosper and Lending Club. We conduct a geographical analysis of the adoption of this technology by exploiting the heterogeneity at the county level to analyze three main hypothesis: the credit crunch due to the financial crisis, the lack of competition in the traditional banking sector, and the propensity to innovate and the Internet adoption. We control for potential spatial spillovers between contingent counties which are likely to be caused by human interactions. Moreover, we control for socio-demographic characteristics.

# Chapitre 2:
# Qu'est-ce qui stimule l'adoption de l'innovation par les consommateurs dans l’industrie de la banque de détail?

Ce chapitre est composé d'un article empirique sur la diffusion de plate-formes de prêt peer-to-peer aux États-Unis en utilisant les données des deux principaux prêteurs en ligne, Prosper and Lending Club. Nous effectuons une analyse géographique de l'adoption de cette technologie en exploitant l'hétérogénéité au niveau du comté pour analyser trois hypothèses principales: la crise du crédit due à la crise financière, le manque de concurrence dans le secteur bancaire traditionnel et la propension à innover et l'adoption par internet. Nous contrôlons les « spillovers » spatiaux potentiels entre les comtés contingents susceptibles d'être causés par des interactions humaines. De plus, nous contrôlons pour des caractéristiques sociodémographiques.

# What drives the expansion of the peer-to-peer lending?

Olena Havrylchyk[1], Carlotta Mariotto[2], Talal Rahim[3], Marianne Verdier[4]

## Abstract

Peer-to-peer lending platforms are online intermediaries that match lenders with borrowers. We use data from the two leading P2P consumer lending platforms, Prosper and Lending Club, to explore main drivers of their expansion in the United States. We exploit the heterogeneity in local credit markets at the county level to analyze three hypotheses for the penetration of online lenders: 1) crisis-related; 2) competition-related; and 3) innovation-related. Our findings support the crisis-related and competition-related hypothesis, as lending platforms have expended more to counties with overleveraged banks and lower density of branch network. At the same time, lending platforms have difficulty penetrating countries with high bank concentration. We also document that spatial, socio-economic and demographic characteristics determine the expansion of online lenders.

JEL codes: G21, G23, G01, O33, D40

Keywords: peer-to-peer lending, online lenders, market structure, brand loyalty, financial crisis, internet, information and communication technologies

[1] LEM, University of Lille; CEPII, EconomiX and Labex ReFi, contact: olena.havrylchyk@univ-lille1.fr
[2] ESCP Europe, LabeX ReFi and CERNA, Ecole des Mines de Paris, contact: carlotta.mariotto@mines-paristech.fr
[3] Boston University, contact: rahimt@bu.edu
[4] CRED, University Paris 2 Panthéon Assas, and CERNA, Ecole des Mines de Paris, contact : marianne.verdier@u-paris2.fr

**"Banking is necessary; banks are not"**

Bill Gates, 1990

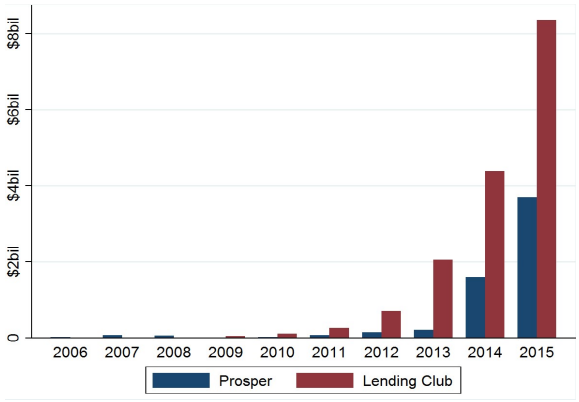
**"Is information technology going to disrupt finance? My first response is: please. My second response is: yes."**

Martin Wolf, 2016

## 1. Introduction

First peer-to-peer (P2P) lending platforms, Zopa, Prosper and Lending Club, have been launched in 2005-2007 in the UK and the US. These online lenders[5] directly match savers with borrowers who need personal and business loans. Although, online lending amounts to a small share of total lending, it has been growing rapidly (Figure 1) and in 2015, the flow of US online consumer lending was equivalent to 12.5% of traditional consumer lending (Wardrop et al., 2016). Not surprisingly, the emergence of online lenders, which are a part of the wider FinTech movement, has provoked a debate about their ability to disrupt traditional banking (Phillipon, 2016; The Economist, 2015; Wolf, 2016; Citi, 2016). Haldane (2016) suggests that the entry of new FinTech players could diversify the intermediation between savers and borrowers, which would make the financial sector more stable and efficient and could ensure greater access to financial services.

**Figure 1:** P2P lending growth in the US (in billions of dollars)




Source: Websites of the Lending Club and Prosper Marketplace

The objective of this paper is to provide the first exploration of the main drivers of the expansion of the P2P lending in the US. Is rapid development of online lenders due to structural factors in the brick-and-mortar banking, such as weak competition in the consumer lending market due to high switching costs or barriers to entry? Has it been spurred by the Great Recession, bank failures, banks' deleveraging and credit crunch? Could the timing of the P2P lending be

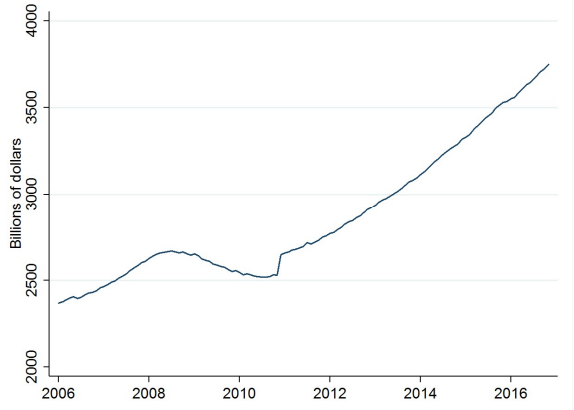
[5] Peer-to-peer lending was born to match directly lenders and borrowers without the use of the intermediation of banks. However, as the market expanded, a large part of it has been funded not by individual lenders, but traditional banks, hedge funds and other financial institutions. Hence, the name peer-to-peer lending has been changing to marketplace lending. In this paper we use terms peer-to-peer lending platforms, marketplace lenders and online lenders interchangeably.

explained by the spread of Internet, sophistication of Internet users and trust in new technologies? What role do social networks play? What are the socio-economic and demographic characteristics of online borrowers? Ultimately, we would like to get closer to understanding whether online lenders could be potentially disrupt the traditional banking sector.

In light of these questions, we outline three main hypotheses for the expansion of online lenders. Our *first hypothesis* is that P2P lending development could be related to the nature of the banking competition. The banking sector is characterized by monopolistic competition due to high entry barriers, switching costs and strong brand loyalty (Claessens and Laeven, 2004; Shy, 2002; Kim et al., 2003). Philippon (2015) demonstrates that the cost of financial intermediation in the US have remained unchanged since the 19 century. This fact is astonishing in the context of rapid progress in the communication and information technologies that should have driven down the price of financial services for end users. Hence, the entry of new Fintech players could be needed to improve the provision of financial services and disrupt traditional players. Indeed, online lenders argue that their operating expenses are much lower than those of brick-and-mortar banks due to the extensive use of new technologies as well as absence of legacy problems and costly branch networks.[6] We test the impact of the market structure on the expansion of online lenders and refer to these explanations as *competition-based hypotheses*.[7]

The expansion of online lenders might have been spurred by the financial crisis and the Great Recession. On the credit supply side, as interest rates approached zero, new lenders entered the market, attracted by the higher return (and risk) available from exposure to P2P assets. On the credit demand side, a wider and more creditworthy pool of potential borrowers appeared as the banking sector was weak, regulation has tightened, banks have deleveraged and mistrust in the banks has spread (Atz and Bholat, 2016). As shown by figure 2 below, total consumer credit significantly decreased in the years 2008-2011. The credit rationing may have spurred the demand for alternative forms of financing.

**Figure 2:** Total consumer loans in the USA in billions of dollars




Source: Federal Reserve Bank of Saint Louis

For example, Koetter and Blaseg (2015) show that bank instability in Germany has pushed

[6] Operating expenses include the costs of originating the loan, processing payments, collection and bad debt expenses.

[7] The existing literature finds weak conclusions on the relationship between innovation and market structure (see the survey of Cohen and Levin, 2010). A number of theoretical studies (e.g., Gilbert, 2006) show that the competition innovation is monotonic only under restrictive conditions. On the one hand, innovation incentives should be lower in more concentrated markets because of the replacement effect identified by Arrow (1962). On the other hand, innovation incentives should be lower in more competitive environments because aggregate industry profits are lower. Aghion et al. (2005) demonstrate that the relationship between competition and innovation should have a nonlinear inverted U-pattern. Other studies include measures of entry and exit in the market (Geroski, 1989).

businesses to use equity crowdfunding as a source of external finance. We refer to this explanation as *crisis-based hypothesis*.

It is also possible that the surge in P2P lending is not caused by problems in the banking sector. Online lenders claim to harness big data innovations to revolutionize credit risk assessment and efficiently match lenders with borrowers. Furthermore, the entry of online lenders reflects the readiness of the society to embrace internet to perform financial transactions. Indeed, Fintech is part of the larger revolution as new internet platforms (Amazon, Uber, BlaBlaCar and AirBnB) are on the way to disrupt other service markets, such as retail trade, transport and accommodation. Similar to previous financial innovation, online lenders could expand and cheapen access to financial services (Einav et al., 2013). We refer to this explanation as *innovation-based hypothesis*.

Sorting out these three competing hypotheses is difficult because the expansion of the P2P lending has coincided with the post-crisis period, increased concentration of the banking sector and the diffusion of communication and information technologies (e.g., smartphones, broadband). Our identification strategy relies on the exploration of the geographic heterogeneity of the P2P lending expansion at the county level. The choice of the local dimension of a market is relevant for consumer and SME lending that are targeted by online lenders. The county unit is the standard definition of the local banking market in the literature (e.g., Prager and Hannan, 1998; Berger, Demsetz, and Strahan, 1999; Rhoades, 2000; and Black and Strahan, 2002).

Since the expansion of the P2P lending is similar to the diffusion of other technologies, it could be explained by spatial network effects due to human interactions (Comin et al., 2012). Notwithstanding the online nature of the P2P lending, geography might still play a crucial role in its diffusion. Indeed, we document an important spatial correlation, as P2P lending per capita is higher in counties close to California, New York and Florida. Hence, our econometric approach relies on incorporating a spatial lag variable in our model.[8]

This paper contributes to the nascent literature on the peer-to-peer lending. The largest strand of this literature explores how borrower characteristics affect loan outcomes and how lenders on P2P platforms mitigate informational frictions (see the literature review by Morse, 2015).[9] The only paper that explores how borrowers choose between traditional and alternative sources of finance is Butler et al. (2014), who show that borrowers who reside in areas with good access to bank finance request loans with lower interest rates.

This paper makes the first attempt to analyze the expansion patterns of online lenders. For the first time, we aggregate data for the two leading P2P consumer lending platforms in the US - Prosper and Lending Club – and study the geography of online lenders. We measure the expansion of the P2P lending by aggregating the number and the volume of loans provided by

[8] This hypothesis is different from but related to the study by Agrawal et al. (2011) who find that crowdfunding largely overcomes the distance-related economic frictions as the average investor is not in the local market but is 3,000 miles away. Our hypothesis that the expansion of the P2P lending exhibits spatial correlation does not contradict the fact that investors could be located far away.

[9] Morse (2015) provides a literature survey of papers that study how P2P lending mitigates information frictions by relying on real world social connections (Freedman and Jin, 2014; Everett, 2010), textual analysis of successful funding bids (Mitra and Gilbert, 2014), psychology text mining techniques to uncover deception (Gao and Lin, 2012), identity claim methodology to identify trustworthy and hardworking borrowers (Sonenshein and Dholakia, 2011) as well as discrimination (Ravina, 2012; Pope and Sydnor, 2011; Duarte et al., 2012).

these two online lenders. As early as 2007, 1183 counties had P2P borrowers, and their number has increased to 2609 in 2013. We then use this data to relate the amount of P2P lending to a wide range of county level determinants that could affect the speed of its penetration.

By focusing on the expansion of a new technology, our paper is related to the literature on the diffusion of innovation (Bass, 1969 and Rogers, 2003).[10] The literature on financial innovation is scarce and focuses on the new products and distribution channels in the traditional banking (Frame and White, 2009). Most of these studies have focused on users' incentives to adopt innovations according to their individual characteristics.[11] DeYoung et al. (2007) and Hernando et al. (2007) analyze the impact of the adoption of online banking on banks' profitability and find that the Internet channel is a complement to rather than a substitute for physical branches.

The paper is structured as follows. In section 2, we describe the institutional environment in which peer-to-peer lending platforms evolve. In section 3, we explain how we assemble our data set, provide data sources and variable definition. In section 4, we explain our identification strategy and provide empirical results. In section 5, we conclude.

## 2. Institutional environment of peer-to-peer lending platforms in the United States

Online lending marketplaces are platforms that connect individuals or businesses wishing to obtain a loan with individuals and institutions willing to commit to fund this loan. Marketplace lending encompasses P2P lending platforms, which offer lending-based crowdfunding for consumers and small businesses, and online lending platforms by large institutions (e.g., OnDeck Capital, Kabbage), which offer credit exclusively to businesses, rather than consumers.[12] In our paper, we focus on P2P lending platforms, on which multiple lenders lend small sums of money online to consumers or small businesses with the expectation of periodic repayment.

Prosper Marketplace and Lending Club launched the first online P2P lending platforms in the United-States respectively in 2006 and 2007, followed by other companies such as Upstart, Funding Circle, CircleBack Lending or Peerform. Between 2006 and 2015, the two most important platforms, Prosper and Lending Club, have facilitated approximately $8.7 billion loans.[13] Both platforms believe that their online marketplace model has key advantages relative to traditional bank lending both for borrowers and investors, among which convenience of online operations, automation, reduced cost and time to access credit.

Consumer loan amounts vary between a minimum loan of $1,000 for Prosper and $500 for Lending Club and a maximum loan of $35,000 for both platforms ($300,000 for businesses). They fund various types of projects ranging from credit card debt consolidation to home improvement, short-term and bridge loans, vehicle loans or engagement loans.[14]

[10] Rogers (2003) argues that the more people that use a technology, the more non-users are likely to adopt.
[11] Frame and White (2009) mention three different types of innovations: products and services (e.g., subprime mortgages, new means of payment and online banking), production processes (such as Automated Clearing Houses, small business credit scoring, asset securitization, risk management), organizational forms (such as Internet only banks).
[12] Other types of crowdfunding include donation or reward-based crowdfunding.
[13] The figures and information of this paragraph is based on the study of Prosper and Lending Club annual reports, which can be found on the companies' websites.
[14] Consumer lending does not include credit for purchase of a residence or collateralized by real estate or by specific financial assets like stocks and bonds.

Prosper and Lending Club rely on a partnership with WebBank, an FDIC-insured, Utah-chartered industrial bank that originates all borrower loans made through their marketplaces. In December 2014, Lending Club became the first publicly traded online peer-to-peer lending company in the United-States, after its Initial Public Offering on the New York Stock Exchange.

As in many other two-sided markets (Rysman, 2009), online lending marketplaces try to attract two different groups of users, namely borrowers and investors, by choosing an appropriate structure of fees that increases the size of network effects. On the borrower side of the market, both companies compete with banking institutions, credit unions, credit card issuers and other consumer finance companies. They also compete with each other and with other online marketplaces such as Upstart or Funding Circle. Platforms claim that their prices are lower on average than the ones consumers would pay on outstanding credit card balances or unsecured installment loans funded by traditional banks.[15] Online marketplaces perform the traditional screening function of banks by defining various criteria that must be met by borrowers. Any U.S. resident aged at least 18 with a U.S. bank account and a social security number may apply and request a loan, provided that the platform is authorized in her/his state. Platforms collect online some information about the applicant (i.e., FICO score, debt-to-income ratio, credit report…), which is used to compute a proprietary credit score. Some additional enquiries may also be performed offline (e.g., employment verification). Consumers are divided into several rating segments, which correspond to different fixed interest rates ranging from 6% to 26% for Lending Club in 2014. Origination fees paid to the platform depend on the consumer's level of risk.

On the investor side, online lending marketplaces face potential competition from investment vehicles and asset classes such as equities, bonds and commodities. Prosper claims to offer an asset class that has attractive risk adjusted returns compared to its competitors. Investors can be divided into two different populations: individuals and institutions. Both populations are subject to different requirements. Individual investors must be U.S. residents aged at least 18, with a social security number, and sometimes a driver's license or a state identification card number. Institutional investors must provide a taxpayer identification number and entity formation documentation. Investors' annual income must exceed a floor defined by platforms' rules. Prosper and Lending Club issue a series of unsecured Notes for each loan that are sold to the investors (individual or institutional), and recommend that each investor diversifies his/her portfolio by purchasing small amounts from different loans.[16] Each investor is entitled to receive pro-rata principal and interest payments on the loan, net of a service charge paid to the platform. In addition to the "Note Channel", Prosper has designed specifically a "Whole Loan Channel" for accredited investors (according to the definition set forth in Regulation D under the Securities Act of 1933), which must be approved by the platform. Accredited Investors can purchase a borrower loan in its entirety directly from Prosper.

The lending market in the United-States is subject to many regulations, which are changing continuously (e.g., State Usury Laws, State Securities Laws, Dodd-Frank Wall Street Reform and Consumer Protection Act, Truth-in-Lending Act…). Online lending platforms need to obtain a license to operate in a given state and comply with all existing regulations on consumer

[15] This view is confirmed by a study conducted by Demyanyk and Kolliner at the Federal Reserve Bank of Cleveland. They offer time-series evidence that, on average, marketplace loans carry lower interest rates than credit cards and perform similarly.
[16] Notes can be viewed as debt-back securities.

lending. For example, currently, Lending Club does not facilitate loans to borrowers in Idaho, Iowa, Maine, Nebraska and North Dakota, but has obtained a license in all other jurisdictions. Furthermore, state and local government authorities may impose additional restrictions on their activities (such as a cap on the fees charged to borrowers) or mandatory disclosure of information. In some states, platforms are opened to borrowers but not to investors, or vice versa. Authorizations can also differ for Prosper and Lending Club.

An important issue is the potential violation of states' usury laws. The interest rates charged to borrowers are based upon the ability under federal law of the issuing bank that originates the loan (i.e., WebBank) to "export" the interest rates of its jurisdiction (i.e., Utah) to other states. This enables the online marketplace to provide for uniform rates to all borrowers in all states in which it operates. Therefore, if a state imposes a low limit on the maximum interest rates for consumer loans, some borrowers could still borrow at a higher rate through an online marketplace since the loan is originated in Utah.[17] Some states have opted-out of the exportation regime, which allows banks to export the interest rate permitted in their jurisdiction, regardless of the usury limitations imposed by the borrower's state.

## 3. Data

To construct variables about the diffusion of P2P lending, we rely on loan book data from Lending Club and Prosper Marketplace. For Lending Club we have 376 261 observation points, corresponding to a total volume of funded loans equal to $3.2 billion, starting from January 2007 to December 2013. This amounts to 99.25% of the Lending club portfolio. For Prosper we have 88 988 observation points, corresponding to a total volume of originated loans equal to $662 million, starting from January 2006 to 30 October 2013. This amounts to 100% of the total Prosper portfolio. There are 313 counties with zero P2P loans in our final dataset.

Since loan book data provides information about each borrower's city, we can assign a county name to each borrower by matching with an official data containing US States, cities and counties.[18] Our analysis ends in 2013, because platforms have stopped providing city names afterwards. Due to missing values and mistakes in city names, we lose 4.8% of the volume of funded loans in the Lending Club dataset and 10% from the Prosper dataset. Next, we aggregate this data at the year-county level to construct two measures of P2P lending diffusion: number of P2P loans per capita and volume of P2P lending per capita. For large cities belonging to multiple counties, we split the total data between counties weighted by total income per county. Table 1 shows the total volume of funded loans, the number of counties and the total number of loans that we have in our dataset.

**Table 1:** Our dataset (loan volumes, number of counties and loans)

| **Lending Club** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|---|
| Volume (in mln $) | 0 | 2 | 13 | 46 | 116 | 257 | 718 | 2064 |
| N. of counties | 0 | 110 | 379 | 676 | 987 | 1359 | 1836 | 2384 |

[17] Of the fourty-six jurisdictions whose residents may obtain loans in the United-States, only seven states have no interest rate limitations on consumer loans (Arizona, Nevada, New Hampshire, New Mexico, South Carolina, South Dakota and Utah), while all other jurisdictions have a maximum rate less than the maximum rate offered by WebBank through online marketplaces.

[18] We use the Americas Open Geocode (AOG) database. Source: http://www.opengeocode.org/download.php.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| N of. loans | 0 | 246 | 1488 | 4500 | 10594 | 19861 | 49811 | 137824 |

| **Prosper** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|---|
| Volume (in mln $) | 29 | 81 | 69 | 9 | 27 | 75 | 154 | 217 |
| N. of counties | 673 | 1175 | 1377 | 631 | 1029 | 1397 | 1739 | 1721 |
| N. of loans | 6145 | 11592 | 11683 | 2118 | 5864 | 11508 | 20054 | 21990 |

Data source: Lending Club and Prosper loan books

We can now map the depth of the P2P development at the county level for each year (Figure 3). As early as 2007, 1183 counties had P2P borrowers, and their number has increased to 1881 in 2010 and to 2609 in 2013.

For cross-sectional regressions, we aggregate yearly data for each county and, then, merge our dataset with other datasets that contain our explanatory variables. Our specification accounts for a large number of county characteristics that could influence the expansion of the P2P lending.

*Crisis variables*

To measure the effects of the financial crisis on the penetration of the P2P lending, we rely on two types of variables. First, we compute the share of deposits in each county affected by bank failures during the analyzed period. To do this, we merge FDIC Failed Bank List with the data on branches of these banks in each county from the FDIC Summary of Deposits. This is an exhaustive database about all branches of deposit taking institutions in the US, providing data on the amount of deposits at the branch level. We then compute the share of deposits held by failed banks in a county *i* in the total amount of deposits held by all banks in a county *i* as of 31 December, 2013. As shown by Aubuchon and Wheelock (2010), there is a wide geographic heterogeneity with respect to bank failures in the US and it is possible that customers from counties that have been the most affected by the crisis have relied more on alternative credit providers. If our *crisis-related hypothesis* is confirmed, we expect a positive sign on this variable.

Our second measure of the depth of the financial crisis relies on the FDIC Summary of Deposits to identify the presence of branches in each county that we merge with information on capital at the bank consolidated level, taken from Call Reports. This measure is based on the assumption that banks' capital management is done at the consolidated level (Haas and van Lelyveld, 2010). We rely on two measures of capital (unweighted leverage ratio and risk-weighted tier 1 capital ratio) computed during the crisis period 2009-2010[19]. Solvency ratio of a county *i* is computed as an average capital ratios of banks present in a county *i* weighted by deposits of their branches in county *i*. If our *crisis-related hypothesis* is confirmed, we expect a negative sign on this variable.

*Measuring competition and brand loyalty*

[19] We define these two years as crisis-years because bank capital ratios and loan growth were at their lowest and bank failures and credit-card delinquencies at the highest during this period. This allows us to capture the severity of the crisis.

Ideally, we would like to explore banking competition, but this is notoriously difficult to measure, particularly at the county level. The FDIC Summary of Deposits allows us to compute concentration measures, such as HHI and C3 indices, as well as branch density per 10000 population. To eliminate any endogeneity due to reverse causality, we estimate these variables in 2007. Since some studies show that market structure could be unrelated to the banking competition (Claessens and Laeven, 2004), we prefer to refer to these measures as market structure or concentration measures. Indeed, individual banks in concentrated markets are more able to collude and extract monopolistic rents from their customers (relative market power hypothesis). At the same time, concentrated markets could be a result of more efficient banks increasing their market share (efficiency-structure hypothesis).

One of the sources of high market concentration are high switching costs that include financial costs, administrative costs, learning costs as well as psychological costs. Switching costs are notoriously high in banking, as a number of studies show that despite being unsatisfied with their bank (negative net promoter score), the switching rates remain very low. If bank customers wanted to switch to P2P lending, they would need to incur learning costs about P2P platforms, transaction costs to set up their profile, describe their loan (a task that is performed by their credit officer in a bank), as well as to overcome brand loyalty. Since our study is done in the homogeneous institutional environment in the context of switching to one of the two very similar lending platforms, learning and transaction costs should be similar across counties. We control for educational attainment and age, which could be correlated with learning costs. Spatial effects could also reflect learning costs, as technological diffusion is speeded up by human interactions.

Controlling for psychological costs of switching is more difficult, but concentrated markets could be a sign of high psychological switching costs due to brand loyalty. Indeed, customers living in counties with only one bank might be less exposed to advertising from rival banks and be less familiar with people who are customers at other banks. This might develop strong brand loyalty because bank customers are less familiar with other alternatives and have lower incentives to search for an alternative to their bank. To further test this idea we include other alternative credit providers, such as pay-day loans.

In light of this discussion, the impact of the concentration measures on the expansion of the P2P lending is difficult to interpret. A positive correlation between market concentration and P2P lending platforms could signal that customers from highly concentrated markets try to switch to alternative less costly providers. A negative correlation, on the other hand, could either signal that bank customers are satisfied with their banks or be a sign that high market concentration reflects high switching costs due to brand loyalty.

Branch density measures financial isolation or the outreach of the financial sector in terms of access to banks' physical outlets (Benfratello et al., 2008; Beck et al., 2007). Importantly, an extensive branch network is also often considered as an important barrier to bank entry due to brand loyalty. Location models show that incumbent banks have an incentive for branch proliferation to such an extent that entry with an additional network would become unprofitable (Vives 1991). Branches are a form of advertising for banks and branch density could play an important role in the bank's advertising strategy to develop brand loyalty (Dick, 2007). Dick (2007) provides plenty of anecdotal evidence on how banks hope to attract customers using their branches, usually with stylish merchandising and customer service. Banks become more visible to consumers through their branches; in fact, banks are known to put clocks outside their branches for this reason. Importantly, there is evidence that banks open branches mostly in

response to their own market targets, as opposed to their existing customers' needs. We expect a negative sign on this variable.

*Measuring openness to innovation and new communication and informational technologies*

To proxy for openness to innovation, we use U.S. Patent and Trademark Office data to compute the number of patents per capita. This measure is often used as a measure of innovation and, as such, it has a number of shortcomings, since some innovations are not patented and patents differ enormously in their economic impact. Nonetheless, our objective is not to measure innovation per se, but rather to account for a local culture that has a high propensity to generate innovative ideas and, hence, accept innovative ideas of others. Such culture could be more open to new forms of financing though P2P lending.

To measure the penetration of internet at the county level, we rely on the NTIA's State Broadband Initiative that allows us to compute the following measures: 1) percent of county population with access to any broadband technology (excluding satellite); 2) percent of county population with access to Mobile Wireless (Licensed) technology; 3) percent of county population with access to upload speed 50 mbps or higher. Each measure is computed as an average between 2010 and 2013, the only data available at the county level. All these variables should have an expected positive sign if our *innovation-based hypothesis* is confirmed.

*Socio-economic characteristics*

We control for the socio-economic characteristics, such as age, education attainment, population density, poverty level, race etc. We expect that counties with higher educational attainment, higher population density and higher proportion of young people, should have higher levels of P2P lending penetration because human capital and network effects of urban areas are significant predictors of the technological diffusion. These characteristics could also be correlates with brand loyalty.[20]

As to poverty rate and race, we have no theoretical priors about the sign of their impact. Racial minorities might be less familiar with online lending opportunities, but their demand could be higher because race identification is no longer possible on P2P lending platforms.[21] Interestingly, racial identification was possible during earlier years of the P2P lending when borrowers had the possibility to post a picture. This has led to the well documented discrimination of racial minorities on the Prosper lending platform (Pope and Sydnor, 2011; Ravina, 2012; Duarte et al., 2012). Consequently, platforms have removed the possibility of posting a photo which has made the identification of borrowers' race impossible. This could incentivise racial minorities to turn to the P2P platforms to avoid discrimination that is well documented in traditional credit markets (see a literature review by Pagern and Shepherd, 2008).

We introduce state level dummies to control for differences in state-level regulation of consumer lending and P2P lending platforms, as well as other state characteristics that are not captured by our county-level variables. These dummies account for the fact that Iowa was

[20] Surveys have found that consumer credit use is greatest in early family life stages when the rate of return of additional goods that might be financed using credit is high.

[21] However, the platforms have removed the possibility of posting the photo, which has made the identification of borrowers' race impossible.

closed for borrowers from both Lending Club and Prosper platforms, while Maine and North Dakota were closed for Prosper platform.

*Spatial relations*

Our data contain explicit spatial relationships, as counties are likely to be subject to observable and unobservable common disturbances which will lead to spatial correlation. This could be explained by various channels of interdependence due to regional business cycles and economic shocks, technology diffusion, access to bank branches, policy coordination, regional disparities for which we do not control with our right-hand variables (see e.g. Garrett et al. 2005 for the importance of spatial correlation in state branching policy). Spatial correlation could also occur because of the boundary mismatch problems when the economic notion of a market does not correspond well with the county boundaries (Rey and Montouri, 1999). Spatial correlation is particularly important for the diffusion of technology due to a theory of human interactions (Comin et al., 2012). Borrowers from P2P lending platform require acquiring knowledge about their existence, as well as trust in their reliability, which often comes from interactions with other agents. The frequency and success of these interactions is likely to be shaped by geography. Hence, we expect that knowledge about P2P potential is likely to be more easily transmitted between agents in counties that are close than between counties that are far apart. Figure 3 also attest to this hypothesis. To account for spatial correlation, we introduce a spatial lag in our model.

Overall, we have sufficient cross-sectional data for 3,059 out of 3,144 counties and county equivalents. Table 2 provides exact definition of all variables and Table 3 provides summary statistics.

## 4. Methodology

### A. Model specification: a spatial autoregressive model

Our objective is to test

i) The three hypothesis on the adoption of P2P lending (See Section 3);
ii) Whether adopting P2P lending in a county has a positive impact on the adoption of P2P lending in neighboring counties.

We specify the following regression model, also known as a SARAR model in the literature (See Anselin, 1988):

$$y_i = \beta_0 + \lambda\, \mathrm{W}y_j + \beta_1 * competition_i + \gamma_1 * crisis_i + \delta_1 * innovation_i + \alpha * X_i + \mathrm{u}_i;$$

where

$$\mathrm{i}, \mathrm{j} = 1, \dots, \mathrm{n};$$

and

$$u_i = \rho \sum_{j=1}^{n} w_{ij}\, u_j + \varepsilon_i, \qquad \text{with } \varepsilon_i \sim \mathrm{N}(0, \sigma^2 \mathrm{I}).$$

*i* and *j* represent the $n^{th}$ counties; $y_i$ is the log of our observed dependent variable, that is either the volume of P2P lending per county per capita or the number of P2P loans per county per capita; W= $\sum_{j=1}^{n} w_{ij}\, y_j$ is a weighted average of our dependent variable (volume or number of P2P loans per capita), known as a spatial lag, where the weights are determined by an N × N spatial weights contiguity matrix W=$\sum_{j=1}^{n} w_{ij}$ where each element $w_{ij}$ expresses the degree of

spatial proximity between county i and county j[22]; λ is the unobserved spatial autoregressive coefficient; $\beta_1$ is the unobserved coefficient of our observed independent variables regarding competition and market structure; $\gamma_1$ is the unobserved coefficient of our observed independent variables regarding the credit rationing; $\delta_1$ is the unobserved coefficient of our observed independent variables regarding the innovation and internet variables; α is the coefficient for our socio-economic and demographic variables (See table 2 for the detailed list of observed independent variables) ; ρ is the unobserved spatial autoregressive coefficient as, in our model, we allow the error term to be affected by the disturbances of neighbors; $\varepsilon_i$ and $u_i$ are unobserved error terms.

Thus, this model specification accounts not only for spatial correlation of the dependent variable, but also for spatial correlation within the error terms, which could be affected by unobservable factors such as regional economic cycles. Ignoring spatial relation, in this case, could potentially lead to inconsistency in the standard errors.

Our main objects of interest are the coefficients $\beta, \gamma$ ,δ, α and λ. $\beta, \gamma$ , δ measure the marginal impact of market structure variables, crisis variables, innovation variables as well as socio-economic and demographic variables on the adoption of P2P lending in each county. When the dependent variable is the volume of P2P loans per capita, the magnitude of the coefficient $\beta, \gamma, \delta, \alpha$ predict of how many dollars the volume of P2P loans will increase or decrease for a one unit increase of the control variable. When the dependent variable is the number of loans, the magnitude of the coefficients $\beta, \gamma, \delta, \alpha$ predict how many additional or less loans there will be following a one unit increase of the control variable. Finally, λ measures how the adoption of P2P lending in a given county positively impacts neighbour counties. If this coefficient is significantly greater than 0, we can conclude that there is a correlation between the adoption of P2P lending between neighbouring counties,

To compute our cross-sectional spatial regressions, we use the Maximum-Likelihood Estimator method,[23]as the OLS estimation will be biased and inconsistent due to simultaneity bias (See Anselin, 2003 and LeSage and Pace, 2009 for a theoretical explanation on why MLE solves the simultaneity bias).[24]As a matter of fact, the spatial lag term must be treated as an endogenous variable since the volumes of loans in contingent counties are simultaneously impacting one another.

Our findings are presented in Tables 4-7 and they all show that we always reject the null hypothesis that the spatial lag lambda is greater or equal to 0. Spatial lag is always positive and statistically significant, pointing to the existence of strong spatial effects. In other words, the higher the level of P2P loans in one county, the higher it is going to be in the contingent counties.

### B. OLS vs. SARAR

[22] The matrix W we use is a "minmax-normalized" matrix, where the $(i,j)^{th}$ element of W becomes $w_{ij}=\frac{\text{wij}}{m}$, where $m = \{max_i(\text{r}_i), max_i(\text{c}_i)\}$, being $max_i(\text{r}_i)$ the largest row sum of W and $max_i(\text{c}_i)$, the largest column sum of W. We also use the inverse-distance matrix composed of weights that are inversely related to the distances between the units, and we obtain similar results in our regression. Obtaining similar results with an inverse-distance and a contiguity matrix is consistent with the findings of LeSage and Pace, 2010.

[23] The maximum likelihood estimator method relies on the assumption that the error terms are normally distributed.

Since from the SARAR model the estimates for the coefficients ρ and λ are significantly different from zero, ordinary least-squares may lead to inconsistent estimations. Table 10 shows the estimates from the OLS regression model. If we compare these estimates to the output from our SARAR model, we realize that OLS estimates are mostly biased up-words as in Lesage (2008).

## 5. Empirical results

The SARAR model estimates cannot be interpreted as partial derivatives like in the typical regressions (see Le Sage and Pace, 2009). Therefore the coefficients cannot be interpreted as marginal effects of the explanatory variable on the dependent variable in one region, because a change in the explanatory variable is likely to impact the dependent variable in all neighboring regions too. In subsection A we will discuss the short-run impacts of a change in the explanatory variables on the volume and number of P2P lending per capita in each county. In subsection B, we will compute the average total direct impact (ATDI), the average total indirect impacts (ATII) and the average total impact (ATI) which is the sum of the direct and indirect impacts.

### A. Empirical results: short run impacts of the explanatory variables on the dependent variable

Table 4 and table 5 present our empirical findings for the P2P expansion (in terms of volume and number of loans respectively) as a function of different county characteristic, with a particular focus on crisis and competition characteristics.

Our findings show that in both specifications of table 4 and 5, the leverage ratio is statistically significant and has a negative effect on P2P lending expansion both in terms of volume and loans. A decrease of the leverage ratio during the financial crisis increases the volume of lending, and increases the number of loans. The share of deposits affected by failed banks and the Tier 1 capital ratios during the crisis did not have an impact on the diffusion of P2P lending. This finding is consistent with the idea that leverage ratios appear to be better predictors of future banks' performance and problems (Blundell-Wignall and Roulet, 2013; Haldane, 2011a, 2012) with respect to weighted leverage ratios, since weights may be inconsistent and subject to manipulations Mariathasan and Merrouche, 2014; Le Leslé and Avramova, 2012; Haldane 2012; FSA, 2010).

Most of P2P borrowers use lending platforms to consolidate and manage their credit card debt and a minority borrow for business purposes. To account for difficulties in the credit card market, we test the robustness of our results by constructing two additional crisis variables: percentage change in credit card debt balance per capita and percent of credit card debt balance with more than 90 days of delinquency during crisis years. The data comes from the New York Fed Consumer Credit Panel / Equifax that is available only for 2220 counties. None of these variables turns out to be statistically significant. Results are available upon request.

Concerning market structure variables, we find that low branches density in 2007 is a statistically significant driver of the P2P lending. We interpret this result as a suggestion that customers living in counties with low outreach of traditional banks and low quality of financial services are more likely to turn to P2P lending due to weaker brand loyalty.

Turning our attention to concentration measures, both our concentration measures C3 and HHI have a negative and statistically significant sign. In other words, P2P lending penetrates fewer

counties with higher concentration of the largest three banks and with a higher overall traditional banking market concentration. As discussed earlier, this could be interpreted as a sign of strong brand loyalty either due to customer satisfaction or high switching costs. We additionally test the impact of the alternative consumer credit providers, such as payday loans. To do so, we use County Business Patterns to construct the ratio of non-bank establishments that are related to consumer lending and credit intermediation per capital (Bhutta, 2013). We find that P2P lending is more diffused in counties with a higher number of payday loan establishments. This might reflect a higher familiarity with alternative consumer credit.

Among socio-demographic variables, higher population density, higher educational attainment, lower levels of poverty, lower levels of income and higher share of Hispanic and Black minorities have a positive and significant impact on the expansion of the P2P lending. The variables measuring the age of the population are never significant for these specifications. The positive effect of the higher educational attainment is consistent with the fact that human capital is a significant predictor of the technological diffusion and could diminish switching costs due to lower cost of learning. A positive effect of population density reflects the existence of network effects in urban areas that is another well-known predictor of the diffusion of new technologies.

Our finding that the expansion of the P2P lending is faster in counties with higher share of Black and Hispanic minorities could be a sign of higher demand from these areas to escape discrimination in traditional credit markets. As online lenders have removed the possibility to post a photo, identifying the race of the borrower has become much more difficult. During our sample period, 2007-2013, investors had access to the information on the location of borrowers. Although this information could have been used by institutional investors as a proxy for race, it is unlikely that retail investors would do that. Recently, any information on the location of the borrower has been removed, which makes the identification of the race completely impossible. Hence, racial discrimination is not anymore possible in the online lending. The fact that P2P lending has expanded faster in counties with racial minorities might also reflect the fact that informal peer-to-peer lending markets are widely spread among minorities. Hence, P2P lending could be an opportunity to switch from informal to formal peer-to-peer lending.

Table 6 and table 7 present results with variables that capture the geographic heterogeneity of the innovation, measured by the quality of Internet connection and by the number of patents issued by each county. Since the variable which measures the number of patents is correlated to the level of education, we performed one specification excluding the level of education, and found that it is statistically significant and with a positive sign. Among the variables describing the quality of Internet, only broadband and mobile are statistically significant and have a negative sign only when the dependent variable is the volume of loans. High internet quality and speed do not impact the number of P2P borrowers.

To compare the expansion patterns of different online platforms, we estimate the model separately for Prosper Marketplace and Lending Club. The results, presented in Table 8, show that not all local characteristics play a similar role in the case of both online lenders. The market structure variables (HHI and Branches) played a similar role for the two platforms, whereas payday loan establishments have a strong and positive impact only on Prosper's volume of loans and a negative but small impact on the number of Lending Club borrowers. Moreover, the leverage ratio during the crisis played a role in the case of Prosper but is not significant for Lending Club. Interestingly, broadband access plays a positive role for the Prosper lending, and a negative one for Lending Club volume of loans. To understand this difference, one should

remember that Proper platform had an earlier start than the Lending Club. A large part of the Prosper's lending in our sample has been done in 2006-2008 and it has experienced a sharp decline in 2008-2009 due to regulatory uncertainty about its legal status, followed by a slow expansion since 2010. The finding that broadband access plays a role for the Prosper lending is likely to reflect this earlier period when there was still an important geographic heterogeneity in access to Internet. This intuition is reinforced by the estimates of the SARAR model regressions performed each year separately, as shown in table 9. As a matter of fact, the negative and significant effect of broadband is present only starting from the year 2012, whereas it is positive and significant on the year 2008 and otherwise it is never significant.

The age structure only plays a role for Lending Club: a higher percentage of population aged between 20 and 34 increases the volume of P2P loans but decreases the number of loans. With respect to the minorities, counties with a higher share of Hispanic population have a higher number of P2P loans on both platforms but only a higher volume of Lending Club loans.

Finally, the spatial lag is always positive and significant in all the regressions, suggesting the presence of positive spatial relations among contingent counties. It is interesting to note from table 9, that, starting from 2008, this coefficient increased systematically during the years, going from 0.3777 in 2008 to 0.915 in 2013.

### B. Computing marginal effects

Following the method proposed by Drukker et al. 2013, we manually compute the average total direct and indirect impacts of the explanatory variables (crisis, competition, innovation and socio-economic and demographic variables) on the dependent variable (either volume or number of P2P loans per capita per county) using the reduced-form predictors coming from the SARAR regression. Doing so allows us to understand the magnitude of these effects. For example, as shown in table 11, an increase by one standard deviation of the number of branches in a given region decreases the average volume of P2P lending per capita of all regions by 0.0013% (ATDI). Similarly, an increase by one standard deviation of the number of branches in all neighboring regions, reduces by 0.0004 % the volume of P2P lending per capita in that one region (ATII). The signs of the coefficients are the same as the short-run impacts shown in table 4-8, and in general the direct impacts are stronger than the indirect ones, which leads to the fact that total impacts are composed mainly by direct impacts in our main sample.

## Concluding remarks and future extensions

This paper is a first attempt to explore the drivers of the expansion of online lenders. We have proposed three hypotheses related to (1) the competition in the brick-and-mortar banking sector and switching costs to online lenders, (2) the consequences of the financial crisis and (3) the innovation and internet expansion. We also account for spatial effects and socio-economic and demographic characteristics.

Our findings suggest that online lenders have made inroads into counties that have a poor branch network. This suggests that borrowers that either live far away from a brick and mortar bank branch or have a poor branch experience due to long waiting times are more likely to turn to online lenders due to lower brand loyalty. We also find that counties with a more concentrated banking structure have witnessed slower growth of online lenders, which is also consistent with the idea of higher brand loyalty. Higher education and higher propensity to innovate play a significant and positive role, possibly because these characteristics diminish the

costs of learning about online lenders. Our results show that the leverage ratio during the crisis has affected the demand for online lending. Despite the online nature of the P2P lending, spatial effects play a crucial role, which could be interpreted as an important role of social interactions in building trust in online markets.

Our analysis could be extended in a number of ways. First, we would like to use the panel nature of the data to estimate Bass model of the innovation diffusion. Second, we would like to explore the balancing of demand and supply in the P2P lending. This is possible due to the information in our dataset about loan demand that has not been met because loans have been rejected by online lenders or have failed to attract potential lenders.

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**Figure 3:** Depth of the P2P development at the county level during 2007-2013.

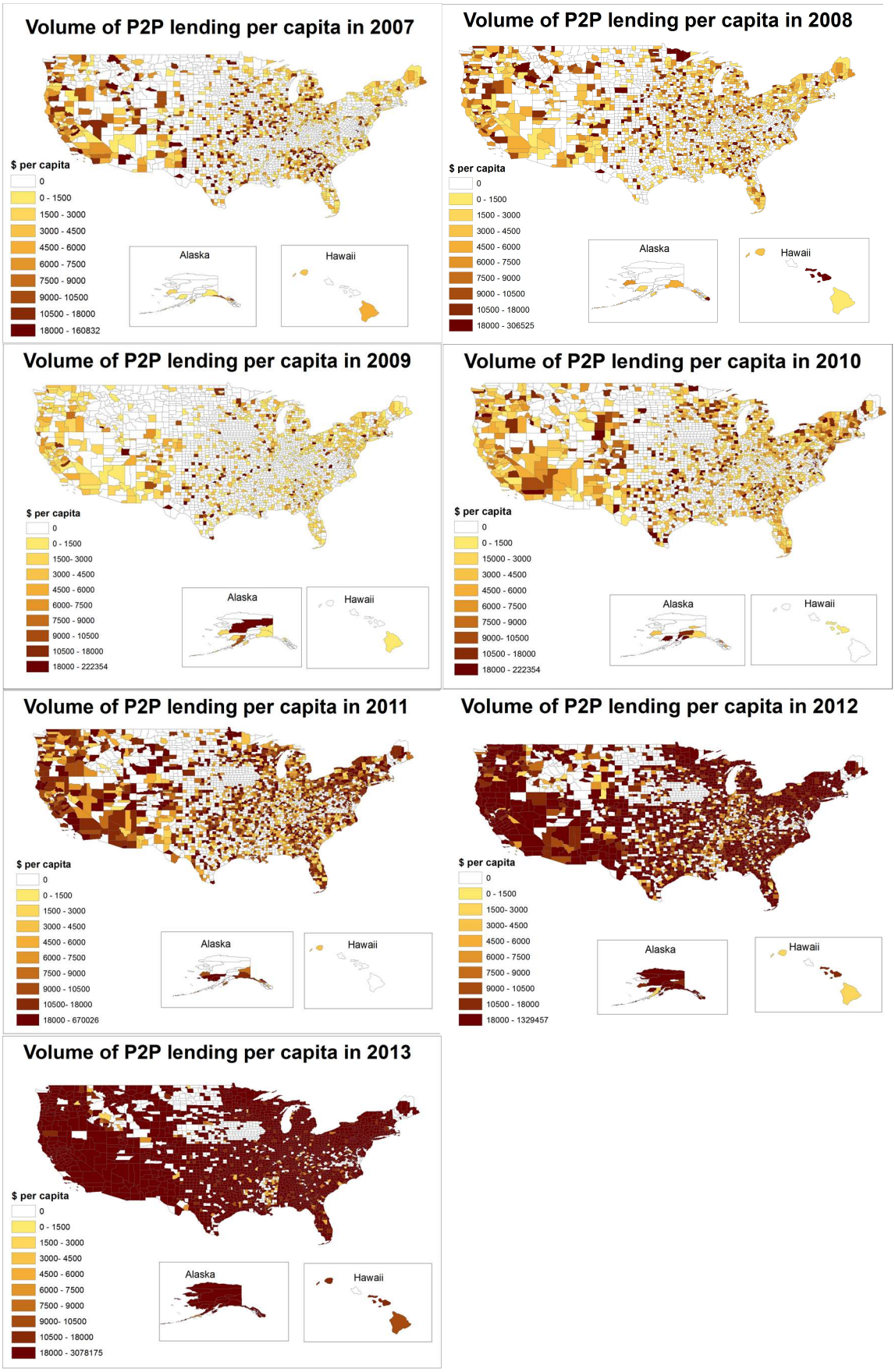

**Table 2. Variable definitions and data sources**

| Variable | Definition and data source |
|---|---|
| | |
| **Dependant variables** | |
| Number of P2P loans per capita | The sum of credit lines from Prosper and Lending Club aggregated for the period 2006-2013 at the county level per 10 000 population.<br>Sources: Prosper and Lending Club |
| P2P volume per capita | The sum of lending from Prosper and Lending Club aggregated for the period 2006-2013 at the county level per 10 000 population<br>Sources: Prosper and Lending Club |
| | |
| **Market structure variables** | |
| HHI | Herfindahl-Hirschmann index, computed in terms of deposits<br>Source: FDIC Summary of Deposits |
| C3 | The share of deposits of the three largest deposit taking institutions in a county<br>Source: FDIC Summary of Deposits |
| Branches per capita | Number of branches in a county divided per 10 000 population<br>Source: FDIC Summary of Deposits |
| Pay Day loans | Number establishment divided by 10 000 population. Non-depository consumer lending (NAICS: 522291)<br>Other activities related to credit intermediation (NAICS 522390)<br>Source: County Business Patterns |
| | |
| **Crisis variables** | |
| Crisis Leverage | The average leverage ratio of deposit taking institutions present via branches in a county weighted by the deposit share of their branches in a county, calculated during crisis years of 2008-2009.<br>Source: FDIC Call Reports, Summary of Deposits |
| Crisis Tier 1 capital | The average Tier A capital ratio of deposit taking institutions present via branches in a county weighted by the deposit share of their branches in a county, calculated during crisis years of 2008-2009.<br>Source: FDIC Call Reports, Summary of Deposits |
| Failed banks | % of deposits affected by bank failures in a county during the whole period.<br>Source: FDIC Failed Bank List |
| Credit growth | % change in Credit Card Debt Balance per Capita during crisis years 2009-2010<br>Source: New York Fed Consumer Credit Panel / Equifax |
| Delinquencies | % of Credit Card Debt Balance 90+ Days Delinquent during crisis years 2009-2010<br>Source: New York Fed Consumer Credit Panel / Equifax |
| | |
| **Innovation and internet variables** | |
| Patents | Number of patents per 10 000 population<br>Source: U.S. Patent And Trademark Office |
| Broadband | % of county population with access to any broadband technology (excluding satellite)<br>Source: NTIA's State Broadband Initiative |
| Mobile | % of county population with access to Mobile Wireless (Licensed) technology<br>Source: NTIA's State Broadband Initiative |
| Speed | % of county population with access to upload speed 50 mbps or higher<br>Source: NTIA's State Broadband Initiative |

| Socio-economic and demographic variables | |
|---|---|
| Age 20 to 34 | The share of the population between 20-34 years<br>Source: American Community Survey 5-year average (2009-2013) |
| Population density | Population number divided by area in sq. m. in a county<br>Source: Bureau of Economic Analysis for the population and United States Census Bureau (2013 TIGER/Line Shapefiles) for the area in sq.m. |
| Bachelor | % of county population with at least bachelor education<br>Source: American Community Survey 5-year average (2009-2013) |
| Poverty | % of county population below poverty line<br>Source: American Community Survey 5-year average (2009-2013) |
| Black | % of Afro-Americans in the county population<br>Source: American Community Survey 5-year average (2009-2013) |
| Hispanic | % of Hispanic population in the county population<br>Source: American Community Survey 5-year average (2009-2013) |
| Asian | % of Asian population in the county population<br>Source: American Community Survey 5-year average (2009-2013) |

## Table 3. Summary statistics

| Variable | Obs | Mean | Std.Dev. | Min | Max |
|---|---|---|---|---|---|
| Prosper volume | 3059 | 13930 | 28786 | 0 | 777512 |
| Lending Club volume | 3059 | 81080 | 147689 | 0 | 4517468 |
| Volume of P2P loans | 3059 | 95010 | 171766 | 0 | 5294980 |
| Number of P2P loans | 3059 | 5.96 | 11.58 | 0.00 | 451.34 |
| **Crisis variables** | | | | | |
| Failed | 3059 | 0.02 | 0.08 | 0.00 | 1.00 |
| Crisis Tier1 | 3059 | 0.14 | 0.08 | 0.06 | 3.99 |
| Crisis leverage | 3059 | 0.09 | 0.02 | 0.04 | 0.33 |
| **Competition variables** | | | | | |
| C3 | 3059 | 0.77 | 0.19 | 0.28 | 1.00 |
| HHI | 3059 | 0.31 | 0.21 | 0.05 | 1.00 |
| Branches | 3059 | 15.68 | 17.18 | 0.61 | 216.74 |
| Payday | 3059 | 1.01 | 1.25 | 0.00 | 8.67 |
| **Innovation variables** | | | | | |
| Mobile | 3059 | 0.95 | 0.11 | 0.00 | 1.00 |
| Broadband | 3059 | 0.98 | 0.05 | 0.01 | 1.00 |
| Speed50000k | 3059 | 0.42 | 0.35 | 0.00 | 1.00 |
| Speed10000k | 3059 | 0.23 | 0.35 | 0.00 | 1.00 |
| Patents | 3059 | 8.60 | 19.32 | 0.00 | 372.86 |
| **Other variables** | | | | | |
| Density | 3059 | 77 | 473 | 0 | 18354 |
| Age 20 to 34 | 3059 | 0.19 | 0.02 | 0.09 | 0.32 |
| Bachelor | 3059 | 0.17 | 0.08 | 0.04 | 0.61 |
| Income | 3059 | 34733.9 | 8860.966 | 14885.43 | 158212.1 |
| Poverty | 3059 | 0.17 | 0.06 | 0.03 | 0.50 |
| Asian | 3059 | 0.01 | 0.02 | 0.00 | 0.58 |
| Hispanic | 3059 | 0.05 | 0.08 | 0.00 | 0.49 |
| Black | 3059 | 0.08 | 0.15 | 0.00 | 0.88 |

## Table 4. Spatial lag model for the P2P expansion as a function of competition and crisis variables with volume of loans per capita as a dependent variable

We estimate cross-sectional models of the geographic expansion of the P2P lending during the period 2006-2013. Dependant variable is the amount of P2P lending per capital in a county. Variable definitions are provided in Table 2. Models are estimated with maximum likelihood approach while controlling for the spatial dependence with a spatial lag term (lambda). State dummies are not shown. Standard errors are in parentheses.
***, **, * denote significance at the 1, 5 and 10 percent level, respectively.

| | Volume of P2P loans per capita in log | | | | | |
|---|---|---|---|---|---|---|
| **Competition variables** | | | | | | |
| Branches | -0.0138*** | -0.0135*** | -0.0149*** | -0.0150*** | -0.0150*** | -0.0139*** |
| | (0.00384) | (0.00382) | (0.00381) | (0.00381) | (0.00380) | (0.00384) |
| C3 | -0.800** | | | | | |
| | (0.390) | | | | | |
| HHI | | -1.997*** | -2.029*** | -2.035*** | -2.038*** | |
| | | (0.330) | (0.331) | (0.331) | (0.331) | |
| Payday | 0.119** | 0.0848* | 0.0898* | 0.0900* | 0.0900* | 0.134*** |
| | (0.0480) | (0.0480) | (0.0480) | (0.0480) | (0.0481) | (0.0475) |
| **Crisis variables** | | | | | | |
| Crisis leverage | -11.31*** | -10.75*** | | | | -11.55*** |
| | (3.442) | (3.426) | | | | (3.442) |
| Capital_crisis | | | -0.441 | | | |
| | | | (1.030) | | | |
| Tier1_crisis | | | | -0.0844 | | |
| | | | | (0.663) | | |
| Failed banks | | | | | 0.0181 | |
| | | | | | (0.558) | |
| **Other variables** | | | | | | |
| Density_log | 0.546*** | 0.466*** | 0.480*** | 0.480*** | 0.480*** | 0.592*** |
| | (0.0471) | (0.0461) | (0.0460) | (0.0460) | (0.0460) | (0.0414) |
| Broadband | -3.626*** | -4.395*** | -4.532*** | -4.534*** | -4.536*** | -3.495*** |
| | (0.918) | (0.924) | (0.924) | (0.924) | (0.925) | (0.916) |
| Income_log | -1.755*** | -1.914*** | -1.984*** | -1.989*** | -1.989*** | -1.691*** |
| | (0.412) | (0.411) | (0.411) | (0.411) | (0.412) | (0.411) |
| Poverty | -7.070*** | -6.524*** | -6.649*** | -6.662*** | -6.664*** | -7.387*** |
| | (1.425) | (1.417) | (1.419) | (1.419) | (1.419) | (1.417) |
| Bachelor | 2.672*** | 3.291*** | 3.581*** | 3.598*** | 3.599*** | 2.830*** |
| | (1.001) | (0.996) | (0.993) | (0.993) | (0.993) | (0.998) |
| Black | -0.240 | 0.0493 | 0.0430 | 0.0434 | 0.0427 | -0.399 |
| | (0.461) | (0.458) | (0.458) | (0.459) | (0.459) | (0.454) |
| Hispanic | 6.362*** | 6.583*** | 6.691*** | 6.684*** | 6.677*** | 6.539*** |
| | (1.045) | (1.037) | (1.038) | (1.038) | (1.042) | (1.042) |
| Age 20 to 34 | 4.058 | 2.225 | 2.053 | 2.061 | 2.067 | 4.474 |
| | (3.133) | (3.133) | (3.137) | (3.137) | (3.142) | (3.128) |
| Constant | 31.93*** | 34.36*** | 34.37*** | 34.38*** | 34.37*** | 30.52*** |
| | (4.554) | (4.525) | (4.532) | (4.532) | (4.551) | (4.504) |
| Lambda | 0.571*** | 0.557*** | 0.558*** | 0.557*** | 0.557*** | 0.581*** |
| | (0.0347) | (0.0344) | (0.0345) | (0.0345) | (0.0345) | (0.0343) |
| Sigma2 | 8.078*** | 7.998*** | 8.023*** | 8.024*** | 8.024*** | 8.085*** |
| | (0.207) | (0.205) | (0.205) | (0.206) | (0.206) | (0.207) |
| Number of counties | 3,059 | 3,059 | 3,059 | 3,059 | 3,059 | 3,059 |
| State dummies | Yes | Yes | Yes | Yes | Yes | Yes |

## Table 5. Spatial lag model for the P2P expansion as a function of competition and crisis variables with number of loans per capita as dependent variable

We estimate cross-sectional models of the geographic expansion of the P2P lending during the period 2006-2013. Dependant variable is the amount of P2P lending per capital in a county. Variable definitions are provided in Table 2. Models are estimated with maximum likelihood approach while controlling for the spatial dependence with a spatial lag term (lambda). State dummies are not shown. Standard errors are in parentheses.
***, **, * denote significance at the 1, 5 and 10 percent level, respectively.

| | Number of P2P loans per capita in log | | | | | |
|---|---|---|---|---|---|---|
| **Competition variables** | | | | | | |
| Branches | -0.00301*** | -0.00295*** | -0.00321*** | -0.00319*** | -0.00314*** | -0.00278*** |
| | (0.000997) | (0.000995) | (0.000992) | (0.000992) | (0.000989) | (0.000996) |
| C3 | -0.346*** | | | | | |
| | (0.1000) | | | | | |
| HHI | | -0.329*** | -0.337*** | -0.336*** | -0.341*** | |
| | | (0.0865) | (0.0866) | (0.0866) | (0.0866) | |
| Payday | -0.0105 | -0.0123 | -0.0113 | -0.0113 | -0.0107 | -0.00307 |
| | (0.0128) | (0.0128) | (0.0128) | (0.0128) | (0.0129) | (0.0126) |
| **Crisis variables** | | | | | | |
| Crisis leverage | -1.813** | -1.789* | | | | -1.944** |
| | (0.921) | (0.920) | | | | (0.921) |
| Capital_crisis | | | 0.0483 | | | |
| | | | (0.276) | | | |
| Tier1_crisis | | | | -0.00377 | | |
| | | | | (0.178) | | |
| Failed banks | | | | | 0.155 | |
| | | | | | (0.150) | |
| **Other Variables** | | | | | | |
| Density | 0.0557*** | 0.0542*** | 0.0563*** | 0.0563*** | 0.0559*** | 0.0717*** |
| | (0.0110) | (0.0110) | (0.0109) | (0.0109) | (0.0109) | (0.00996) |
| Broadband | -0.192 | -0.324 | -0.352 | -0.352 | -0.370 | -0.0818 |
| | (0.320) | (0.325) | (0.325) | (0.325) | (0.325) | (0.319) |
| Income_log | -0.0936 | -0.101 | -0.114 | -0.114 | -0.103 | -0.0835 |
| | (0.108) | (0.108) | (0.108) | (0.108) | (0.108) | (0.108) |
| Poverty | -2.146*** | -2.157*** | -2.181*** | -2.180*** | -2.167*** | -2.317*** |
| | (0.384) | (0.383) | (0.383) | (0.383) | (0.383) | (0.381) |
| Bachelor | 1.486*** | 1.620*** | 1.674*** | 1.672*** | 1.661*** | 1.595*** |
| | (0.257) | (0.255) | (0.254) | (0.253) | (0.254) | (0.255) |
| Age 20 to 34 | -0.174 | -0.348 | -0.389 | -0.389 | -0.343 | 0.0615 |
| | (0.778) | (0.782) | (0.782) | (0.782) | (0.784) | (0.776) |
| Black | 0.346*** | 0.355*** | 0.355*** | 0.355*** | 0.351*** | 0.291** |
| | (0.119) | (0.120) | (0.120) | (0.120) | (0.120) | (0.119) |
| Hispanic | 0.982*** | 1.044*** | 1.051*** | 1.052*** | 1.038*** | 1.020*** |
| | (0.195) | (0.195) | (0.195) | (0.195) | (0.196) | (0.195) |
| Constant | 2.596** | 2.644** | 2.650** | 2.651** | 2.548** | 2.102* |
| | (1.197) | (1.196) | (1.197) | (1.197) | (1.201) | (1.190) |
| Lambda | 0.960*** | 0.964*** | 0.965*** | 0.966*** | 0.964*** | 0.973*** |
| | (0.0402) | (0.0401) | (0.0401) | (0.0401) | (0.0401) | (0.0400) |
| Sigma2 | 0.577*** | 0.576*** | 0.577*** | 0.577*** | 0.577*** | 0.579*** |
| | (0.0149) | (0.0149) | (0.0149) | (0.0149) | (0.0149) | (0.0149) |
| Number of counties | 3,059 | 3,059 | 3,059 | 3,059 | 3,059 | 3,059 |
| State dummies | Yes | Yes | Yes | Yes | Yes | Yes |

## Table 6. Spatial lag model for the P2P expansion as a function of innovation variables with volume of loans per capita as dependent variable

We estimate cross-sectional models of the geographic expansion of the P2P lending during the period 2006-2013. Variable definitions are provided in Table 2. Models are estimated with maximum likelihood approach while controlling for the spatial dependence with a spatial lag term (lambda). State dummies are not shown. Standard errors are in parentheses. ***, **, * denote significance at the 1, 5 and 10 percent level, respectively.

| | Volume of P2P loans per capita in log | | | | | |
|---|---|---|---|---|---|---|
| **Innovation variables** | | | | | | |
| Patents_log | 0.118** | | | | | |
| | (0.0566) | | | | | |
| Broadband | | -4.395*** | | | | |
| | | (0.924) | | | | |
| Optical fiber | | | -0.348 | | | |
| | | | (0.255) | | | |
| Mobile | | | | -1.278*** | | |
| | | | | (0.348) | | |
| Speed10000k | | | | | -0.0316 | |
| | | | | | (0.168) | |
| Speed50000k | | | | | | 0.0367 |
| | | | | | | (0.169) |
| **Other variables** | | | | | | |
| Branches | -0.0121*** | -0.0135*** | -0.0126*** | -0.0135*** | -0.0131*** | -0.0132*** |
| | (0.00382) | (0.00382) | (0.00385) | (0.00382) | (0.00385) | (0.00384) |
| HHI | -1.630*** | -1.997*** | -1.738*** | -1.978*** | -1.744*** | -1.744*** |
| | (0.327) | (0.330) | (0.327) | (0.333) | (0.327) | (0.327) |
| Payday | 0.0668 | 0.0848* | 0.0685 | 0.0837* | 0.0702 | 0.0689 |
| | (0.0482) | (0.0480) | (0.0480) | (0.0481) | (0.0481) | (0.0481) |
| Crisis levergae | -12.19*** | -10.75*** | -11.34*** | -11.70*** | -11.55*** | -11.49*** |
| | (3.431) | (3.426) | (3.437) | (3.428) | (3.436) | (3.441) |
| Density | 0.449*** | 0.466*** | 0.446*** | 0.465*** | 0.449*** | 0.444*** |
| | (0.0476) | (0.0461) | (0.0461) | (0.0462) | (0.0468) | (0.0488) |
| Income_log | -1.460*** | -1.914*** | -1.899*** | -1.955*** | -1.962*** | -1.964*** |
| | (0.371) | (0.411) | (0.415) | (0.411) | (0.412) | (0.412) |
| Poverty | -5.722*** | -6.524*** | -5.865*** | -6.481*** | -5.882*** | -5.852*** |
| | (1.431) | (1.417) | (1.415) | (1.422) | (1.417) | (1.417) |
| Bachelor | | 3.291*** | 3.454*** | 3.313*** | 3.439*** | 3.392*** |
| | | (0.996) | (0.999) | (0.997) | (1.007) | (1.004) |
| Age 20 to 34 | 4.916* | 2.225 | 2.075 | 2.552 | 1.944 | 1.927 |
| | (2.981) | (3.133) | (3.145) | (3.142) | (3.145) | (3.148) |
| Black | -0.0367 | 0.0493 | -0.107 | 0.0653 | -0.115 | -0.135 |
| | (0.463) | (0.458) | (0.458) | (0.460) | (0.462) | (0.460) |
| Hispanic | 6.690*** | 6.583*** | 6.419*** | 6.668*** | 6.451*** | 6.424*** |
| | (1.040) | (1.037) | (1.040) | (1.040) | (1.045) | (1.041) |
| Constant | 25.08*** | 34.36*** | 29.82*** | 31.71*** | 30.50*** | 30.51*** |
| | (4.048) | (4.525) | (4.494) | (4.471) | (4.468) | (4.468) |
| Lambda | 0.550*** | 0.557*** | 0.549*** | 0.548*** | 0.551*** | 0.550*** |
| | (0.0346) | (0.0344) | (0.0346) | (0.0345) | (0.0345) | (0.0345) |
| Sigma2 | 8.079*** | 7.998*** | 8.055*** | 8.025*** | 8.059*** | 8.059*** |
| | (0.207) | (0.205) | (0.206) | (0.206) | (0.206) | (0.206) |
| Number of counties | 3,059 | 3,059 | 3,059 | 3,059 | 3,059 | 3,059 |
| State dummies | Yes | Yes | Yes | Yes | Yes | Yes |

## Table 7. Spatial lag model for the P2P expansion as a function of innovation variables with number of loans per capita as dependent variable

We estimate cross-sectional models of the geographic expansion of the P2P lending during the period 2006-2013. Variable definitions are provided in Table 2. Models are estimated with maximum likelihood approach while controlling for the spatial dependence with a spatial lag term (lambda). State dummies are not shown. Standard errors are in parentheses. ***, **, * denote significance at the 1, 5 and 10 percent level, respectively.

| | Number of P2P loans per capita | | | | | |
|---|---|---|---|---|---|---|
| **Innovation variables** | | | | | | |
| Patents_log | 0.0252* | | | | | |
| | (0.0149) | | | | | |
| Broadband | | -0.324 | | | | |
| | | (0.325) | | | | |
| Optical fiber | | | -0.109 | | | |
| | | | (0.0663) | | | |
| Mobile | | | | -0.0313 | | |
| | | | | (0.148) | | |
| Speed10000k | | | | | -0.0412 | |
| | | | | | (0.0515) | |
| Speed50000k | | | | | | 0.0239 |
| | | | | | | (0.0517) |
| **Other variables** | | | | | | |
| Branches | -0.00229** | -0.00295*** | -0.00277*** | -0.00295*** | -0.00286*** | -0.00298*** |
| | (0.000996) | (0.000995) | (0.00100) | (0.000995) | (0.00100) | (0.000999) |
| HHI | -0.280*** | -0.329*** | -0.310*** | -0.316*** | -0.315*** | -0.307*** |
| | (0.0856) | (0.0865) | (0.0848) | (0.0871) | (0.0850) | (0.0854) |
| Payday | -0.0161 | -0.0123 | -0.0137 | -0.0129 | -0.0136 | -0.0133 |
| | (0.0129) | (0.0128) | (0.0128) | (0.0129) | (0.0128) | (0.0128) |
| Crisis leverage | -2.348** | -1.789* | -1.782* | -1.828** | -1.872** | -1.786* |
| | (0.922) | (0.920) | (0.920) | (0.919) | (0.921) | (0.924) |
| Density | 0.0620*** | 0.0542*** | 0.0533*** | 0.0537*** | 0.0551*** | 0.0516*** |
| | (0.0113) | (0.0110) | (0.0109) | (0.0110) | (0.0111) | (0.0117) |
| Income_log | 0.178* | -0.101 | -0.0844 | -0.105 | -0.104 | -0.106 |
| | (0.0984) | (0.108) | (0.109) | (0.108) | (0.108) | (0.108) |
| Poverty | -2.119*** | -2.157*** | -2.098*** | -2.119*** | -2.132*** | -2.091*** |
| | (0.385) | (0.383) | (0.379) | (0.384) | (0.380) | (0.380) |
| Bachelor | | 1.620*** | 1.651*** | 1.629*** | 1.664*** | 1.615*** |
| | | (0.255) | (0.255) | (0.255) | (0.257) | (0.257) |
| Age 20 to 34 | 0.685 | -0.348 | -0.355 | -0.381 | -0.419 | -0.405 |
| | (0.766) | (0.782) | (0.781) | (0.784) | (0.781) | (0.781) |
| Black | 0.363*** | 0.355*** | 0.335*** | 0.344*** | 0.353*** | 0.334*** |
| | (0.120) | (0.120) | (0.119) | (0.120) | (0.120) | (0.119) |
| Hispanic | 1.116*** | 1.044*** | 1.017*** | 1.032*** | 1.044*** | 1.027*** |
| | (0.195) | (0.195) | (0.194) | (0.196) | (0.195) | (0.194) |
| Constant | -0.531 | 2.644** | 2.145* | 2.391** | 2.374** | 2.360** |
| | (1.072) | (1.196) | (1.172) | (1.169) | (1.164) | (1.164) |
| Lambda | 0.977*** | 0.964*** | 0.963*** | 0.963*** | 0.964*** | 0.962*** |
| | (0.0401) | (0.0401) | (0.0401) | (0.0401) | (0.0401) | (0.0401) |
| Sigma2 | 0.583*** | 0.576*** | 0.576*** | 0.577*** | 0.577*** | 0.577*** |
| | (0.0150) | (0.0149) | (0.0149) | (0.0149) | (0.0149) | (0.0149) |
| Number of counties | 3,059 | 3,059 | 3,059 | 3,059 | 3,059 | 3,059 |
| State dummies | Yes | Yes | Yes | Yes | Yes | Yes |

## Table 8. Spatial lag model for the expansion of Prosper and Lending Club

We estimate cross-sectional models of the geographic expansion of the P2P lending during the period 2006-2013. Variable definitions are provided in Table 2. Models are estimated with maximum likelihood approach while controlling for the spatial dependence with a spatial lag term (lambda). State dummies are not shown. Standard errors are in parentheses. ***, **, * denote significance at the 1, 5 and 10 percent level, respectively.

| | **Volume of P2P loans per capita** | | **Number of P2P loans per capita** | |
|---|---|---|---|---|
| | Lending Club | Prosper | Lending Club | Prosper |
| Branches | -0.0177*** | -0.00816* | -0.00325*** | -0.00118 |
| | (0.00406) | (0.00471) | (0.00105) | (0.000865) |
| HHI | -1.157*** | -4.339*** | -0.284*** | -0.0352 |
| | (0.349) | (0.407) | (0.0915) | (0.0751) |
| Payday | -0.0796 | 0.273*** | -0.0281** | -0.0124 |
| | (0.0510) | (0.0591) | (0.0136) | (0.0112) |
| Crisis leverage | -5.110 | -24.37*** | -0.657 | -1.546* |
| | (3.643) | (4.228) | (0.974) | (0.800) |
| Density | 0.540*** | 0.637*** | 0.0190 | 0.0443*** |
| | (0.0494) | (0.0574) | (0.0116) | (0.00952) |
| Broadband | -6.414*** | 3.009*** | -0.546 | 0.382 |
| | (0.981) | (1.139) | (0.344) | (0.283) |
| Income_log | -0.601 | -2.197*** | -0.0349 | -0.230** |
| | (0.435) | (0.507) | (0.114) | (0.0934) |
| Poverty | -3.414** | -8.524*** | -2.068*** | -1.978*** |
| | (1.504) | (1.756) | (0.404) | (0.333) |
| Bachelor | 2.473** | 4.979*** | 0.995*** | 1.709*** |
| | (1.058) | (1.227) | (0.269) | (0.222) |
| Age 20 to 34 | -3.879 | 14.23*** | -0.227 | -1.290* |
| | (3.332) | (3.864) | (0.828) | (0.680) |
| Black | -0.447 | -0.0792 | 0.440*** | 0.408*** |
| | (0.487) | (0.566) | (0.127) | (0.104) |
| Hispanic | 6.677*** | 2.032 | 0.912*** | 0.627*** |
| | (1.106) | (1.275) | (0.207) | (0.169) |
| Constant | 19.80*** | 28.79*** | 1.825 | 2.829*** |
| | (4.797) | (5.587) | (1.259) | (1.034) |
| Lambda | 1.169*** | 0.378*** | 1.033*** | 0.679*** |
| | (0.0293) | (0.0446) | (0.0436) | (0.0525) |
| Sigma2 | 9.045*** | 12.16*** | 0.646*** | 0.436*** |
| | (0.233) | (0.311) | (0.0167) | (0.0112) |
| Number of counties | 3,059 | 3,059 | 3,059 | 3,059 |
| State dummies | Yes | Yes | Yes | Yes |

## Table 9. Spatial lag model for the expansion of P2P lending year by year

We estimate cross-sectional models of the geographic expansion of the P2P lending during the period 2007-2013 for each year. Variable definitions are provided in Table 2. Models are estimated with maximum likelihood approach while controlling for the spatial dependence with a spatial lag term (lambda). State dummies are not shown. Standard errors are in parentheses. ***, **, * denote significance at the 1, 5 and 10 percent level, respectively.

| Volume of P2P lending | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|
| Branches | -0.00557 | 0.00490 | 0.00236 | -0.00380 | -0.0109** | -0.0111** | -0.0166*** |
| | (0.00448) | (0.00457) | (0.00391) | (0.00451) | (0.00489) | (0.00480) | (0.00422) |
| HHI | -1.426*** | -1.981*** | -0.718** | -2.186*** | -2.923*** | -3.413*** | -2.180*** |
| | (0.388) | (0.396) | (0.340) | (0.390) | (0.421) | (0.415) | (0.365) |
| Payday | 0.0639 | 0.0706 | -0.00717 | 0.0668 | 0.148** | 0.109* | 0.0899* |
| | (0.0532) | (0.0559) | (0.0491) | (0.0571) | (0.0620) | (0.0568) | (0.0512) |
| Crisis leverage | -18.14*** | -15.27*** | -8.714** | -13.22*** | -14.52*** | -11.41*** | -2.877 |
| | (4.052) | (4.129) | (3.546) | (4.075) | (4.421) | (4.339) | (3.826) |
| density_log | 0.561*** | 0.728*** | 0.678*** | 0.767*** | 0.787*** | 0.531*** | 0.530*** |
| | (0.0541) | (0.0560) | (0.0481) | (0.0558) | (0.0611) | (0.0591) | (0.0523) |
| Broadband | 1.281 | 1.997* | -1.088 | -0.882 | -0.730 | -3.385*** | -5.488*** |
| | (1.093) | (1.110) | (0.955) | (1.096) | (1.187) | (1.169) | (1.030) |
| income_log | -0.123 | -1.301*** | 0.300 | 0.388 | -1.075** | -1.762*** | -1.447*** |
| | (0.534) | (0.496) | (0.459) | (0.496) | (0.471) | (0.442) | (0.384) |
| Poverty | -2.520 | -7.419*** | -1.526 | -3.929** | -5.620*** | -6.741*** | -6.658*** |
| | (1.699) | (1.724) | (1.475) | (1.678) | (1.795) | (1.741) | (1.542) |
| Bachelor | 9.016*** | 9.365*** | 9.182*** | 6.777*** | 6.128*** | 5.310*** | 1.803* |
| | (1.245) | (1.218) | (1.046) | (1.176) | (1.248) | (1.228) | (1.063) |
| Black | -0.743 | -0.726 | 0.275 | -0.940* | -0.581 | 0.347 | 0.00288 |
| | (0.548) | (0.553) | (0.476) | (0.542) | (0.586) | (0.574) | (0.505) |
| Hispanic | 6.900*** | 4.552*** | 6.814*** | 6.204*** | 5.107*** | 7.809*** | 7.375*** |
| | (1.253) | (1.249) | (1.082) | (1.236) | (1.331) | (1.314) | (1.157) |
| Age 20 to 34 | 8.764** | 10.72*** | 2.962 | 10.15*** | 7.376* | 5.554 | -0.575 |
| | (3.757) | (3.780) | (3.252) | (3.708) | (4.008) | (3.950) | (3.466) |
| Constant | 2.268 | 15.47*** | -0.129 | 0.468 | 18.02*** | 28.71*** | 28.68*** |
| | (5.853) | (5.460) | (5.056) | (5.458) | (5.228) | (4.941) | (4.266) |
| Lambda | 0.742*** | 0.377*** | 0.568*** | 0.565*** | 0.616*** | 0.754*** | 0.915*** |
| | (0.0481) | (0.0521) | (0.0502) | (0.0481) | (0.0465) | (0.0411) | (0.0339) |
| Sigma2 | 11.21*** | 11.57*** | 8.556*** | 11.29*** | 13.24*** | 12.82*** | 9.934*** |
| | (0.288) | (0.296) | (0.220) | (0.290) | (0.340) | (0.329) | (0.255) |
| Observations | 3,059 | 3,059 | 3,059 | 3,059 | 3,059 | 3,059 | 3,059 |

## Table 10. OLS regressions

| VARIABLES | Volume | Number |
|---|---|---|
| Branches | -0.0110*** | -0.00211* |
| | (0.00400) | (0.00110) |
| HHI | -2.632*** | -0.465*** |
| | (0.344) | (0.0955) |
| Payday | 0.113** | -0.0160 |
| | (0.0503) | (0.0142) |
| Crisis leverage | -10.80*** | -2.304** |
| | (3.594) | (1.017) |
| Density | 0.499*** | 0.0700*** |
| | (0.0483) | (0.0121) |
| Broadband | -3.843*** | -0.0923 |
| | (0.968) | (0.359) |
| income_log | -3.083*** | -0.445*** |
| | (0.424) | (0.118) |
| Poverty | -8.178*** | -3.124*** |
| | (1.483) | (0.421) |
| Bachelor | 3.899*** | 2.142*** |
| | (1.044) | (0.281) |
| Black | 0.228 | 0.512*** |
| | (0.480) | (0.132) |
| Hispanic | 7.831*** | 1.703*** |
| | (1.084) | (0.214) |
| Age 20 to 34 | 2.981 | -0.420 |
| | (3.286) | (0.865) |
| Constant | 48.71*** | 6.739*** |
| | (4.655) | (1.309) |
| Observations | 3,059 | 3,059 |
| R-squared | 0.192 | 0.150 |

## Table 11. Marginal effects

| Volume of P2P loans | ATDI | ATII | ATI |
|---|---|---|---|
| Branches | -0,0013 | -0,0004 | -0,0018 |
| HHI | -0,1963 | -0,0628 | -0,2591 |
| Broadband | -0,4321 | -0,1382 | -0,5703 |
| Poverty | -0,6414 | -0,2052 | -0,8466 |
| Hispanic | 0,6472 | 0,2070 | 0,8542 |
| Income_log | -0,1882 | -0,0602 | -0,2484 |
| Payday | 0,0083 | 0,0027 | 0,0110 |
| Education | 0,3235 | 0,1035 | 0,4270 |
| Black | 0,0048 | 0,0016 | 0,0064 |
| Age | 0,2187 | 0,0700 | 0,2887 |
| Crisis leverage | -1,0565 | -0,3379 | -1,3944 |
| Density | 0,0458 | 0,0147 | 0,0605 |

| Number of P2P loans | ATDI | ATII | ATI |
|---|---|---|---|
| Branches | -0,0022 | -0,0016 | -0,0038 |
| HHI | -1,4631 | -0,4680 | -1,9312 |
| Broadband | -3,2202 | -1,0300 | -4,2502 |
| Poverty | -4,7799 | -1,5290 | -6,3089 |
| Hispanic | 4,8232 | 1,5428 | 6,3660 |
| Income_log | -1,4023 | -0,4486 | -1,8509 |
| Payday | 0,0621 | 0,0199 | 0,0820 |
| Education | 2,4111 | 0,7712 | 3,1823 |
| Black | 0,0361 | 0,0116 | 0,0477 |
| Age | 1,6300 | 0,5214 | 2,1514 |
| Crisis leverage | -7,8735 | -2,5185 | -10,3921 |
| Density | 0,3417 | 0,1093 | 0,4509 |

| Lending Club_volume | ATDI | ATII | ATI |
|---|---|---|---|
| Branches | -0,0020 | -0,0021 | -0,0041 |
| HHI | -0,1318 | -0,1352 | -0,2670 |
| Broadband | -0,7305 | -0,7494 | -1,4799 |
| Poverty | -0,3888 | -0,3988 | -0,7876 |
| Hispanic | 0,7605 | 0,7801 | 1,5405 |
| Income_log | -0,0684 | -0,0702 | -0,1386 |
| Payday | -0,0091 | -0,0093 | -0,0184 |
| Education | 0,2817 | 0,2890 | 0,5707 |
| Black | -0,0509 | -0,0522 | -0,1031 |
| Age | -0,4418 | -0,4532 | -0,8950 |
| Crisis leverage | -0,5820 | -0,5970 | -1,1790 |
| Density | 0,0615 | 0,0631 | 0,1246 |

| Prosper_volume | ATDI | ATII | ATI |
|---|---|---|---|
| Branches | -0,0011 | -0,0002 | -0,0013 |
| HHI | -0,5643 | -0,1117 | -0,6760 |
| Broadband | 0,3914 | 0,0775 | 0,4688 |
| Poverty | -1,1087 | -0,2195 | -1,3282 |
| Hispanic | 0,2643 | 0,0523 | 0,3166 |
| Income_log | -0,2857 | -0,0566 | -0,3423 |
| Payday | 0,0355 | 0,0070 | 0,0426 |
| Education | 0,6477 | 0,1282 | 0,7759 |
| Black | -0,0103 | -0,0020 | -0,0123 |
| Age | 1,8512 | 0,3665 | 2,2176 |
| Crisis leverage | -3,1695 | -0,6275 | -3,7970 |
| Density | 0,0829 | 0,0164 | 0,0993 |

| Lending Club_number | ATDI | ATII | ATI |
|---|---|---|---|
| Branches | -0,0035 | -0,0028 | -0,0063 |
| HHI | -0,3026 | -0,2445 | -0,5471 |
| Broadband | -0,5816 | -0,4700 | -1,0516 |
| Poverty | -2,2045 | -1,7814 | -3,9859 |
| Hispanic | 0,9721 | 0,7855 | 1,7576 |
| Income_log | -0,0372 | -0,0300 | -0,0672 |
| Payday | -0,0299 | -0,0242 | -0,0541 |
| Education | 1,0607 | 0,8571 | 1,9178 |
| Black | 0,4693 | 0,3793 | 0,8486 |
| Age | -0,2423 | -0,1958 | -0,4382 |
| Crisis leverage | -0,7002 | -0,5658 | -1,2660 |
| Density | 0,0203 | 0,0164 | 0,0367 |

| Prosper_number | ATDI | ATII | ATI |
|---|---|---|---|
| Branches | -0,0026 | -0,0011 | -0,0036 |
| HHI | -0,0767 | -0,0320 | -0,1088 |
| Broadband | 0,8330 | 0,3479 | 1,1809 |
| Poverty | -4,3074 | -1,7989 | -6,1064 |
| Hispanic | 1,3654 | 0,5702 | 1,9356 |
| Income_log | -0,5017 | -0,2095 | -0,7113 |
| Payday | -0,0270 | -0,0113 | -0,0383 |
| Education | 3,7217 | 1,5543 | 5,2760 |
| Black | 0,8891 | 0,3713 | 1,2604 |
| Age | -2,8091 | -1,1732 | -3,9822 |
| Crisis leverage | -3,3679 | -1,4066 | -4,7745 |
| Density | 0,0966 | 0,0403 | 0,1369 |

# Chapter 3:
# Is regulation of innovation necessary?

This chapter is composed by two theoretical articles that analyze whether regulation is always optimal from the social welfare perspective.

The first article contributes to the debate on the interchange fee regulation by developing a model of a payment platform where consumer demand in the product market is elastic. We then analyze the role of merchants' pass-through rate of their costs to consumers in the allocation of total surplus, and we look at how merchants' pass-through rate impacts the difference between the profit maximizing and the welfare maximizing interchange fee.

The second article studies competition between a platform and merchants for selling services with a model where consumers can buy different versions of the same product, either through a platform or directly from a merchant. Platforms may impose to merchants several restrictive clauses such as exclusivity arrangements and price parity clauses. Following the debates on the online reservation platforms, we examine whether these restrictions are always detrimental for society. This paper can illustrate the case of a merchant who competes with a payment card platform for the payment of a product. As a matter of fact, the merchant can have incentives to develop his own payment system and to bypass the traditional payment platform.

# Chapitre 3 : La réglementation de l'innovation est-elle nécessaire?

Ce chapitre est composé de deux articles théoriques qui analysent si la réglementation est toujours optimale du point de vue du bien-être social.

Le premier article contribue au débat sur le règlement des frais d'interchange en développant un modèle de plate-forme de paiement où la demande des consommateurs sur le marché du produit est élastique. Nous analysons ensuite le rôle du taux de transfert des marchands sur leurs coûts pour les consommateurs dans l'allocation de l'excédent total, et nous considérons comment le taux de transfert des commerçants affecte la différence entre la maximisation du profit et les frais d'échange maximal du bien-être social.

Le deuxième article étudie la concurrence entre une plate-forme et des marchands pour la vente des services avec un modèle où les consommateurs peuvent acheter différentes versions du même produit, soit par une plate-forme, soit directement chez un marchand. Les plates-formes en monopole peuvent imposer aux commerçants plusieurs clauses restrictives : des accords d'exclusivité et des clauses de parité des prix. Suite aux débats sur les plateformes de réservation en ligne (Booking.com), nous examinons si ces restrictions sont toujours préjudiciables à la société. Cet article peut aussi illustrer le cas d'un marchand qui est en concurrence avec une plate-forme de carte de paiement pour le paiement d'un produit. En fait, le marchand peut avoir incitation à développer son propre système de paiement et à contourner la plate-forme de paiement traditionnelle.

# The Role of Merchants' Pass-Through in Payment Platform Markets

Carlotta Mariotto*, Marianne Verdier†

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**Abstract**

In this article, we analyze a general model of a payment card platform in which banks charge usage fees. We relax the standard assumption of the literature that the product market is covered. We show that the difference between the privately set structure of payment card fees and the socially optimal one depends both on banks' and merchants' pass-through of their costs to consumers.

*Keywords*: Interchange fees; Two-Sided Markets; Payment systems.

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*MINES ParisTech, PSL Research University, CERNA - Centre for industrial economics, i3, CNRS. Email: carlotta.mariotto@mines-paristech.fr

†CRED (TEPP), Université Paris II Panthéon-Assas and MINES ParisTech, PSL Research University, CERNA - Centre for industrial economics, i3, CNRS. Email: marianne.verdier@u-paris2.fr.

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# 1 Introduction

Nowadays, the payment card industry handles a significant part of sales all over the world. Only in Europe, the total sales volume with point-of-sale card transaction in 2005 was more than €1350 billion. The Payment Cards Report from 2005 estimated that banks collected more than €25 billion in fees, and that cards alone constitute up to 25% of retail banking profits. Payment card platforms, such as MasterCard or Visa, contribute to a large diffusion of cards among consumers and merchants. To increase the volume of card transactions, they use a fee called "interchange" which is paid by the merchant's bank (the acquirer) to the cardholder's bank (the issuer). As the interchange fee reduces the issuer's marginal cost and increases the acquirer's marginal cost, the cardholder pays a lower fee for using the card, whereas the merchant's cost of accepting the card increases. Recently, following merchants' complaints, interchange fees have been regulated in various countries and jurisdictions (e.g., in Europe and in the United States).[1]

The purpose of this article is to examine whether a monopolistic payment platform chooses an interchange fee that exceeds the socially optimal one when merchants pass-through their transaction costs to consumers if consumer demand is elastic.

A number of recent articles (e.g., Rochet and Tirole (2002), Wright (2012), Bedre and Calvano (2013)) have found that payment platforms choose an inefficient level of interchange fee that results in overusage of payment cards. A first source of distortion is the role of "merchant internalization" identified by Rochet and Tirole (2002) and Wright (2012). These authors show that a monopolistic platform chooses an inefficiently high level of interchange fee because merchants internalize a fraction of cardholders' surplus in their decision to accept cards. A second source of distortion identified by Bedre and Calvano (2013) arises from the fact that consumers make two distinct decisions (membership and usage), whereas merchants make only one (membership). Our article identifies another source of distortion which is due to merchants' pass-through of their transaction costs to consumers. We show that this distortion may in some cases offset the effect of merchant internalization, and even eliminate the systematic bias in the choice of the profit-maximizing interchange fee when consumer

[1] See in Europe the Regulation (EU) 2015/751 of the European Parliament and of the Council of 29 April 2015. In the United-States, see the Durbin Amendment to the Dodd-Frank Act in 2011.

demand on the product market is elastic to retail prices, if the market is not covered.

The optimal level of interchange fees in payment platforms is a controversial issue, which has generated rich theoretical and empirical debates. According to the Interim Report on retail banking conducted by the European Commission in 2006, Europe registers a high fragmentation on the level of interchange fees across countries and suggests that their level lays far from optimal. Moreover, estimates presented in the report reveal that issuing banks would be still capable of making profits without receiving any interchange fee. Thus, the profit-maximizing interchange fee can be too high, in particular if higher interchange fees lead to higher transaction fees for merchants and if issuers do not pass the additional revenues back to consumers. Several theoretical articles (e.g., Bedre and Calvano (2013) or Wright (2012)) support the view that interchange fees are biased against merchants, with the result of an excessive use of cards by consumers.

To contribute to this debate, we start by building a general framework in which a monopolistic platform acts as an intermediary between banks offering payment services to consumers and merchants.[2] Banks only charge usage fees. The merchant's bank (the acquirer) pays an interchange fee to the consumer's bank (the issuer). As interchange fees are passed through by banks to consumers and merchants, respectively, consumers pay a lower price for using the card, whereas merchants pay a higher price for accepting it. We relax the standard assumption of the literature that merchants' card acceptance policy has no impact on consumer demand on the product market. We show that the profit-maximizing interchange fee depends on four different pass-through rates: the pass-through rates of issuers' and acquirers' costs to consumers and merchants, respectively, and the pass-through rates of merchants' costs to consumers (which include the pass-through of the issuer fee and the acquirer fee, respectively). Then, we study the impact of the interchange fee on consumer and merchant surplus by using a broader notion, which takes into account not only the surplus obtained from card transactions, but also that originated from transactions on the product market. Finally, we explain why the profit-maximizing interchange fee may differ from the welfare-maximizing

[2]The platforms Visa and MasterCard are examples of four-party payment platforms, as opposed to three-party platforms (or "Closed Network System") such as American Express. A three-party platform chooses directly the fees paid by consumers and merchants, and there are no interchange fees. For further description, see Rysman and Wright (2015).

interchange fee and relate our framework to the literature.

In the next section, we enrich the existing papers on payment platforms by building a simple model that enables us to focus on the role of merchants' pass-through. We assume that consumers and merchants are respectively homogenous and heterogeneous with respect to their benefit of making a transaction on the platform. Consumers have heterogeneous valuations for the good that they purchase from monopolistic merchants. Sellers pass through the cost of accepting cards (i.e., the merchant fee) to consumers through higher retail prices. It follows that consumers' decision to buy the product depends on the merchant fee. Merchants internalize a part of consumers' transaction (net) cost in their decision to accept cards as they expect that a higher price for using the card reduces consumer demand for the product. Therefore, their decisions to accept cards depend on the consumer fee. In our setting, each side of the market takes into account a fraction of the other side's net cost of making a transaction on the platform.

We show that the variations of consumer and merchant surplus with respect to the interchange fee depend on a weighted sum of the pass-through rates, that includes the elasticity of consumer demand for the product. Then, we compare the profit-maximizing and the welfare-maximizing interchange fee.

Our article is related to a vast literature on payment card platforms, which studies the difference between the profit-maximizing and welfare-maximizing interchange fee (See Chakravorti (2010) and Verdier (2011) for a survey). Our paper is the first to combine merchant internalization, elastic merchant participation to the platform and elastic consumer demand for the product. Our welfare analysis also takes into account the impact of the interchange fee on the product market. Wright (2012) finds that the profit-maximizing interchange fee can be inefficiently high if there is merchant internalization. In his framework, consumer demand is inelastic to retail prices. Ding and Wright (2014) find that this result remains valid if the platform is allowed to price discriminate between sellers. Wright (2010) studies merchants' decision to accept cards in a Cournot setting. His framework combines merchant internalization and elastic consumer demand. However, merchants are homogenous with respect to the benefit that they receive when they accept cards. He does not conduct any welfare analysis. In the Appendix of their paper, Rochet and Tirole (2011) study a framework in which con-

sumer demand is elastic and merchants are homogenous. Nevertheless, they do not take into the product market in their welfare analysis. Wang (2010) also explores a four-party card platform setting with elastic consumer demand for the product. Nevertheless, he does not take into account merchant internalization nor different market structures on the acquiring side. Bedre-Defolie and Calvano (2013) study a different framework that combines membership and usage decisions. They argue that with a two-part tariff, a monopolistic issuer can fully internalize the usage surplus of cardholders, which is impossible on the merchant side, because merchants cannot refuse cards once they have decided to join the platform. They show that the profit-maximizing interchange fee is biased against retailers.

A series of articles investigates the welfare effects of surcharges in payment platforms, that is, merchants' ability to charge a higher retail price for card transactions. Schwartz and Vincent (2002) assume elastic consumer demand to analyze the effects of the no-surcharge rule (NSR) on social welfare in a three-party platform. They show that the NSR has an ambiguous effect on total user surplus. However, they do not relate their findings to merchant internalization of consumer fees, nor to merchant pass-through. Gans and King (2003) demonstrate that if surcharges are allowed or alternatively, if there is perfect competition at the merchant level, a variation in the interchange fees has no impact on the product market. In other words, the interchange fee is neutral. Our article extends their work by identifying the real effects of interchange fees when surcharges are forbidden and when merchants have market power. Furthermore, a key difference in our article is that a merchant's decision to accept cards is endogenous. Our findings confirm the view expressed by Gans and King (2003) that the potential bias of interchange fees lies in the nature of consumer-merchant interactions. In a recent work, Bourguignon, Gomes and Tirole (2014) study the optimal regulation of surcharges. They use a different timing than in our model and assume that consumers observe the retail price before the merchant's card acceptance policy. This enables them to identify the conditions under which concerns about "missed sales" induce merchants to accept cards. In their article, they also assume elastic consumer demand but do not model merchant heterogeneity. They focus on the optimal regulation of surcharges in the presence of naive consumers. Finally, Edelman and Wright (2015) develop a model to show that an intermediary prefers to impose price coherence on sellers. They show that price coherence

results in an excessive demand for intermediation services. In the online Appendix of their article, they extend their work to allow for elastic consumer demand.

The remainder of the article is organized as follows. In Section 2, we build a general model of a payment card platform, in which banks only charge usage fees. In Section 3, we determine the profit-maximizing and the welfare-maximizing interchange fee. In Section 4, we study a simplified version of our model and enrich the results of the literature by studying a framework that combines merchant internalization and elastic consumer demand for the product. In Section 5, we discuss how to extend our general model when banks charge two-part tariffs. In Section 6, we present a discussion on the policy implications of our results. Finally, we conclude. All proofs can be found in the Appendix.

# 2 A general model of a card platform

In this section, we build a general model that encompasses several works of the literature to study whether the profit-maximizing interchange fee set by a four-party card platform exceeds the welfare-maximizing one.

**Platform and banks** A four-party payment platform provides services to $n_I$ symmetric issuers and $n_A$ symmetric acquirers. As in the literature, the platform sets an interchange fee $a \in [\underline{a}, \overline{a}]$ such that it maximizes the sum of banks' profits.[3] The interchange fee is paid by the merchant's bank (the acquirer) to the consumer's bank (the issuer), each time a consumer pays by card. After observing the interchange fee, the issuers and the acquirers choose the fees $p_B$ and $p_S$ paid by cardholders and merchants to use and accept the card, respectively. The total price is $p_T = p_B + p_S$. Banks bear the marginal costs $c_I$ and $c_A$ per card transaction, respectively, and the total marginal cost is $c = c_I + c_A$. To remain as general as possible, we do not specify the nature of competition on banking retail markets. Consistent with Wright (2004), Wright (2012) and Rochet and Tirole (2011), we assume that the equilibrium transaction fees $p_B^*$ and $p_S^*$ that result from competition between symmetric issuers and symmetric acquirers, respectively, are continuously differentiable functions of $a$

[3] The lower bound $\underline{a}$ and the upper bound $\overline{a}$ are defined such that the product market and the card market in each industry are not covered in equilibrium.

the level of interchange fee. The equilibrium total price $p_T^*$ is such that $p_T^* \geq c$. Finally, we denote by $\rho_B \equiv (p_B^*)'$ and $\rho_S \equiv (p_S^*)'$ the pass-through rates of the interchange fee on the issuing side and on the acquiring side, respectively, and by $\rho_T \equiv \rho_B + \rho_S$ the total pass-through rate.

**Sellers** Sellers always accept to be paid in cash and may decide to accept card payments. A merchant's profit is $\Pi_S^{cash}$ if he accepts only cash and $\Pi_S^{card}$ if he accepts both cash and cards. The marginal cost of production is $d$ and the card acceptance benefit is $b_S > 0$.

If sellers differ across their card acceptance benefit, we assume that $b_S$ is drawn on the interval $\left[\underline{b_S}, \overline{b_S}\right]$ from the continuously differentiable distribution $H_S$, with a density of $h_S$. The survival function is $D_S(.) = 1 - H_S(.)$. We refer to the merchant who is indifferent between accepting cards and refusing them as the marginal merchant and we denote it by $\widehat{b_S}$.

When a consumer pays by card, the merchant pays a fee $p_S$ to the acquiring bank. We assume that the No-Discrimination Rule (NDR) holds, such that a merchant charges the same price $p_G$ to card users and cash users for the product. We denote by $\rho_M^B \equiv dp_G^{card}/dp_B$ and $\rho_M^S \equiv dp_G^{card}/dp_S$ the merchant's pass-through rates of the issuer's fee and the acquirer's fee to consumers, respectively.

**Buyers** A fraction $\beta \in [0,1]$ of consumers hold a card and there are no annual fees for holding the card. Buyers can choose, depending on their preferences, whether to pay by card or to pay cash. They obtain a benefit $b_B > 0$ if they pay by card, whereas the benefit of paying cash is normalized to zero.

If buyers differ across their card usage benefit, we assume that $b_B$ is drawn on the interval $\left[\underline{b_B}, \overline{b_B}\right]$ from the continuously differentiable distribution $H_B$, with a density of $h_B$. The survival function is $D_B(.) = 1 - H_B(.)$. The marginal consumer $\widehat{b_B}$ is the consumer who is indifferent between paying by card or paying cash.

If buyer demand is elastic on the product market, we assume that each merchant of type $b_S$ faces a continuum of buyers. A buyer gives a value $y$ to the good that is drawn independently from $b_S$ and $b_B$ on the support $[0, \overline{y}]$ from the continuously differentiable

cumulative distribution $F_G(y)$, with a density of $f_G(y)$. The survival function is $D_G(.) = 1 - F_G(.)$. Therefore, a consumer of value $y$ and card usage benefit $b_B$ obtains a utility $u = y + b_B - p_B - p_G$ if he pays by card and $u = y - p_G$ if he pays cash. The indifferent card user $\widehat{y_B}$ is the consumer who is indifferent between buying the product and paying by card and not buying the product.[4] The indifferent cash user $\widehat{w_B}$ is the consumer who is indifferent between buying the product and paying cash and not buying the product.

**Timing of the game:**

The timing of the game is as follows:

1. The platform chooses the interchange fee $a$ such that it maximizes the sum of banks' profits.

2. The issuers set the consumer fee $p_B^*$, and the acquirers choose the merchant fee $p_S^*$.

3. Each seller learns its transaction benefit $b_S$, decides whether or not to accept payment cards, and chooses the price of the product $p_G$.

4. In each industry, consumers learn their valuation for the product $y$ and their card usage benefit $b_B$, and decide whether or not to buy it and how to pay.

# 3 Pass-through rates and interchange fees

To understand the role of pass-through in payment platform markets, we determine the profit-maximizing and the welfare-maximizing interchange fee in our general framework.

## 3.1 The profit-maximizing interchange fee

At stage 2, symmetric issuers and acquirers choose the prices that maximize their profits, respectively. Let $V \equiv V(p_B^*, p_S^*)$ denote the total volume of card transactions at the equilibrium of stage 2. Depending on the assumptions on consumer and merchant heterogeneity, the volume of transactions may depend on the marginal merchant $\widehat{b_S}$, the marginal consumer $\widehat{b_B}$, the indifferent card user $\widehat{y_B}$ and the indifferent cash user $\widehat{w_B}$. We will explain in the next

[4] The indifferent card user may be different from the marginal consumer.

paragraph how the volume of transactions is expressed in several models of the literature. This general specification enables us to account for interactions between consumers' and merchants' decisions to use the platform. For example, a merchant may internalize consumers' surplus of using the card in its decision to accept it.

At stage 1, since banks only charge usage fees, the platform chooses the interchange fee that maximizes the sum of banks' profits given by

$$\Pi^{PF} = (p_B^* + p_S^* - c)V(p_B^*, p_S^*),$$

where $p_B^*$ and $p_S^*$ denote the fees that are charged at the equilibrium by symmetric issuers and symmetric acquirers, respectively. The platform cannot choose the total price $p_B^*+p_S^*$ and the price structure $p_B^*/p_S^*$ to extract rents from end-users as in Rochet and Tirole (2006). It can only choose the interchange fee $a$, which impacts banks' usage fees $p_B^*$ and $p_S^*$, respectively.

Assume that the platform's profit is concave in $a$ and that there is an interior solution to the platform's profit-maximization problem. Using the terminology of Fabinger and Weyl (2009), we define $m_T(a) = p_T^*(a) - c$, the platform's mark-up on the total price, $\mu_i(a) = -\frac{V}{\partial V/\partial p_i}$ for $i = S$ or $B$ the vulnerability of the transaction volume to the price that is charged on side i. Proposition 1 gives the profit-maximizing interchange fee that is chosen by a monopolistic platform.

**Proposition 1** *Suppose that banks only charge usage fees. If the pass-through rates on both sides are symmetric, the profit-maximizing interchange fee is chosen such that*

$$\mu_B(a^\pi) = \mu_S(a^\pi).$$

*If the pass-through rates on both sides are asymmetric, the profit-maximizing interchange fee is chosen such that*

$$m_T(a) = \frac{\rho_T(a^\pi)}{\frac{\rho_B}{\mu_B}(a^\pi) + \frac{\rho_S}{\mu_S}(a^\pi)}.$$

**Proof.** See Appendix A. ■

If the pass-through rates are symmetric, the platform chooses an interchange fee such that the marginal increase in the transaction volume that is due to lower fees on the consumer

side is equal to the marginal decrease that is due to higher fees on the merchant side. In other words, at the profit-maximizing interchange fee, the vulnerability of the transaction volume to the consumer fee equals the vulnerability of the transaction volume to the merchant fee.

If the pass-through rates are asymmetric[5], a monopolistic platform chooses an interchange fee such that the mark-up over the total price equals a ratio that depends on banks' pass-through rates on both sides ($\rho_B$ and $\rho_S$) weighted by the inverse of the vulnerability of the transaction volume on each side to the fee that is charged on this side.

The vulnerability of the transaction volume to the fee that is charged on each side of the market ($\mu_B$ and $\mu_S$) may depend on merchants' pass-through. For example, if consumer demand for card usage is elastic to retail prices, the volume of card transactions depends on the price of the product because it impacts the indifferent card user. Since merchants pass-through the benefits and costs of accepting cards (and thus banks' fees) to consumers, the impact of banks' fees on the volume of card payments (i.e., $\partial V/\partial p_B$ and $\partial V/\partial p_S$) also depends on merchants' pass-through.

Therefore, in a general setting, the platform's mark-up over the total price may depend on four different pass-through rates, that is, the pass-through rates of the interchange fee on the issuing and the acquiring side, $\rho_B$ and $\rho_S$ respectively, and the pass-through rates of banks' fees to consumers through retail prices, $\rho_B^M$ and $\rho_S^M$ respectively.

## 3.2 The welfare-maximizing interchange fee

To understand whether the platform chooses an interchange fee that exceeds the social optimum, we denote by $S_B(p_B^*, p_S^*)$ and $S_S(p_B^*, p_S^*)$ the consumer and merchant surplus, respectively. Consumer surplus includes the surplus of buying the product and the surplus of paying with a given payment method (cash or card). Merchant surplus includes the sum of the profits from selling the product and from being paid by card instead of cash.

Social welfare is given by $W = \Pi^{PF} + S_B(p_B^*, p_S^*) + S_S(p_B^*, p_S^*)$ and we assume that it is concave in the interchange fee. Taking the derivative of $W$ with respect to the interchange

[5] We will provide examples in which the pass-through rates are asymmetric in Section 4 (Appendix D).

fee and evaluating it at $a^\pi$, we find that

$$\left.\frac{dW}{da}\right|_{a^\pi} = \rho_B(a^\pi)\left.\frac{\partial S_B}{\partial p_B}\right|_{a^\pi} + \rho_S(a^\pi)\left.\frac{\partial S_B}{\partial p_S}\right|_{a^\pi} + \rho_B(a^\pi)\left.\frac{\partial S_S}{\partial p_B}\right|_{a^\pi} + \rho_S(a^\pi)\left.\frac{\partial S_S}{\partial p_S}\right|_{a^\pi}. \quad (1)$$

If the pass-through rates on both sides are symmetric at the profit-maximizing interchange fee, we have $\rho_B(a^\pi) = -\rho_S(a^\pi)$. Therefore, Eq. (1) becomes

$$\left.\frac{dW}{da}\right|_{a^\pi} = \rho_S(a^\pi)\left(\left.\frac{\partial S_B}{\partial p_S}\right|_{a^\pi} - \left.\frac{\partial S_B}{\partial p_B}\right|_{a^\pi} - \left.\frac{\partial S_S}{\partial p_B}\right|_{a^\pi} + \left.\frac{\partial S_S}{\partial p_S}\right|_{a^\pi}\right). \quad (2)$$

Proposition 2 summarizes the comparison between the profit-maximizing and the welfare-maximizing interchange fee if banks' pass-through rates on both sides are symmetric.

**Proposition 2** *Assume that social welfare is concave in $a$. If $\rho_B(a^\pi) = -\rho_S(a^\pi)$ and*

$$\left.\frac{\partial S_B}{\partial p_S}\right|_{a^\pi} + \left.\frac{\partial S_S}{\partial p_S}\right|_{a^\pi} < \left.\frac{\partial S_B}{\partial p_B}\right|_{a^\pi} + \left.\frac{\partial S_S}{\partial p_B}\right|_{a^\pi} \textit{(resp., } > \textit{)},$$

*the profit-maximizing interchange fee is too high (resp., low) to maximize social welfare.*

When banks' pass-through rates are symmetric, the profit-maximizing interchange fee is too high to maximize social welfare if total user surplus increases more with the consumer fee than with the merchant fee. Unless in specific cases, the profit-maximizing interchange fee can be either too high or too low to maximize social welfare.

## 3.3 The results of the literature

Our general framework encompasses several works from the literature. The relationship between the volume of transactions $V$ and banks' fees $p_B^*$ and $p_S^*$ depends on key assumptions: (a1) consumer heterogeneity in their card usage benefits, (a2) merchant heterogeneity in their card acceptance benefits, (a3) merchant internalization of consumers' benefits of using their cards, (a4) consumer demand elasticity, (a5) impact of merchants' investment decisions on the marginal consumer. The models of the literature can be described as follows.

1. In Rochet and Tirole (2003) or Wright (2004), consumers and merchants are heterogeneous on their benefit of using and accepting the card, respectively (a1, a2). There is no

modelling of the product market and no internalization. Therefore, the marginal consumer and the marginal merchant are given respectively by $\widehat{b_B} = p_B^*$ and $\widehat{b_S} = p_S^*$. As consumers and merchants' card usage and card acceptance conditions are independent, the transaction volume is the product of consumers' and merchants' quasi-demands, that is, the probability that each user wants to use/accept the card. Therefore, we have $V(p_B^*, p_S^*) = D_B(p_B^*)D_S(p_S^*)$. Wright (2004) shows that the profit-maximizing interchange fee can be either too low or too high to maximize social welfare.

3. In Wright (2012), merchants internalize consumers' benefit of making a transaction on the platform (a3). The product market plays no role in the model. Consumers and merchants are heterogeneous on their benefit of using and accepting the card, respectively (a1, a2). The marginal merchant equals the merchant fee minus the expected surplus that a consumer obtains from card usage, that is, we have $\widehat{b_S} = p_S^* - v_B(p_B^*)$, where $v_B(p_B^*) = E(b_B - p_B^* \mid b_B \geq p_B^*)$. Therefore, the transaction volume is given by

$$V(p_B^*, p_S^*) = D_B(p_B^*)D_S(p_S^* - v_B(p_B^*)).$$

Wright (2012) finds that the profit-maximizing interchange fee is too high to maximize social welfare.

4. In Bourguignon, Gomes and Tirole (2015), consumers are heterogeneous both on their benefit of using the card and on the value that they attribute to the product (a1, a4). There is only one monopolistic merchant that is able to steer consumers to pay by card by using surcharges or cash discounts. The marginal consumer $\widehat{y_B}(p_B^*, p_S^*)$ is defined as the consumer who obtains the same utility ex ante whether he chooses to visit or not the merchant's store. The merchant's optimal surcharge is denoted by $\tau^*(p_B^*, p_S^*)$ and the merchant's optimal cash discount is denoted by $\sigma^*(p_B^*, p_S^*)$. The volume of transactions is then given by

$$V(p_B^*, p_S^*) = D_B(p_B^* + \tau^*(p_B^*, p_S^*) + \sigma^*(p_B^*, p_S^*))D_G(\widehat{y_B}(p_B^*, p_S^*)).$$

5. In Creti and Verdier (2014), consumers and merchants are heterogeneous on their benefit of using and accepting the card, respectively (a1, a2). The product market is covered

and the volume of transactions is given by

$$V(p_B^*, p_S^*) = \int_{\widehat{b_S}(p_S^*)}^{\overline{b_S}} D_B(\widehat{b_B}(p_B^*, p_S^*)) h_S(b_S) db_S,$$

where the marginal consumer $\widehat{b_B}$ is such that $\widehat{b_B}(p_B^*, p_S^*) \equiv p_B^* + \alpha_B x(1 - q^*(p_S^*, p_B^*, b_S))$. It corresponds to the sum of the usage fee charged by the issuer and the consumer's loss in case of a fraudulent transaction. The parameter $\alpha_B$ denotes consumer liability for fraud, $x$ the probability that a fraud occurs and $1 - q^*(p_S^*, p_B^*, b_S)$ the probability that a fraud is not detected by the merchant. The probability that a merchant detects a fraudulent transaction is related to the cardholder fee and the merchant fee, because a merchant chooses how much to invest in fraud prevention according to the volume of card transactions and its transaction costs. The marginal consumer is related to the merchant fee through the merchant's investment decision (a5).

5. In Section 5 of the online Appendix of Bedre-Defolie and Calvano (2013), consumers and merchants are heterogeneous on their benefits of using and accepting the card, respectively (a1, a2). Consumer demand on the product market is elastic to prices (a4). The volume of transactions is given by

$$V(p_B^*; p_S^*) = \int_{\widehat{b_S}}^{\overline{b_S}} T(p_B^*; p^*(p_B^*; p_S^* - b_S)) h_S(b_S) db_S,$$

where

$$T(p_B^*; p^*) = (1 - F_G(p^*)) D_B(p_B^*) + \int_{\underline{y}}^{p^*} D_B(p_B^* + p^* - y) f_G(y) dy$$

is the total volume of card transactions of a store accepting cards and $p^* \equiv p^*(p_B^*, p_S^* - b_S)$ denotes the price chosen by a profit-maximizing monopolistic merchant. However, the model of Bedre and Calvano (2013) differs from examples 1 to 4 because issuing banks use two-part tariffs. Therefore, they are able to extract consumers' surplus of holding the card and the platform's profit is expressed differently. We will discuss this issue in our extension section.

# 4 An illustration: Merchant internalization with elastic consumer demand

In this section, we enrich the results of the literature on the comparison between the profit-maximizing and the welfare-maximizing interchange fee. We build a new framework that combines merchant internalization and elastic consumer demand on the product market. This enables us to illustrate specifically how merchant pass-through impacts the difference between the profit-maximizing and the welfare-maximizing interchange fee.

We assume that the product is sold by monopolistic merchants, who differ across their card acceptance benefit $b_S$. To obtain tractable expressions of consumer demand, we assume that all consumers obtain the same benefit $b_B > 0$ of paying by card, but that they differ across the value that they attribute to the product $y$. We explain how the results of Proposition 1 and 2 are applied in this framework.

## 4.1 Stage 3 and stage 4: card acceptance and card usage decisions

### 4.1.1 The consumer's purchasing decision

We start by studying the consumer's decision to purchase the product. We assume that at the equilibrium of the game, we have $p_B^* < b_B$, otherwise no consumer pays by card. When meeting a merchant that accepts cards, a cardholder pays by card if and only if $y + b_B - (p_G + p_B) > y - p_G$ and $y + b_B - (p_G + p_B) > 0$. A cash user (i.e., a consumer who does not hold a card or a cardholder who meets a merchant who refuses cards) buys the product if and only if $y - p_G > 0$. Therefore, the indifferent card user is $\widehat{y_B} = p_G + p_B - b_B$, whereas the indifferent cash user is $\widehat{w_B} = p_G$. The demand of cardholders is $D_G(p_G + p_B - b_B)$, whereas the demand of consumers who only hold cash is $D_G(p_G)$.

### 4.1.2 The merchant's decision to accept cards

We now study a merchant's decision to accept cards. Merchants who do not accept cards make a profit

$$\Pi_S^{cash} = D_G(p_G)(p_G - d),$$

and a merchant of type $b_S$ who accepts cards makes a profit

$$\Pi_S^{card} = \beta D_G(p_G + p_B - b_B)(p_G + b_S - p_S - d) + (1-\beta)D_G(p_G)(p_G - d). \tag{3}$$

We denote by $p_G^{card}$ the profit-maximizing price of a merchant who accepts cards and by $p_G^{cash}$ the profit-maximizing price of a merchant who accepts only cash. The marginal merchant $\widehat{b_S}$ is implicitly defined by $\Pi_S^{card}(p_G^{card}, \widehat{b_S}) = \Pi_S^{cash}(p_G^{cash})$. Since the retail price $p_G^{card}$ depends both on $p_B$ and $p_S$, the marginal merchant also depends both on $p_B$ and $p_S$. Therefore, as in Wright (2012), there is merchant internalization in our framework. At the equilibrium of stage 3, the indifferent card user is given by $\widehat{y_B} = p_G^{card} + p_B - b_B$.

We are now able to analyze how banks' fees impact a merchant's decision to accept cards. For this purpose, let

$$\kappa(b_S, p_B, p_S) \equiv \psi(\widehat{y_B})(\widehat{y_B} + b_S + b_B - p_T - d)/\widehat{y_B}, \tag{4}$$

where $\psi = f_G(p)p/D_G(p)$ is the elasticity of consumer demand. In Appendix B, we analyze how banks' fees impact the marginal merchant. We show that

$$\frac{d\widehat{b_S}}{dp_S} = 1, \tag{5}$$

and

$$\frac{d\widehat{b_S}}{dp_B} = \kappa(\widehat{b_S}, p_B, p_S). \tag{6}$$

If $\beta = 1$, we show in Appendix C that a profit-maximizing merchant sets a price such that $\kappa(b_S, p_B, p_S) = 1$. This implies that $d\widehat{b_S}/dp_B = 1$.

If $\beta \neq 1$, the price structure impacts the marginal merchant. The fee charged on the issuing side impacts more the marginal merchant when the elasticity of consumer demand on the product market is high. Indeed, when the price charged by the issuer increases, consumer demand on the product market is reduced, and therefore, merchants have less incentives to accept cards. In other words, merchant internalization increases with the elasticity of consumer demand on the product market.

**Examples**

**Mature market ($\beta = 1$)** In Appendix C, we analyze the special case in which all consumers hold a card, that is, $\beta = 1$. We show that if $\beta = 1$, the marginal merchant is given by $\widehat{b_S} = p_B + p_S - b_B$. As in Wright (2012), it corresponds to the sum of the merchant fee net of the surplus that a consumer expects from a card transaction. Since we assume that consumers are homogeneous with respect to their benefit of using the card $b_B$, the expected surplus that a consumer obtains from using the card is $v_B(p_B) = p_B - b_B$. If $\beta = 1$, the indifferent card user is given by $\widehat{y_B} = \delta(d + p_T - b_B - b_S)$, where $\delta$ is increasing. This expression corresponds to a standard relationship between the price that is set by a monopolistic merchant and its marginal cost.

**Emerging market** In Appendix D, we analyze the special case in which $\beta < 1$, $b_S$ is uniformly distributed on $[0, 1]$ and $y$ is uniformly distributed on $[0, v]$. We show that the marginal merchant is a non-linear function of the fee that is charged by the issuers.

**The impact of the interchange fee on merchants' decision to accept cards** Lemma 1 summarizes how the interchange fee impacts merchant acceptance when there is merchant internalization and consumer demand for the product is elastic.

**Lemma 1** *The impact of the interchange fee on the marginal merchant depends on a weighted sum of the pass-through rates of the interchange fee to consumers and merchants, that is we have*

$$(\widehat{b_S})'(a) = \rho_S + \kappa(\widehat{b_S}, p_B^*, p_S^*)\rho_B.$$

*If $\beta = 1$, we have $(\widehat{b_S})'(a) = \rho_T$.*

**Proof.** From (6) and (5). ■

As in Rochet and Tirole (2002), Wright (2012), Ding and Wright (2014), the marginal merchant's decision to accept cards is related to the consumer fee. In our framework, the impact of the interchange fee on the marginal merchant depends on a weighted sum of the pass-through rates. The pass-through rate on the issuing side is weighted by the elasticity of

consumer demand on the product market. If the elasticity of consumer demand is very small, the impact of the interchange fee on merchant acceptance only depends on the pass-through rate of the acquirers' fee to merchants. The higher the pass-through rate on the acquiring side, the lower merchant acceptance. If the elasticity of consumer demand on the product market is high, and the pass-through rate on the issuing side is high, this can offset the negative impact of a higher interchange fee on merchant acceptance. In the special case in which $\beta = 1$, merchant acceptance depends on the total pass-through rate.

**The impact of the interchange fee on consumer demand** The impact of the interchange fee on consumer demand depends on the pass-through rates of the interchange fee on both sides and on the pass-through rates of merchants' costs to consumers. Indeed, since the indifferent card user is given by $\widehat{y_B} = p_G^{card} + p_B - b_B$, we have

$$(\widehat{y_B})'(a) = (\rho_M^B + 1)\rho_B + \rho_M^S \rho_S,$$

where $\rho_M^B = \partial p_G^{card}/\partial p_B$ and $\rho_M^S = \partial p_G^{card}/\partial p_S$.

If $\beta = 1$, we show in Appendix C that $\rho_M^B + 1 = \rho_M^S$ and $(\widehat{y_B})'(a) = \rho_M^S \rho_T$. In other words, a higher interchange fee can increase consumer demand for the product if $\rho_M^S \rho_T < 0$ or decrease consumer demand if $\rho_M^S \rho_T > 0$.

## 4.2 The profit-maximizing interchange fee

The volume of card transactions is given by

$$V(p_B^*, p_S^*) = \beta \int_{\widehat{b_S}}^{\overline{b_S}} D_G(\widehat{y_B}) h_S(b_S) db_S.$$

We have

$$\frac{\partial V(p_B^*, p_S^*)}{\partial p_B} = -\beta \kappa(\widehat{b_S}, p_B, p_S) h_S(\widehat{b_S}) D_G(\widetilde{y_B}) + \beta \int_{\widehat{b_S}}^{\overline{b_S}} f_G(\widehat{y_B}) h_S(b_S) \frac{\partial \widehat{y_B}}{\partial p_B} db_S,$$

and

$$\frac{\partial V(p_B^*, p_S^*)}{\partial p_S} = -\beta h_S(\widehat{b_S}) D_G(\widetilde{y_B}) + \beta \int_{\widehat{b_S}}^{\overline{b_S}} f_G(\widehat{y_B}) h_S(b_S) \frac{\partial \widehat{y_B}}{\partial p_S} db_S,$$

where $\widetilde{y_B}$ denotes the indifferent card user evaluated at the marginal merchant. Since $\partial \widehat{y_B}/\partial p_B = \rho_M^B + 1$ and $\partial \widehat{y_B}/\partial p_S = \rho_M^S$, the vulnerability of the transaction volume to banks' fees depends on the pass-through of merchants' costs to consumers. The profit-maximizing interchange fee is given by Proposition 1. The weights $\rho_B/\mu_B$ and $\rho_S/\mu_S$ are given by

$$\frac{\rho_B}{\mu_B} = \beta \rho_B \kappa(\widehat{b_S}, p_B, p_S) h_S(\widehat{b_S}) \frac{D_G(\widetilde{y_B})}{V} - \beta \rho_B \int_{\widehat{b_S}}^{\overline{b_S}} \frac{f_G(\widehat{y_B})}{V} (\rho_M^B + 1) h_S(b_S) db_S,$$

and

$$\frac{\rho_S}{\mu_S} = \beta \rho_S h_S(\widehat{b_S}) \frac{D_G(\widetilde{y_B})}{V} - \beta \rho_S \int_{\widehat{b_S}}^{\overline{b_S}} \frac{f_G(\widehat{y_B})}{V} \rho_M^S h_S(b_S) db_S.$$

Since $\rho_B < 0$ and $\rho_S > 0$, if pass-through rates are constant, a higher $\rho_M^B$ reduces the platform's mark-up on the total price, whereas a higher $\rho_M^S$ increases the platform's mark-up on the total price.

## 4.3 The impact of the interchange fee on consumer and merchant surplus

### 4.3.1 The impact of the interchange fee on merchant surplus

We analyze how the choice of the profit-maximizing interchange fee impacts consumer and merchant surplus. A merchant who accepts only cash makes profit $\Pi_S^{cash}(p_G^{cash})$, whereas a merchant who accepts cards makes profit $\Pi_S^{card}(p_G^{card}, b_S)$. Therefore, merchants' surplus equals

$$S_S = \int_0^{\widehat{b_S}} \Pi_S^{cash}(p_G^{cash}) h_S(b_S) db_S + \int_{\widehat{b_S}}^{\overline{b_S}} \Pi_S^{card}(p_G^{card}, b_S) h_S(b_S) db_S.$$

Since $\Pi_S^{cash}(p_G^{cash}) = \Pi_S^{card}(p_G^{card}, \widehat{b_S})$, the impact of the interchange fee on merchant surplus is given by

$$\frac{dS_S}{da} = \int_{\widehat{b_S}}^{\overline{b_s}} \frac{d\Pi_S^{card}}{da} h_S(b_S) db_S.$$

We analyze the impact of the interchange fee on the profit of a merchant who accepts cards. From the envelop theorem, we can ignore the effect of the interchange fee that impacts the profit-maximizing price chosen by the merchant $p_G^{card}$ at stage 3. Therefore, the total derivative of the profit of a merchant that accepts cards with respect to $a$ is given by

$$\frac{d\Pi_S^{card}}{da} = \frac{\partial \Pi_S^{card}}{\partial p_B}\rho_B + \frac{\partial \Pi_S^{card}}{\partial p_S}\rho_S.$$

From (3), we have $\partial \Pi_S^{card}/\partial p_B = -\beta(\widehat{y_B} + b_S + b_B - p_S - p_B - d)f_G(\widehat{y_B})$ and $\partial \Pi_S^{card}/\partial p_S = -\beta D_G(\widehat{y_B})$. Therefore, the impact of the interchange fee on the profit of a merchant who accepts cards is given by

$$\frac{d\Pi_S^{card}}{da} = -\beta(\rho_B(\widehat{y_B} + b_S + b_B - p_S - p_B - d)f_G(\widehat{y_B}) + \rho_S D_G(\widehat{y_B})).$$

Replacing for $\kappa(b_S, p_B, p_S)$ given by (4), we find that

$$\frac{d\Pi_S^{card}}{da} = -\beta D(\widehat{y_B})(\rho_B \kappa(b_S) + \rho_S). \tag{7}$$

An increase in the interchange fee has two opposite effects on the profit of a merchant who accepts cards. First, it increases consumer demand on the product market and the merchant's profit, because consumers pay a lower fee for using the card. This effect depends on the pass-through rate on the issuing side and on the elasticity of consumer demand on the product market. Second, it increases the merchants' costs of accepting cards, and therefore reduces the merchant's profit. This effect depends on the pass-through rate on the acquiring side.

If $\beta = 1$, since $\kappa(\widehat{b_S}) = 1$, we have $d\Pi_S^{card}/da = -\beta D(\widehat{y_B})\rho_T$. Therefore, if the pass-through rates are symmetric (i.e., $\rho_T = 0$), the interchange fee is neutral. If $\rho_T > 0$, a merchant's profit decreases with the interchange fee, whereas the reverse is true if $\rho_T < 0$.

If $\beta \neq 1$, if the pass-through rates are symmetric, the interchange fee impacts the profit of a merchant who accepts cards. If $\rho_B \kappa(b_S) + \rho_S > 0$, a merchant's profit decreases with the interchange fee, wherease the reverse is true if $\rho_B \kappa(b_S) + \rho_S < 0$. From (7), the impact of the interchange fee on merchant surplus depends on the sign of $\rho_B \kappa(b_S) + \rho_S$. If $\rho_B \kappa(b_S) + \rho_S > 0$, merchant surplus decreases with the interchange fee, whereas the reverse is true if

$\rho_B \kappa(b_S) + \rho_S < 0.$

### 4.3.2 The impact of the interchange fee on consumer surplus

We now analyze the impact of the interchange fee on consumer surplus. Consumer surplus is given by

$$\begin{aligned} S_B &= \int_0^{\widehat{b_S}} \int_{p_G^{cash}}^{\overline{y}} (y - p_G^{cash}) f_G(y) h_S(b_S) dy db_S + (1-\beta) \int_{\widehat{b_S}}^{\overline{b_s}} \int_{p_G^{card}}^{\overline{y}} (y - p_G^{card}) f_G(y) h_S(b_S) dy db_S \quad (8) \\ &\quad + \beta \int_{\widehat{b_S}}^{\overline{b_s}} \int_{\widehat{y_B}}^{\widehat{y_B}} (y - \widehat{y_B}) f_G(y) h_S(b_S) dy db_S. \end{aligned}$$

Consumer surplus is divided into three terms. The first term corresponds to the surplus obtained by consumers at merchants' who refuse cards (i.e., such that $b_S < \widehat{b_S}$). A consumer of type $y$ obtains a surplus $y - p_G^{cash}$. The second term corresponds to the surplus of cash users at merchants who accept cards (i.e., such that $b_S > \widehat{b_S}$). The third term represents the surplus of cardholders who use their cards. At a merchant who accepts cards, a cardholder of type $y$ obtains a surplus $y - \widehat{y_B}$ and a cash user of type $y$ obtains a surplus $y - p_G^{card}$.

We denote by $\widetilde{y_B}$ the indifferent consumer evaluated at the marginal merchant $\widehat{b_S}$ and by $\widetilde{p_G}$ the retail price evaluated at the marginal merchant. The impact of the interchange fee on consumer surplus is expressed as follows

$$\begin{aligned} \frac{dS_B}{da} &= (\widehat{b_S})'(a) h_S(\widehat{b_S}) \left( \int_{p_G^{cash}}^{\overline{y}} (y - p_G^{cash}) f_G(y) dy - \beta \int_{\widetilde{y_B}}^{\overline{y}} (y - \widetilde{y_B}) f_G(y) dy \right) \\ &\quad - \beta \int_{\widehat{b_S}}^{\overline{b_S}} \int_{\widehat{y_B}}^{\overline{y}} ((\widehat{y_B})'(a) f_G(y) dy) h_S(b_S) db_S \\ &\quad - (1-\beta) \left( (\widehat{b_S})'(a) h_S(\widehat{b_S}) \int_{\widetilde{p_G}}^{\overline{y}} (y - \widetilde{p_G}) f_G(y) dy + \int_{\widehat{b_S}}^{\overline{b_s}} \int_{p_G^{card}}^{\overline{y}} (p_G^{card})'(a) f_G(y) h_S(b_S) dy db_S \right). \end{aligned}$$

An increase in the interchange fee has three different impacts on consumer surplus. The first effect is due to the variation in merchants' acceptance of cards. If $(\widehat{b_S})'(a) > 0$, merchant acceptance is reduced when the interchange fee increases. This reduction of the (card) trans-

action volume increases the surplus of consumers who pay in cash at merchants' who refuse cards and decreases the surplus of cardholders at merchants who accept cards. The second effect is a reduction of consumer demand for the product if $(\widehat{y_B})'(a) > 0$. The third effect is a reduction of the demand of consumers who pay in cash at a merchant who accepts cards if $\left(p_G^{card}\right)'(a) > 0$. The sign and the magnitude of the second and the third effects depend on merchants' pass-through of their costs to consumers.

**The comparison of the profit and the welfare maximizing interchange fee** We now compare the profit-maximizing interchange fee to the level of interchange fee that maximizes social welfare, defined as the sum of consumer surplus, merchant surplus and platform's profit. In the special case where $\beta = 1$, since $(\widehat{y_B})'(a) = \rho_M^S \rho_T$ and $p_G^{cash} = \widetilde{y_B}$, we have

$$\frac{dS_B}{da} = -\rho_T \int_{\widehat{b_S}}^{\overline{b_S}} \int_{\widehat{y_B}}^{\overline{y}} (\rho_M^S f_G(y)dy) h_S(b_S) db_S, \tag{9}$$

and

$$\frac{dS_S}{da} = -\rho_T \int_{\widehat{b_S}}^{\overline{b_s}} D(\widehat{y_B}) h_S(b_S) db_S. \tag{10}$$

In Proposition 3, we compare the profit-maximzing and the welfare-maximizing interchange fee if the market is mature ($\beta = 1$).

**Proposition 3** *Assume that $\beta = 1$. If the pass-through rate is higher on the acquiring side than on the issuing side at $a^\pi$, that is, if $\rho_T(a^\pi) \geq 0$, the platform sets an interchange fee that is too high to maximize social welfare, that is, we have $a^\pi \geq a^W$. Otherwise, if the pass-through rate is higher on the issuing side than on the acquiring side at $a^\pi$, the platform sets an interchange fee that is too low to maximize social welfare. If the pass-through rates are identical at the profit-maximizing interchange fee, that is, if $\rho_T(a^\pi) = 0$, the platform sets an interchange fee that maximizes social welfare.*

**Proof.** See Appendix C. ■

If $\beta < 1$, the comparison between the profit-maximizing interchange fee and the welfare-maximizing interchange fee is more complex. In Appendix D, we focus on the special case in which $y$ is uniformly distributed on $[0, \overline{y}]$, $b_S$ is uniformly distributed on $[0, 1]$ and $d = 0$.

To understand how the pass-through rates on the issuing and on the acquiring side impact the profit-maximizing and the welfare-maximizing interchange fee, we analyze two polar cases: A/ a monopolistic issuer and perfectly competitive acquirers, B/ perfectly competitive issuers and a monopolistic acquirer. We are able to show that the maturity of the card market impacts merchants' pass-through rate of banks' fees to consumers. We resort to numerical simulations to find results on the comparison between $a^{\pi}$ and $a^{W}$, which can be found in Appendix D, and find that the profit-maximizing interchange fee can be either too high or too low to maximize social welfare. For example, with perfectly competitive issuers and a monopolistic acquirer the welfare-maximizing interchange fee is higher than the profit-maximizing interchange fee. With perfectly competitive acquirers and a monopolistic issuer the profit-maximizing interchange fee is too high to maximize social welfare when $\overline{y}$ is sufficiently low. The profit-maximizing interchange fee can even become negative in this case if $b_B$ is high enough. The elasticity of consumer demand for the product decreases with the parameter $\overline{y}$. We also find that the difference between the profit-maximizing and the welfare-maximizing interchange fee is higher for $\overline{y} = 10$ than for $\overline{y} = 1$.

Therefore our model enables us to show that the elasticity of consumer demand on the product market may impact the optimal regulation of interchange fees. In particular, in our example, regulatory interventions become less essential when the elasticity of consumer demand is high.

# 5 Extension: two-part tariffs

The general model that we designed does not account for the fact that banks may charge two-part tariffs (i.e., membership and usage fees). The work of Bedre and Calvano (2013) focuses on this issue by studying specific cases.[6] Whilst it is impossible to account for two-

[6]First, they analyze a setting in which the issuer is a monopoly and the acquirers are perfectly competitive. In this framework, consumers and merchants are heterogeneous both on their membership and usage benefits. Consumers make two distinct decisions (on whether or not to join and to use the platform), whereas merchants make only one. The issuer can extract consumers' surplus of using the card by charging two-part tariffs at the adoption stage, with a usage fee set at its marginal cost. Second, they analyze the case in which both the issuer and the acquirer are monopolies. In this second framework, all consumers hold a card. Consumers and merchants are heterogeneous on their benefit of using the card. Usage fees are set at banks' marginal costs and the issuer extracts consumers' surplus through a fixed fee.

part tariff competition in our general framework, we are able to explain how it is modified in the different settings used by Bedre and Calvano (2013). The key difference is that the platform takes into account both its intensive margin (resulting from the volume of card usage) and its extensive margin (resulting from the consumers' decisions to adopt the card) when it chooses the profit-maximizing interchange fee.

At the equilibrium of stage 2, issuing banks charge consumers with a membership fee $P_B^*$ and a usage fee $p_B^*$, whereas the acquirers charge merchants with an average usage fee $p_S^*$. Consumers expect a surplus $\Phi_B(p_B^*, p_S^*)$ of using the card, assuming that they learn their transaction benefit at the last stage, when they meet the merchant. Consumers differ across their membership benefit, which is drawn independently from $b_B$ and $b_S$ from the continuously differentiable distribution $G$. The survival function is $Q = 1 - G(.)$. The indifferent member consumer (i.e., the consumer who is indifferent between joining or not the platform) is $\widehat{B_B} = P_B^* - \Phi_B(p_B^*, p_S^*)$ and consumer demand for membership is $\widetilde{Q}(P_B^*, p_B^*, p_S^*) = Q(\widehat{B_B})$. The platform's profit is the sum of banks' intensive margins and the issuers' extensive margin, that is we have

$$\Pi^{PF} = ((p_T^* - c)V(p_B^*, p_S^*) + P_B^*)Q(\widehat{B_B}).$$

We denote the adjusted transaction volume by

$$V^M(P_B^*, p_B^*, p_S^*) = V(p_B^*, p_S^*)Q(\widehat{B_B}).$$

The adjusted transaction volume $V^M$ takes into account consumers' membership decisions. Using the same notations as before, we define $m_T(a) = p_T^*(a) - c$, the platform's mark-up on the total usage fee , $\mu_i^M(a) = -\frac{V^M}{\partial V^M/\partial p_i}$ for $i = S$ or $B$ the vulnerability of the adjusted transaction volume to the usage fee that is charged on side i, and $\rho_i = (p_i^*)'$ the pass-through rate of the usage fee on side i. We also denote by $\gamma_B = (P_B^*)'$ the pass-through rate of the consumers' membership fee. Finally, we denote by $\alpha_B^M = -\frac{\widetilde{Q}}{d\widetilde{Q}/da}$ the vulnerability of the volume of card adoption and by $\varphi_B^M = -\frac{V^M}{\partial V^M/\partial P_B}$ the vulnerability of the adjusted transaction volume to the consumers' membership fee, respectively. Proposition 5 is then modified as follows. If there is an interior solution, the profit-maximizing interchange fee is

chosen such that

$$m_T(a) = \frac{\rho_T(a^\pi) + \gamma_B/V - P_B^*/(\alpha_B^M V)}{\frac{\rho_B}{\mu_B^M}(a^\pi) + \frac{\rho_S}{\mu_S^M}(a^\pi) + \frac{\gamma_B}{\varphi_B^M}(a^\pi)}.$$

In other words, the platform also takes into account the elasticity of consumers' participation to the platform when it chooses the profit-maximizing interchange fee (see Appendix E).

# 6 Policy implications

First of all, the result arising from our article suggests that regulatory bodies and competition authorities should take into account all the mechanisms through which costs and benefits are transferred from one side to the other in two-sided markets. As a matter of fact, in platform industries there are many sources of cross-effects between one side of the market and the other. For example, investments on fraud prevention on the merchants' side may impact consumers' decision to use the card, as in Creti and Verdier (2014). These effects confirm that authorities should take into account both sides for the definition of the relevant market and the assessment of the optimal interchange fee.

Secondly, results from the article suggest that, if merchants have market power, any excessive level of interchange fee may be explained by the degree of market power exerted by the issuing and acquiring banks. Indeed, we show that the platform's mark-up over the total price depends on how much banks retain from their increase in costs (or revenues) triggered by the increase in the interchange fee, and also on how much of the increase in merchants' costs will be reflected in higher retail prices. The degree of pass-through depends on the market structure. In particular, the more the market is close to being perfectly competitive, the more the increase in costs and revenues will be fully passed-through to end-users, with a one to one relation. Moreover, the effect of the pass-through rates depends on the elasticity of consumer demand for the product.

Several regulatory measures to cap interchange fee level have been recently implemented in USA, Europe and Australia. The aim of these measures was to shift a part of the monopolistic platform' surplus to consumers and society, through a decrease in the retail prices. Consistent with such prediction, our article highlights the mechanism through which inter-

change fees may impact retail prices. Indeed, we show that an increase in the interchange fee may not only lower consumer surplus, but also lower consumer demand for the product, because merchants pass through their transaction costs to consumers.

However, there is limited empirical evidence on merchants' pass-through of payment card fees to consumers. One possible explanation may be that the acquiring side does not translate the reduced cost into lower merchants fees. For example, the Reserve Bank of Australia capped the interchange fees to 0.55% from a level of 0.95%, but, from surveys to consumers' organizations, no evidence was found neither of a decrease in the retail prices, nor of an improvement in the quality of the products.[7] The Spanish experience, as described by Iranzo et al. (2012) also showed neither evidence of a pass-through of the interchange fee in terms of lower prices nor increased quality. Chang et al. (2013) investigated the impact on retail prices of the Durbin Amendment in the United States, which caused a reduction of merchants fees by $7 billions, and an equal increase in the consumers' fees. Nevertheless, they estimated, that the present discounted value of the losses for consumers as a result of the implementation of the Durbin Amendment is between $22 and $25 billion. However, as the authors explain, this result arises from the fact that issuing banks passed through to cardholders the increase in interchange fees into higher transaction fees. This effect compensated for the benefits coming from the reduction in retail prices.

The empirical studies on pass-through in payment platforms entail several limits. First, the analysis is often mostly qualitative and shows evidence based on surveys to consumers' organizations. Second, the evaluation of the extent to which merchants pass through their reduced marginal costs into lower retail prices may be complicated. Indeed, cost savings associated with reduced interchange are relatively small for retailers on a per-transaction basis (See CRA report, 2005). The RBA has commented that the reduction in fees,when perfectly passed through, would be expected to reduce the Consumer Price Index (CPI) by between 0.1 and 0.2%, even though it is hard to detect this reduction as the overall CPI is increasing, on average, by around 2.5% per year. Secondly, contrary to the transaction fees that adjust rapidly, retail prices may be sticky (See Evans and Mateus (2011)). Finally, it is non trivial to empirically identify the role that interchange fees play on final good prices,

[7] See the report by Europe Economics (2013).

due to the presence of other factors that could affect price levels or retailers margins (see the report by Europe Economics, 2014). Moreover, Shapiro (2013), in a simulation on US data, found that the reduction in interchange fees due to the cap set by the Durbin Amendment saved consumers and merchants about 8.5 billion dollars in 2012, of which, about 5.87 dollars were passed through into lower retail prices for final consumers. Therefore, the effect that interchange fees have on consumer surplus through retail prices is not negligible.

# 7 Conclusion

In this article, we enrich the works of Rochet and Tirole (2011) and Wright (2012) by analyzing the difference between the profit-maximizing and the welfare-maximizing interchange fee when consumer demand is elastic to retail prices. We show that when merchant pass-through and merchant internalization occur, the profit-maximizing interchange fee is not systematically biased towards one side, nor is it systematically too high to maximize social welfare.

To conclude, authorities should take into account not only the issuing and the acquiring markets for the assessement of the optimal interchange fee, but also the market structure on the product market. The role played by the pass-through rates of platform's fees is indeed crucial for the efficient allocation of surplus between the different players. Finally, we believe that a key priority for future research is to find empirical evidence on the role of pass-through in two-sided markets, in particular if consumer demand on the product market is elastic to retail prices.

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# Appendix

## Appendix A: Proof of Proposition 1

Taking the derivative of the platform's profit with respect to the interchange fee, we find that

$$\frac{d\Pi^{PF}}{da} = \rho_B((\frac{\partial V}{\partial p_B})(p_T^* - c) + V(p_B, p_S)) + \rho_S((\frac{\partial V}{\partial p_S})(p_T^* - c) + V(p_B, p_S)).$$

This implies that at the profit-maximizing interchange fee $a^\pi$, we have

$$\rho_B((\frac{\partial V}{\partial p_B})(p_T^* - c) + V(p_B, p_S)) + \rho_S((\frac{\partial V}{\partial p_S})(p_T^* - c) + V(p_B, p_S)) = 0.$$

Assume that the pass-through rates are symmetric. In this case, since $p_T^* - c > 0$, the first-order condition of profit-maximization can be rewritten as

$$\rho_B((\frac{\partial V}{\partial p_B}) - (\frac{\partial V}{\partial p_S})) = 0.$$

Hence, at the profit-maximizing interchange fee, we have $\mu_B(a^\pi) = \mu_S(a^\pi)$.

Assume that the pass-through rates are asymmetric. Rearranging the first-order condition we find that

$$(p_T^* - c)(-\rho_B(\alpha^\pi)\frac{\partial V}{\partial p_B} - \rho_S(\alpha^\pi)\frac{\partial V}{\partial p_S}) = \rho_T(\alpha^\pi)V,$$

Substituting for $m_T = p_T^* - c$, $\mu_B = -V/(dV/dp_B)$ and $\mu_S = -V/(dV/dp_S)$ into the equation above, we obtain that at the profit-maximizing interchange fee, the mark-up equals

$$m_T = \frac{\rho_T(\alpha^\pi)}{(\frac{\rho_B}{\mu_B})(\alpha^\pi) + (\frac{\rho_S}{\mu_S})(\alpha^\pi)}.$$

## Appendix B: The impact of platform's prices on the marginal merchant and the marginal consumer

In (i), we analyze the impact of the platform's prices on the marginal merchant. In (ii), we analyze the impact of the platform's prices on the hedonic price paid by card users.

i) We analyze the impact of the platform's prices on the marginal merchant. Since the marginal merchant is implicitely defined by $\Pi_S^{card}(p_G^{card}, \widehat{b_S}) = \Pi_S^{cash}(p_G^{cash})$, from the implicit function theorem, we have

$$\frac{d\widehat{b_S}}{dp_S} = 1,$$

and

$$\frac{d\widehat{b_S}}{dp_B} = -\left.\frac{\partial \Pi_S^{card}/\partial p_B}{\partial \Pi_S^{card}/\partial b_S}\right|_{p_G^{card}}.$$

Since from (3) we have $\partial \Pi_S^{card}/\partial p_B = -\beta f_G(p_G + p_B - b_B)(p_G^{card} + b_S - p_S - d)$, $\widehat{y_B} = p_G^{card} + p_B - b_B$ and $\partial \Pi_S^{card}/\partial b_S = -\beta(1 - F_G(p_G + p_B - b_B))$, this implies that

$$\frac{d\widehat{b_S}}{dp_B} = \psi(\widehat{y_B})\frac{(\widehat{y_B} + \widehat{b_S} + b_B - p_S - p_B - d)}{\widehat{y_B}},$$

where $\psi(p) = -pf_G(p)/(1 - F_G(p))$.

ii) We analyze the impact of the platform's prices on the hedonic price paid by card users. Since $\widehat{y_B} = p_G^{card} + p_B - b_B$, we have

$$\frac{d\widehat{y_B}}{dp_B} = \frac{dp_G^{card}}{dp_B} + 1,$$

and

$$\frac{d\widehat{y_B}}{dp_S} = \frac{dp_G^{card}}{dp_S}.$$

Since $p_G^{card}$ is implicitely defined by $\partial \Pi_S^{card}/\partial p_S = 0$, from the implicit function theorem, we have that

$$\frac{dp_G^{card}}{dp_B} = -\frac{\partial^2 \Pi_S^{card}/\partial p_G \partial p_B\big|_{p_G^{card}}}{\partial^2 \Pi_S^{card}/\partial^2 p_G\big|_{p_G^{card}}} = \frac{\beta(f'_G(\widehat{y_B})(\widehat{y_B} + b_S + b_S - p_S - p_B - d) + f_G(\widehat{y_B}))}{d^2\Pi_S^{card}/d^2 p_G\big|_{p_G^{card}}},$$

and

$$\frac{dp_G^{card}}{dp_S} = \frac{\beta f_G(\widehat{y_B})}{d^2\Pi_S^{card}/d^2 p_G\big|_{p_G^{card}}}.$$

This implies that

$$\frac{d\widehat{y_B}}{dp_B} = \frac{d\widehat{y_B}}{dp_S} + 1 + \frac{\beta f'_G(\widehat{y_B})(\widehat{y_B} + b_S + b_S - p_S - p_B - d)}{d^2\Pi_S^{card}/d^2 p_G\big|_{p_G^{card}}}.$$

## Appendix C: the special case $\beta = 1$

In this Appendix, we solve the model completely in the case where $\beta = 1$.

- Assumptions

The following assumptions ensure that the product market is not covered:

(A1) $f_G(0) = 0$ and for all $y \in [0, v]$, $f'_G(y) \geq 0$.

(A2) $\overline{y} - d - \overline{b_S} > 0$.

Assumptions (A1) and (A2) ensure that the second-order conditions hold and that there is an interior solution when the merchant chooses the price that maximizes its profit when it accepts cash or when it accepts cards, respectively. Assumption (A2) also ensures that the product market is not covered at the equilibrium of the game.

- The conditions under which there is an interior solution to the merchant's profit-maximization problem

We provide here the conditions under which there is an interior solution to the profit-maximization problem of a merchant who accepts only cash. The first-order condition is given by

$$-f_G(p_G)(p_G - d) + D_G(p_G) = 0. \tag{11}$$

There is an interior solution if and only if $\partial^2 \Pi_S^{cash}/\partial^2 p_G < 0$, $\partial \Pi_S^{cash}/\partial p_G\big|_{p_G=0} > 0$ and $\partial \Pi_S^{cash}/\partial p_G\big|_{p_G=\overline{y}} < 0$. Since $f_G(0) = 0$, from (11), we have

$$\left.\frac{\partial \Pi_S^{cash}}{\partial p_G}\right|_{p_G=0} = 1 > 0.$$

Furthermore, since $\overline{y} - d > 0$ from (A2), we have

$$\left.\frac{\partial \Pi_S^{cash}}{\partial p_G}\right|_{p_G=\overline{y}} = -f_G(\overline{y})(\overline{y} - d) < 0.$$

From (11) and since from (A1) $f'_G(p_G) \geq 0$ for all $p_G \in [0, \overline{y}]$, we have

$$\frac{\partial^2 \Pi_S^{cash}}{\partial^2 p_G} = -f'_G(p_G)(p_G - d) - 2f_G(p_G) < 0.$$

Therefore, we have an interior solution.

We provide here the conditions under which there is an interior solution when the merchant accepts cards and cash. Since $f' \geq 0$ from (A1), from (3), we have

$$\frac{\partial^2 \Pi_S^{card}}{\partial^2 \widehat{y}} = -f'_G(\widehat{y})(\widehat{y} - (d + p_T - b_B - b_S)) - 2f_G(\widehat{y}) < 0.$$

Therefore, the second-order condition for profit-maximization holds. Furthermore, since $f_G(0) = 0$ from (A1), we have

$$\left.\frac{\partial \Pi_S^{card}}{\partial p_G}\right|_{\widehat{y}=0} = 1 > 0.$$

Since $\overline{y} - \overline{b_S} - d > 0$ from (A2), if $\overline{b_S} + b_B - p_T > 0$, we have $\overline{y} - d + b_B - p_T + b_S > 0$. Therefore, if $\overline{b_S} + b_B - p_T > 0$, we have

$$\left.\frac{\partial \Pi_S^{card}}{\partial p_G}\right|_{\widehat{y}=\overline{y}} = -f_G(v)(v + b_B + b_S - p_T - d) < 0,$$

and there is an interior solution to the profit-maximization problem of a merchant who accepts cards. We will show in Proposition 1 that it must be that $\overline{b_S} + b_B - p_T > 0$ at the equilibrium of the game otherwise no merchant accepts the card.

- The marginal consumer

We prove that if $p_B \leq b_B$, there exists a function $\delta$ such that the marginal consumer $\widehat{y_B}$ is defined by $\widehat{y_B} \equiv p_G^{card} + p_B - b_B = \delta(d + p_T - b_B - b_S)$, where $p_G^{card}$ is implicitly defined by the first-order condition of the merchant's profit-maximization. From (3), if $\beta = 1$, the first-order condition of the merchant's profit-maximization is given by

$$-f_G(\widehat{y_B})(\widehat{y_B} - (d + p_T - b_S - b_B)) + D_G(\widehat{y_B}) = 0, \tag{12}$$

where $\widehat{y_B}$ denotes the marginal consumer at the profit-maximizing price. Therefore, $\widehat{y_B}$ is implicitly defined as a function of $p_T + d - (b_B + b_S)$. Let

$$\widehat{y_B} \equiv \delta(p_T + d - (b_B + b_S)). \tag{13}$$

It remains to prove that $\delta$ is increasing. Let $x \equiv p_T + d - (b_B + b_S)$. From the implicit function theorem, we have

$$\frac{d\widehat{y_B}}{dx} = -\left(\left.\frac{\partial^2 \Pi_S^{card}}{\partial^2 \widehat{y}}\right|_{\widehat{y_B}}\right)^{-1} \left(\left.\frac{d^2 \Pi_S^{card}}{\partial \widehat{y} \partial x}\right|_{\widehat{y_B}}\right).$$

Since the second-order condition of profit-maximization holds, we have $\partial^2 \Pi_S^{card}/\partial^2 \widehat{y} < 0$. Furthermore, we have

$$\frac{d^2 \Pi_S^{cards}}{\partial \widehat{y} \partial x} = f_G(\widehat{y}) > 0.$$

This implies that $d\widehat{y_B}/dx > 0$. Therefore, $\delta$ is increasing.

- The profit-maximizing interchange fee

The profit-maximizing interchange fee is chosen by the platform such that the total price equals the profit-maximizing price chosen by a monopoly facing a demand function $V(p_T)$.

- The difference between the profit-maximizing and the welfare-maximizing interchange fee

At $a = a^\pi$, we have

$$\left.\frac{dW}{da}\right|_{a=a^\pi} = \left.\frac{dS_C}{da}\right|_{a=a^\pi} + \left.\frac{dS_S}{da}\right|_{a=a^\pi}. \tag{14}$$

If $\rho_T \geq 0$ and $\rho_M^S \geq 0$, from (9) and (10), we have that $dS_C/da \mid_{a=a^\pi} \leq 0$ and $dS_S/da \mid_{a=a^\pi} \leq 0$. It follows that if $\rho_T \geq 0$, from (14), we have that $dW/da \mid_{a=a^\pi} \leq 0$. Since $W$ is concave in $a$ and since

$$\left.\frac{dW}{da}\right|_{a=a^\pi} \leq \left.\frac{dW}{da}\right|_{a=a^W},$$

we have $a^\pi \geq a^W$. Similarly, if $\rho_T \leq 0$, we have $a^\pi \leq a^W$.

## 7.1 Appendix D: Uniform distribution when $\beta \neq 1$

In this Appendix, we look at the special case in which $\beta < 1$, $b_S$ is uniformly distributed on $[0, 1]$, $y$ is uniformly distributed on $[0, v]$ and $d = 0$. A merchant that accepts cards maximizes its profit with respect to the price $p_G^{card}$. From (3), we have

$$p_G^{card} = \frac{1}{2}(v + \beta(b_B - b_S - p_B + p_S)), \tag{15}$$

A merchant that accepts cash maximizes its profit with respect to the price $p_G^{cash}$ and we have

$$p_G^{cash} = \frac{v}{2}. \tag{16}$$

Therefore, we have $\rho_M^B = -\beta/2$ and $\rho_M^S = \beta/2$, which implies that the maturity of the card market impacts the pass-through rates of banks' fees to consumers by merchants. By plugging in Eq. (15) into the marginal marchant $\widehat{b_S}$, we have

$$\widehat{b_S} = \frac{1}{\beta}(-2b_B + 2p_B - v + \beta(b_B - p_B + p_S) + \sqrt{X}),$$

where $X = (2b_B - 2p_B + v)^2 - 4\beta(b_B - p_B)(b_B - p_B + v)$. The impact of the platform fees $p_B$ and $p_S$ on the marginal merchant is not symmetric, and we have

$$\frac{d\widehat{b_S}}{dp_S} = 1,$$

and

$$\frac{d\widehat{b_S}}{dp_B} = \frac{2(\beta - 1)(2b_B - 2p_B + v) + (2 - \beta)\sqrt{X})}{\sqrt{X}}.$$

Therefore, the price structure impacts merchants' acceptance and consumer demand. Plugging in (15) into the marginal card-user $\widehat{y}_B = p_G^{card} + p_B - b_B$, we obtain that

$$\widehat{y}_B = \frac{1}{2}(v + \beta(b_B - b_S - p_B + p_S) + 2(p_B - b_B)).$$

At stage 3, the volume of transactions is given by

$$\begin{aligned} V(p_B, p_S) &\equiv \int_{\widehat{b_S}}^{1} (1 - \frac{\widehat{y_B}}{v}) db_S \\ &= \frac{4(p_B - b_B)(p_S - 1) - 2(p_B + p_S - b_B - 1)v + (b_B + p_S - p_B - 1)^2\beta}{4v}. \end{aligned}$$

To check whether the volume of card transactions is impacted by the price structure $p_B/p_S$, we look at the difference of the derivatives of the volume with respect to the issuing and acquiring fees, and we obtain

$$\frac{dV}{dp_B} - \frac{dV}{dp_S} = -\frac{(b_B + p_S - p_B - 1)(\beta - 1)}{v}.$$

Since this difference is different from zero, the transaction fees have different impact on the

volume of transactions, and therefore the price structure plays a role if $\beta \neq 1$.

We are now able to determine the profit-maximizing prices and levels of interchange fees according to the market structure on the issuing and the acquiring side.

i) Perfectly competitive acquirers and monopolistic issuer:

If the acquirers are perfectly competitive and if there is a monopolistic issuer, we have

$$p_S^* = c_A + a.$$

and

$$p_B^* = \frac{1}{3\beta}(-4(-1+a+c_A)+2v+\beta(a+2(-1+b_B+c_A)+c_I)+\sqrt{Z}, \tag{17}$$

where

$$\begin{aligned} Z &= 4(-2(-1+a+c_A)+v)^2 - 2\beta(2(-1+a+c_A)(-4(c_A-1)+5a+b_B-c_I) \\ &\quad +(7(c_A-1)-8a-b_B+c_I)v)) + (-1+2a+b_B+c_A-c_I)^2\beta^2. \end{aligned}$$

From (17), we see that the pass-through rate on the issuing side is different from -1.

At stage 1, the platform sets the profit-maximizing interchange fee $a^\pi$. We simplify our computations by taking $c_I = 0$ and $c_A = 0$. We are able to find the profit-maximizing interchange fee $a^\pi$ and the welfare-maximizing interchange fee $a^W$ for different maturities of the card market $\beta$, different values of the card usage benefit $b_B$ and for different values of $\overline{y}$. We denote by $a^S$ the interchange fee that maximizes merchant surplus, and by $a^B$ the interchange fee that maximizes consumer surplus. Furthermore, we are able to check that the platform's profit and social welfare are concave in $a$ in our set of parameters.

We obtain the following numerical results for $\overline{y} = 10$ :

| $b_B = 0.1$ | $\beta = 0.2$ | $\beta = 0.5$ | $\beta = 0.8$ | $b_B = 0.5$ | $\beta = 0.2$ | $\beta = 0.5$ | $\beta = 0.8$ |
|---|---|---|---|---|---|---|---|
| $a^\pi$ | 0.72 | 0.72 | 0.72 | $a^\pi$ | 0.62 | 0.62 | 0.62 |
| $a^W$ | 1.05 | 1.43 | 1.87 | $a^W$ | 0.94 | 1.31 | 1.76 |
| $a^S$ | 0.19 | 0.18 | 0.18 | $a^S$ | -0.1 | -0.11 | -0.12 |
| $a^B$ | 2.02 | 2.42 | 3.55 | $a^B$ | 2.1 | 2.58 | 3.9 |

| $b_B = 0.8$ | $\beta = 0.2$ | $\beta = 0.5$ | $\beta = 0.8$ |
|---|---|---|---|
| $a^\pi$ | 0.54 | 0.54 | 0.54 |
| $a^W$ | 0.85 | 1.22 | 1.67 |
| $a^S$ | -0.32 | -0.33 | -0.34 |
| $a^B$ | 2.14 | 2.67 | 4.12 |

We obtain the following results for $\overline{y} = 1$ :

| $b_B = 0.1$ | $\beta = 0.2$ | $\beta = 0.5$ | $\beta = 0.8$ | $b_B = 0.5$ | $\beta = 0.2$ | $\beta = 0.5$ | $\beta = 0.8$ |
|---|---|---|---|---|---|---|---|
| $a^\pi$ | 0.69 | 0.69 | 0.69 | $a^\pi$ | 0.58 | 0.58 | 0.58 |
| $a^W$ | 0.68 | 0.67 | 0.68 | $a^W$ | 0.54 | 0.51 | 0.49 |
| $a^S$ | 0.22 | 0.22 | 0.21 | $a^S$ | -0.04 | -0.05 | -0.06 |
| $a^B$ | 1 | 1.17 | 1.6 | $a^B$ | 0.88 | 1.1 | 1.65 |

| $b_B = 0.8$ | $\beta = 0.2$ | $\beta = 0.5$ | $\beta = 0.8$ |
|---|---|---|---|
| $a^\pi$ | 0.48 | 0.48 | 0.48 |
| $a^W$ | 0.44 | 0.39 | 0.35 |
| $a^S$ | -0.26 | -0.26 | -0.27 |
| $a^B$ | 0.79 | 1.04 | 1.69 |

Note that $a^\pi$ seems invariant with respect to $\beta$ since we rounded the interchange fee to the second digit. However there are small variances, and in particular, with this set of parameters, the profit maximizing interchange fee slightly increases with the maturity of the card market $\beta$.

ii) Perfectly competitive issuers and monopolistic acquirer:

In this second case, we assume perfectly competitive issuers and a monopolistic acquirer, we have that

$$p_B^* = c_I - a.$$

and

$$p_S^* = \frac{2}{3}(\frac{2a + 2b_B + v}{\beta} + (2 - 2b_B - a)) + \sqrt{T}, \tag{18}$$

where $T = \beta^2(4(a+b_B)+v)^2-2(10a^2-v+2a(4v+9b_B-1)+b_B(7v+8b_B-2))\beta+(2a+b_B-1)^2\beta^2$. From (18), we see that the pass-through rate on the acquiring side is different from -1.

We conduct the same numerical analysis as above for $\overline{y} = 10$:

| $b_B = 0.1$ | $\beta = 0.2$ | $\beta = 0.5$ | $\beta = 0.8$ | $b_B = 0.5$ | $\beta = 0.2$ | $\beta = 0.5$ | $\beta = 0.8$ |
|---|---|---|---|---|---|---|---|
| $a^\pi$ | 0.18 | 0.18 | 0.18 | $a^\pi$ | -0.12 | -0.12 | -0.12 |
| $a^W$ | 0.6 | 0.84 | 0.67 | $a^W$ | 0.66 | 0.94 | 0.81 |
| $a^S$ | 0.175 | 0.17 | 0.17 | $a^S$ | -0.12 | -0.12 | -0.13 |
| $a^B$ | 1.77 | 2.18 | 2.17 | $a^B$ | 1.77 | 2.25 | 3.56 |

| $b_B = 0.8$ | $\beta = 0.2$ | $\beta = 0.5$ | $\beta = 0.8$ |
|---|---|---|---|
| $a^\pi$ | -0.34 | -0.34 | -0.34 |
| $a^W$ | 0.67 | 0.98 | 0.89 |
| $a^S$ | -0.34 | -0.35 | -0.35 |
| $a^B$ | 1.74 | 2.26 | 3.72 |

We obtain the following results for $\overline{y} = 1$:

| $b_B = 0.1$ | $\beta = 0.2$ | $\beta = 0.5$ | $\beta = 0.8$ | $b_B = 0.5$ | $\beta = 0.2$ | $\beta = 0.5$ | $\beta = 0.8$ |
|---|---|---|---|---|---|---|---|
| $a^\pi$ | 0.2 | 0.2 | 0.2 | $a^\pi$ | -0.08 | -0.08 | -0.08 |
| $a^W$ | 0.28 | 0.37 | 0.45 | $a^W$ | 0.01 | 0.11 | 0.2 |
| $a^S$ | 0.19 | 0.18 | 0.15 | $a^S$ | -0.09 | -0.12 | -0.12 |
| $a^B$ | 0.85 | 0.98 | 1.37 | $a^B$ | 0.73 | 0.9 | 0.9 |

| $b_B = 0.8$ | $\beta = 0.2$ | $\beta = 0.5$ | $\beta = 0.8$ |
|---|---|---|---|
| $a^\pi$ | -0.28 | -0.28 | -0.28 |
| $a^W$ | -0.19 | -0.08 | 0.01 |
| $a^S$ | -0.31 | -0.35 | -0.4 |
| $a^B$ | 0.64 | 0.83 | 1.36 |

## Appendix E: an extension - two-part tariffs

Since $\Pi^{PF} = (p_T^* - c)V^M(P_B^*, p_B^*, p_S^*) + P_B^*\widetilde{Q}(P_B^*, p_B^*, p_S^*)$, the derivative of the platform's profit with respect to the interchange fee is given by

$$\frac{d\Pi^{PF}}{da} = \rho_B(\frac{\partial V^M}{\partial p_B}(p_T^* - c) + V^M) + \rho_S(\frac{\partial V^M}{\partial p_S}(p_T^* - c) + V^M) + \gamma_B(\frac{\partial V^M}{\partial P_B}(p_T^* - c) + \widetilde{Q}) + P_B^*\frac{d\widetilde{Q}}{da}.$$

Substituting for $m_T(a) = p_T^* - c$ into the equation above, we obtain that

$$\frac{d\Pi^{PF}}{da} = m_T(a)(\rho_B\frac{\partial V^M}{\partial p_B} + \rho_S\frac{\partial V^M}{\partial p_S} + \gamma_B\frac{\partial V^M}{\partial P_B}) + \rho_T V^M + P_B^*\frac{d\widetilde{Q}}{da} + \gamma_B\widetilde{Q}.$$

Substituting for $\mu_i^M(a) = -\frac{V^M}{\partial V^M/\partial p_i}$, $\alpha_B^M = -\frac{\widetilde{Q}}{d\widetilde{Q}/da}$ and $\varphi_B^M = -\frac{V^M}{\partial V^M/\partial P_B}$, since $V^M = V\widetilde{Q}$, if there is an interior solution, at the profit-maximizing interchange fee, we have

$$m_T(a^\pi) = \frac{\rho_T(a^\pi) + \gamma_B/V - P_B^*/(\alpha_B^M V)}{\frac{\rho_B}{\mu_B^M}(a^\pi) + \frac{\rho_S}{\mu_S^M}(a^\pi) + \frac{\gamma_B}{\varphi_B^M}(a^\pi)}.$$

# Competition between a platform and merchants for selling services

Carlotta Mariotto*, Marianne Verdier†

**Abstract**

In this paper, we study competition between a platform and merchants for selling services. In our setting, consumers can buy different versions of the same product either through a platform or directly from a merchant. The platform's and the merchant' s selling services are differentiated both on the consumers' side and on the merchants' side. We examine whether restrictions that are imposed by plaforms to sellers such as price parity or single-homing clauses reduce consumer surplus. We show that in some cases, the platform can impose restrictions that are socially optimal.

*Keywords*: Two-Sided Markets, Exclusivity, Selling Channel.

*JEL Codes*: E42; L1; O33.

*Ecole Nationale Supérieure des Mines de Paris - Centre d' Economie Industrielle (CERNA). Email: carlotta.mariotto@mines-paristech.fr

†CRED (TEPP), Université Paris II Panthéon-Assas and Ecole Nationale Supérieure des Mines de Paris - Centre d'Economie Industrielle (CERNA). Email: marianne.verdier@u-paris2.fr

# 1 Introduction

In several markets, selling services impact retailers' transaction costs and consumers' perception of product quality. Retailers may strategically decide to sell directly to consumers or to outsource their selling services to a platform. For example, a florist may sell flowers directly at his physical shop or via an online marketplace such as Interflora. However, platforms have sometimes enough market power to impose restrictions to retailers, such as price parity or single-homing clauses. Price parity clauses are agreements whereby the price of the product sold on the platform cannot be higher than the price available on the merchant's website. Single-homing clauses prevent merchants from selling through a competitive selling channel, such as direct sales or another platform. A key policy question is whether these restrictions reduce consumer surplus and social welfare.

In this paper, we analyze a platform's incentives to impose two different types of restrictions on retailers (price parity or single-homing) when the latter trade-off between direct sales and platform sales.[1] The selling channel impacts the quality of the product sold to consumers and retailers' transaction costs. The two selling channels are differentiated in quality both on the consumers' side and the retailers' side. We show that the platform's restrictions are not always detrimental to consumers.

Recently, in various industries (i.e., hotel booking, e-book, payments) and several countries, competition authorities have examined price parity and single-homing clauses.[2] Both restrictions may reduce consumer and merchant surplus through different mechanisms: inflation of platform's fees or retail prices, constraints on consumers' choices, restrictions of merchants' strategic options. For example, several hotels like Accor have decided to renounce to sell rooms through Online Travel Agencies given the amount of fees paid to online reservation platforms.[3] Our paper contributes to the debate by introducing the role of the quality

[1] Chevalier et al. (2001) look at the opposite case, that is when brick and mortar retailers impose restrictive clauses to online platforms to prevent free riding on the merchant's site.

[2] For the online hotel booking case and price parity clauses: see the District Court Judgment in 2013 (US), the decisions by the European Commission in 2012 and 2013, national cases in the UK (OFT, 2014), Germany (BKartA,2013), and other countries in 2015 (Decision 15-D-06 France of the Competition Authority). In the payments industry single-homing clauses: the "PayPal only" policy case in 2008 (ACCC in Australia), the decision in the Dodd-Frank Act in 2011 (US) to forbid network exclusivity clauses.

[3] The percentage grew of about 28 % on each transaction in the last 4 years. See the article on Le Figaro

of selling services, which may impact the effect of price parity and single-homing clauses on consumer surplus.

We build a model to study competition between a platform and a continuum of monopolistic merchants to market a service. The platform and merchants do not compete on the (main) retail market but only to extract the surplus that consumers obtain when they buy through their preferred selling channel.[4] Merchants have to decide whether to offer their product through the platform or sell it directly to consumers, or through both channels (i.e., they single-home or multi-home). The platform charges a transaction fee both to consumers and merchants. Since consumer demand is elastic to prices, merchants pass through a fraction of their transaction costs to consumers. The platform's marketplace is differentiated from the merchant's selling channel both in terms of value added to the consumer's buying experience and in terms of value added to the merchant's sales. The platform may add value to the consumer's purchase by offering a delivery service of good quality (flowers, food delivery for restaurants). If the quality of the delivery service is too low for consumers, retailers may prefer direct sales.[5] The quality of the delivery service on the retailers' side also matters, because merchants may enjoy lower accounting costs or lower information costs when they sell directly.

Our model aims at analyzing the impact of the restrictions imposed by the platform in a variety of cases according to the value added both on the consumers' side and on the merchants' side. The platform can impose two restrictions to merchants: either single-homing or price parity clauses. If the platform imposes to merchants single-homing, they are forbidden to sell the product directly to consumers when they market their product through the platform. If the platform imposes to merchants price parity, merchants are forbidden to price discriminate according to the selling channel.

(October, 2014) : "La parade d'Accor pour résister à Booking.com".

[4]The literature on online commerce platforms refers to this model as the agency model. By contrast, when the platform buys the primary product directly from the retailer and resells it to consumers, the vertical structure is said to be organized according to the wholesale model. Nevertheless, even if we adopt an agency model, in this paper sales revenue is not split between suppliers and retailers according to endogenously pre-determined shares and the entire revenue coming from the product is of the merchant.

[5]For example, Jin et al. (2007) study the trade-off faced by sportscard sellers on their decision of selling online or offline according to the features of the good. Online platform sales reduce consumers' search costs of rare cards, whereas physical sales offer consumers the ability to test in person the quality of the card.

In the first part of the paper, we determine consumer demand and merchants' profits according to the number of selling channels that are available. Then, we determine the merchant's choice of the number of selling channels depending on whether or not the platform imposes restrictions. By choosing to market another version of its product through a platform, the merchant can extract additional surplus from consumers but incurs different marginal costs. The additional surplus extracted from consumers depends on the differences in costs (related to the degree of differentiation on the merchant side) but also on the degree of differentiation between both selling channels on the consumers'side. We determine in all cases the conditions under which a merchant markets its product through the platform. If the merchant is allowed to price discriminate, his decision to outsource his selling services to the platform depends on the total transaction fee because he internalizes the consumer's cost of buying through the platform. When price discrimination is not allowed, his decision to sell through the platform only depends on the fee he pays to the platform.

Later, we study the platform's pricing strategy in various scenarios: when there are no restrictions, when multi-homing is not allowed and when price discrimination is not allowed. Subsequently, we look at the profit-maximizing strategy of the platform and we compare it to the strategy that maximizes consumer surplus and social welfare. For given platform's fees, merchants would prefer to be given the opportunity to offer more selling modes through multi-homing. However, depending on the elasticity of consumer and merchant demand, the platform can reduce its fees under single-homing. Therefore, merchant surplus may also increase under single-homing. For consumers, the variation in their surplus depends on three effects when multi-homing is allowed. Firstly, more consumers may be able to consume the higher quality. Secondly, the transaction fees may decrease in some cases under multi-homing. Third, merchant's acceptance always increases under multi-homing.

In our numerical simulations, we find that in many cases, the platform chooses a strategy which also maximizes consumer surplus and total user surplus. We also find that the interest of consumers and merchants are often not aligned, but we are able to identify cases in which all agents (platform, merchants and consumers) prefer that the platform imposes single-homing. For low levels of differentiation between the platform and the merchant's

service on the consumer side, if the platform adds high value on the merchant side, it always imposes price parity, which benefits consumers to the detriment of merchants, whose surplus is maximized by multi-homing. On the other side, if the platform does not add value on the merchant side, we find that merchant surplus is maximized by single-homing, because transaction fees are lower, while social welfare is maximized by multi-homing.

In the last section, we look at the case in which the platform only delivers the low quality service with respect to merchants and we see that merchants always accept the platform's service under multi-homing and that if the platform forbids merchants to price discriminate across selling channels, consumers never buy through the platform.

The reminder of the paper is as follows. In Section 2, we survey the literature that is related to our study. In Section 3, we introduce the model and our assumptions. In Section 4, we analyze a merchant's incentives to sell its product through the platform. In Section 5, we study whether the platform chooses a strategy that maximizes consumer surplus when the platform's quality on the consumer side is higher than the merchant's selling channel. In Section 6, we briefly comment the case in which the platform's quality on the consumer side is low. Finally, we conclude.

# 2 Related literature

Our work is linked to several strands of literature on platform markets. First, several papers study whether price coherence reduces consumer surplus. When a platform imposes price coherence[6], merchants have to set the same retail price for consumers who buy through the platform or another selling channel. One strand of literature found that these clauses are always detrimental for social welfare. Wang and Wright (2015) build a model in which consumers can search for firms directly or through a platform. Therefore, differently from our work, they model search costs and they study the possibility for consumers to use platforms as showrooms to learn and compare prices without concluding the transaction through them.

[6]Online travel agencies may impose narrow price parity clauses, i.e. the hotel cannot set a lower room price on the direct sale with respect to the room price on the online travel agency. Online travel agencies may also impose wide price parity clauses, that is the hotel cannot set a lower price for the rooms both for the direct channel and for all the competiting online travel agents platforms.

They find that price coherence has several anticompetitive effects. Firstly, it eliminates competition between the merchant and the platform on the selling channel. As a matter of fact, without price coherence merchants can adjust the retail prices with respect to the fees charged by the platform, and if prices are too high, then consumers will buy directly at the merchant's shop. Price coherence eliminates the competition constraint coming from direct sales, platforms will charge higher fees and merchants will pass-through the increase in fees into higher retail prices for consumers. Secondly price coherence eliminates the possibility for platforms to compete on the fees, for example. Boik and Kurts (2016) analyse a model in which a monopolistic merchant can sell his products via two differentiated platforms, who may impose best price clauses. They show that such clauses increase both retail prices and platform fees. Moreover, they look at market entry and deduce that entry increases with higher platforms profits, whereas it decreases for low quality platforms. Nevertheless, they do not model heterogeneity on the merchants' side, as they only have one hotel, nor they model competition between direct sales and platform sales.

On the other side, some scholars found that price parity clauses do not always reduce social welfare. Johansen and Vergè (2016) model a vertical relationship where two differentiated platforms compete to offer a selling channel to differentiated merchants competing in the downstream market. They show that under pricy parity, since multi-homing is costly, merchants tend to single-home, and therefore platform competition becomes fiercer and leads on one side to rebates for consumers, and on the other higher fees for hotels. Nevertheless, Johansen and Vergè find that to induce a price reduction following a prohibition of price parity clauses, a platform has to offer a fee which is drastically lower than the one proposed by rival platforms, hence deducing that merchants' prices and consumer surplus remain the same with direct and intermediated sales.

Justin Johnson compares the wholesale and the agency models. He shows that most-favored nation clauses (MFNs)[7] may raise industry profits but lower consumer surplus.

[7]Most favoured nation (MFN) clauses are agreements according to which the supplier agrees to offer the distributor a price or rate no higher than the lowest offered to other clients. In the hotel online booking sector, an MFN clause obliges the hotel to always give the platform with which it has signed the clause the best price for hotel online bookings, the highest number of available rooms and the most favourable conditions for booking and cancellation.

However, when profit-sharing rather than revenue-sharing contracts are used, MFNs may have a procompetitive effect by encouraging retailer entry. Edelman and Wright (2015) study the impact of price coherence on buyers' and sellers' choice to access a platform (i.e., consumers pay the same price whether or not they buy the product sold by the merchant through the platform). They find that platforms have incentives to restrict sellers from charging more for intermediated transactions. This restriction increases retail prices and causes an overconsumption of intermediaries' services, over-investment in benefits to buyers, and a reduction in consumer surplus and sometimes welfare. Yet, there is no heterogeneity on the merchants' side. Another work by these authors (2015) explores several examples of platforms requiring sellers to offer their lowest prices through the platform. This restriction poses an harm to competition because it forbids sellers to offer lower prices for direct sales or through competing platforms. Nonetheless, it prevents "showrooming" on the platforms and excessive surcharging of platforms' services.

Moreover, our article is related to the literature on selling modes. This strand of the literature examines merchants' incentives to market a product or a service through a platform and whether the presence of a platform increases efficiency.

In Baye and Morgan (2001) the value for merchants of subscribing to the intermediary stems from the ability to capture distant consumers and the possibility to post a price. Galeotti and Gonzales (2008) study a two-sided market where a monopolistic platform attracts differentiated sellers and buyers. In their model, the platform is able to fully extract the rents generated on the retail market, unless consumers have the outside option of buying the product outside the platform. They show that the presence of the platform does not add any additional distortion over those arising from the market power of sellers. In our model, by contrast, consumers are able to compare the price posted on the platform and on the merchant's selling channel, and decide whether or not to make a transaction through the platform after observing the prices. Furthermore, we assume vertical differentiation between the platform and merchants. It follows that the presence of the platform can even reduce distortions caused by seller market power.

Hagiu and Wright (2014) study the choice and the trade-offs faced by an intermediary between operating as a marketplace, as a reseller, or as a hybrid between the two, having

some products offered under each of the two different modes. Nevertheless, they do not model competition between the marketplace and the reseller for selling services, as we do in our model. Einav et al. (2016) review various examples of peer-to-peer markets and build a model to show that peer-to-peer platforms bear lower fixed costs, are more flexible, and emerge in markets with high volatility of demand.

Moreover, our paper is related to the literature on bypass and platform competition. Bourreau and Verdier (2010) examine the incentives of a merchant to bypass a payment platform by issuing private cards, and find that the payment platform can only deter entry by lowering the level of the interchange fee. However, in their model, merchants' participation to the platform is fixed and they do not study the platform's incentives to impose restrictions on merchants.

The empirical literature on the topic on whether such restrictive clauses reduce social welfare and how they affect market outcomes is scarse. There is a strand on literature on online/offline competition. Jin et al. (2007) examine the trade-off of selling sportcards online vs. offline. Goolsbee (2001) estimates the relative price sensitivity of individuals' choice of whether to buy computers online or in retail stores. Hu and Smith (2013) look at the e-book industry and study whether the digitalization of books cannibalizes the sales of physical books. Nevertheless, in our model, when merchants decide to sell directly their product, they may choose to sell it either online or offline. Therefore, in our paper the nature of competition does not rely on the offline characteristics of the selling channel. Lastly, Hunold et al. (2016) empirically investigate the effects of the abolition of Booking.com narrow price parity clause in Germany on market outcomes. They find that after the abolition, hotels were more frequently able to establish the direct channel as the cheapest channel. Also, they do not find evidence for inflated transaction fees charges by the online travel agents following the imposition of price parity clauses.

# 3 The model

We build a model to study whether consumers benefit from competition between merchants and a platform when they offer different qualities of service, and when merchants decide on

how many selling channels to offer to consumers.

**Merchants** A continuum of monopolistic merchants offer different versions of the same service to consumers through different selling channels, i.e, either a platform or directly.[8] For example, a consumer can book an hotel room either online through a booking platform or directly from a merchant. The quality of service depends on the selling channel.[9] In some markets, consumers may perceive the quality of the selling service offered by the platform as higher (e.g., good delivery service, information). In other markets, consumers prefer to trust merchants. Each merchant decides on the price of the service and on how many selling channels to offer to consumers.

The quality $j$ of the service can be low via direct sale ($j = S$) or high via the intermediated sale ($j = I$)[10]. The merchant's profit depends on how many qualities he sells to consumers. We denote it by $\pi_j$ if only quality $j$ is available through either the merchant or the intermediary, $\pi^{pd}$ if two qualities are available and price discrimination is allowed and $\pi^{npd}$ if two qualities are available and price discrimination is not allowed. The retail price of a service of quality $j$ is $p_j$. The total net cost of selling quality $j$ is $c_j$.

Merchants differ across their total net selling cost. For all $j = I, S$, the benefit of selling quality $j$ is $\sigma^j(b_S)$, where $b_S$ is drawn from the continuously differentiable distribution $H_S$ on $\left[0, \overline{b_S}\right]$ with a density of $h_S$. When a merchant sells directly to consumers, he incurs a marginal cost $d$. When he sells through the platform, he pays a fee $f^S$ to the intermediary but incurs no marginal cost. Therefore, we have $c_S = d - \sigma^S(b_S)$ and $c_I = f_S - \sigma^I(b_S)$. For $(j) \in (S, I)$, the difference $c_S - c_I$ represents the degree of differentiation between a merchant and the platform.

[8] In our model, we choose to focus on competition between merchants and a platform and therefore, we abstract from modelling strategic interactions between merchants.

[9] We do not study the case in which the two qualities are sold through the same selling channel.

[10] If the platform delivers a lower quality of service to consumers, merchants always accept the platform's service under multi-homing. Since consumer demand for the low quality product is higher under single-homing than under multi-homing, the platform always prefers to impose single-homing to merchants. Furthermore, if the platform forbids merchants to price discriminate across selling channels, consumers never buy through the platform. Indeed, they can obtain a better quality without paying a fee to the platform. Therefore, the platform always allows merchants to price discriminate.

**Buyers** Each merchant faces a continuum of buyers. A buyer gives a value $y$ to the basic version of the service that is drawn independently from $b_S$ on the support $[0, v]$ from the continuously differentiable distribution $F$ with a density of $f$. The survival function is $D(.) = 1 - F(.)$. The net utility of buying a service of quality $j$ for a consumer of type $y$ is

$$u_j(y) = \lambda^j(y) - p_j - f_B, \tag{1}$$

where $\lambda^j(y)$ is the fixed utility of consuming the service, $p_j$ the retail price paid to the merchant, and $f_B$ the transaction fee paid for buying through a given selling channel.[11] If he does not buy, the consumer's utility is equal to zero. We assume that a consumer pays no additional transaction fee when he buys directly from the merchant, that is, we have $f_B = 0$, and that he pays a transaction fee to the platform.[12] The functions $\lambda_j$ and $\lambda^I - \lambda^S$ are continuous and strictly increasing. The difference $\lambda^I - \lambda^S$ represents the degree of differentiation between selling channel of high and low quality.

The consumer's choice depends on how many qualities are available. When only one quality is available, a consumer chooses between buying the available quality and not consuming. We denote by $y_j$ the indifferent consumer between buying and not buying if only quality $j$ is available through a given selling channel. If two qualities are available, a consumer chooses between buying either the high quality, the low quality and not consuming. We denote by $y_H^2$ the consumer who is indifferent between buying the high and the low quality and by $y_L^2$ the consumer who is indifferent between buying the low quality version and not consuming.

**The platform** The platform is a marketplace that acts as intermediary between consumers and merchants.[13] Consumers and merchants pay respectively the fees $f_B$ and $f_S$ to use the platform. The platform's total intermediation cost is $c_P$ and the total transaction fee is $f^T$. The platform can impose restrictions to sellers. The first is the impossibility to multi-home. This means that if a merchant decides to sell through the platform, it cannot sell directly to consumers. The second is the impossibility to price discriminate according to the selling

[11] The specification of the fixed utility follows McAfee (2007).

[12] This implies that a merchant bundles the selling service to the purchase of the product.

[13] Therefore, we do not analyze the case in which the platform is a reseller. The platform does not choose the price of the service.

channel. In that case, the seller is constrained to choose the same retail price for all selling channels. The platform's profit is $\pi^i$ for $i \in \{mh, sh, npd\}$, where $mh$ denotes the multi-homing case, $sh$ the single-homing case and $npd$ the case in which price discrimination is not allowed.

**An example:**

Throughout the paper, we develop an example in which consumers' and merchants' valuations for quality are linear, respectively. We assume that $\sigma^j(b_S) = \sigma^j b_S$ and $\lambda^j(y) = \lambda^j y$ for $j = S, I$. Furthermore, we assume that $b_S$ is uniformly distributed on $[0, 1]$ and that $y$ is uniformly distributed on $[0, v]$. We also assume that $\lambda^S v \geq d$. This assumption ensures that there is a positive demand for the merchant's service.

**Timing of the game:**

The timing of the game is as follows:

1. The platform sets the consumer fee $f_B$ and the merchant fee $f_S$ and decides whether or not to impose restrictions to merchants.

2. Merchants learn their transaction benefit $b_S$. They decide on how many selling channels to offer to consumers and on the price of the service.

3. Consumers learn their value for the product $y$, decide whether or not to consume and which version to buy.

# 4 The number of selling channels

In this section, we study whether a merchant prefers to sell through one or two selling channels when he is able to offer different qualities to consumers.

## 4.1 The merchant's profit of selling one quality

If a merchant sells quality $j$, he makes profit

$$\pi_j = D(y_j)(p_j - c_j),$$

where $y_j$ is the consumer who is indifferent between consuming or not the product. From (1), since the reservation utility of the consumer is zero if he does not consume, the indifferent consumer is given by $u_j(y_j) = 0$, that is, we have $\lambda^j(y_j) = p_j + f_B$. Therefore, the merchant's profit of selling quality $j$ can be rewritten as

$$\pi_j = D(y_j)(\lambda^j(y_j) - f_B - c_j). \tag{2}$$

The choice of the profit-maximizing price is therefore equivalent to the choice of the indifferent consumer. As in McAfee (2007), we denote the merchant's marginal revenue of selling quality $j$ by

$$MR_j(p) = p - (\lambda^j)'((\lambda^j)^{-1}(p))D((\lambda^j)^{-1}(p))/f((\lambda^j)^{-1}(p)),$$

and we assume that $MR_j$ is strictly increasing in $p$. Taking the derivative of (2) with respect to $y_j$ and replacing for $MR_j(\lambda^j(\widetilde{y}_j))$ into $(\pi_j)'$, we find that

$$(\pi_j)'(y_j) = -f(y_j)(MR_j(\lambda^j(y_j)) - f_B - c_j). \tag{3}$$

We denote by $\widetilde{y}_j$ the indifferent consumer at the profit-maximizing price. Replacing for $y_j = \widetilde{y}_j$ into (3), since $(\pi_j)'(\widetilde{y}_j) = 0$, we have

$$MR_j(\lambda^j(\widetilde{y}_j)) = f_B + c_j.$$

The merchant chooses his price such that his marginal revenue equals his marginal cost. Since $MR_j$ and $\lambda^j$ are strictly increasing in $p$, $g_j(.) = MR_j(\lambda_j(.))$ is strictly increasing in $p$ and admits as a reciprocal function $g_j^{-1}$. At the profit-maximizing price, the indifferent consumer is given by

$$\widetilde{y}_j = g_j^{-1}(f_B + c_j). \tag{4}$$

Since a merchant passes through its marginal cost to consumers, the indifferent consumer depends on the total cost of making a transaction for the joint agent (consumer+merchant). The merchant also internalizes the transaction fee paid by the consumer in its pricing decision. The literature on platform markets refers to this behavior as merchant internalization

(Wright, 2012).

At the equilibrium of stage 3, from (2), if the merchant sells only quality $j$, he makes profit

$$\pi_j(\widetilde{y}_j) = D(\widetilde{y}_j)(\lambda^j - g_j)(\widetilde{y}_j). \tag{5}$$

The merchant's profit is a function of $\widetilde{y}_j$ or $f_B + c_j$. Since $g_j$ is increasing, we have the standard result that the monopoly's profit $\pi_j$ is decreasing with the total transaction cost incurred by the consumer and the merchant $f_B + c_j$.

## 4.2 The merchant's profit if price discrimination is not allowed

If price discrimination is not allowed, we denote the common price for the two versions of the product by $p$. Assume that both selling channels, for the high and the low quality, are available. Lemma 1 gives the merchant's profit $\pi^{npd}$ under no price discrimination according to the transaction fees paid for selling services.

**Lemma 1** *Assume that price discrimination is not allowed and that both selling channels are available. If* $(\lambda^S - \lambda^I)^{-1}(f_B) \geq \widetilde{y}_S$, *the merchant makes profit*

$$\pi^{npd}(\widetilde{y}_S) = \pi_L(\widetilde{y}_L) + D((\lambda^I - \lambda^S)^{-1}(f_B)(c_L - c_H). \tag{6}$$

*If* $(\lambda^I - \lambda^S)^{-1}((f_B) < \widetilde{y}_L$, *all consumers prefer the selling channel of high quality and the merchant makes profit* $\pi_H(\widetilde{y}_H)$.

**Proof.** See Appendix A ■

If both selling channels are available and price discrimination is not allowed, the consumer's choice of a selling channel only depends on the transaction fee paid for the selling service. If the difference between the fees paid for selling services is very low, consumers always prefer to buy through the selling channel of high quality.

If the difference between the fees paid for selling services is high, consumers who value the selling channel of high quality are ready to pay a higher transaction fee for it, whereas other consumers prefer the selling channel of low quality at a lower fee. Since the merchant is forbidden to price discriminate according to the selling channel, he passes through his

marginal costs to consumers at the same rate through the retail price, whether consumers buy the high or the low quality. Therefore, he makes a profit that equals the profit of selling through the selling channel of low quality and an additional profit (if $c_S - c_I > 0$) that depends on the difference between its marginal costs in both cases. Remark that the merchant internalizes the cost incurred by the consumer for buying through the selling channel of low quality in its pricing decision. However, he is unable to internalize the consumer's cost of buying through the selling channel of high quality.

## 4.3 The profit of selling two qualities under price discrimination

If price discrimination is allowed, the merchant sets a different price for the two versions of the product sold through each selling channel. He sells a service through his own selling channel $S$ at a price $p_S$ and via the platform $I$ at a price $p_I$. We denote by

$$g_2(.) \equiv MR_I(\lambda^I(.)) - MR_S(\lambda^S(.))$$

and we assume that $g_2$ is strictly increasing. Lemma 2 gives the merchant's profit of selling through two selling channels of different qualities $\pi^{pd}$ if price discrimination is allowed.

**Lemma 2** *Assume that price discrimination is allowed. If $\widetilde{y}_I^2 \geq \widetilde{y}_S$, the merchant's profit of selling both qualities is given by*

$$\pi^{pd} = \pi_I(\widetilde{y}_I^2) - \pi_S(\widetilde{y}_I^2) + \pi_S(\widetilde{y}_S), \tag{7}$$

*where*

$$\widetilde{y}_H^2 = g_2^{-1}(f_B + c_I - c_S). \tag{8}$$

**Proof.** See Appendix B ■

The merchant's profit of selling both qualities is equal to the sum of the monopoly profit of selling the low quality to all consumers and the additional profit (loss) that the merchant makes of selling the high quality to the consumers who buy it. Unlike in the case in which price discrimination is forbidden, the merchant is able to internalize the consumer's costs

of buying through a given selling channel both for the high and the low quality. Also, the merchant passes through its transaction costs to consumers through the retail price. Since the merchant is able to price discriminate on the retail market, the degree of pass-through is different for consumers who buy through the selling channel of high and low quality, respectively.

In Appendix A, we compare consumer demand for the high and the low quality, respectively, according to the number of selling channels offered to consumers when price discrimination is allowed.

## 4.4 The merchant's choice of the quality of service and the number of selling channels

We analyze a merchant's decision to offer multiple qualities of selling services according to the transaction fees charged for the selling services and the degree of differentiation between selling channels. For this purpose, we denote by $S_H^l$ (resp., $S_L^l$) the set of merchants that sell through selling the high quality $H$ (resp., $L$) when $l$ selling modes are available.

### 4.4.1 Case 1: price discrimination and multi-homing are allowed

In Lemma 4, we analyze whether the merchant offers both qualities of selling services if price discrimination is allowed.

**Lemma 3** *Assume that price discrimination and multi-homing are allowed. All merchants only sell the product through their own channel, that is, we have* $S_S^2 = \left[0, \overline{b_S}\right]$. *The set of merchants that offer the intermediated selling channel is given by*

$$S_I^2 = \left\{ b_S \in \left[0, \overline{b_S}\right], (\lambda^I - \lambda^S)((g_2)^{-1}(z)) \geq z \text{ and } z = c_S - c_I - f_B \right\}. \tag{9}$$

**Proof.** See Appendix C. ■

A merchant's decision to offer the service through two different selling channels depends on how much surplus he can extract from consumers by offering an additional selling channel

and on the marginal costs incurred respectively in each selling channel.[14]

When a monopoly sells only via the platform at the monopoly price to $D(\widetilde{y}_I^1)$ consumers, it can increase its profit by selling the low quality as well. There is a market expansion effect that increases the merchant's profit by $\pi_S(\widetilde{y}_S) - \pi_S(\widetilde{y}_I)$ (i.e., the profit of selling via his own channel to all consumers plus the loss of not selling via his own channel to $D(\widetilde{y}_I)$ consumers). The merchant can further increase its profit by adjusting the price of the product sold via the platform. Therefore, a merchant always makes more profit by offering both qualities than by offering only the high quality.

When a monopoly sells only the low quality at the monopoly price to all consumers, it does not necessarily increase its profit by offering the high quality as well. There is no market expansion effect in this case, because the price of the low quality remains unchanged. Hence, whether or not the monopoly offers an additional quality depends on the additional margin that it earns from consumers who buy the high quality. The additional surplus extracted from consumers depends on the degree of differentiation between both selling channels on the consumers' side (i.e., the function $(\lambda_H - \lambda_L)(.)$) and on difference in the fees paid by consumers for buying through a specific selling channel. The difference of marginal costs depends on the degree of differentiation between both selling channels for the merchant (i.e., the function $(\sigma^I - \sigma^S)(.)$).

### 4.4.2 Case 2: multi-homing is not allowed

In Lemma 5, we analyze a merchant's incentives to offer the selling channel of high quality rather than the low quality if multi-homing is not allowed.

**Lemma 4** *Assume that multi-homing is not allowed. The set of merchants selling through the intermediated selling channel is given by*

$$S_I^1 = \left\{ b_S \in \left[0, \overline{b_S}\right], D(\widetilde{y}_I)(\lambda^I - g_I)(\widetilde{y}_I) \geq D(\widetilde{y}_S)(\lambda^S - g_S)(\widetilde{y}_S) \right\}, \tag{10}$$

*where* $\widetilde{y}_I = g_I^{-1}((f_B + c_I)$ *and* $\widetilde{y}_S = g_S^{-1}(c_S)$*, whereas the set of merchants offering the direct*

[14] Anderson and Dana (2008) provide general conditions under which price discrimination is a profitable strategy.

*selling channel is given by*

$$S_S^1 = \left\{ b_S \in \left[0, \overline{b_S}\right], D(\widetilde{y}_I)(\lambda^I - g_I)(\widetilde{y}_I) \leq D(\widetilde{y}_S)(\lambda^S - g_S)(\widetilde{y}_S) \right\}.$$

**Proof.** See Appendix C ■

If multi-homing is not allowed, the merchant is constrained to trade off between offering the high and the low quality of the selling service, because we assumed that he is unable to offer both when he refuses the platform's service. His incentives to offer the high quality depend on how much surplus it can extract from consumers through the retail price. The higher the quality of the selling service, the higher the possibility to extract surplus from consumers. Also, the merchant's incentives to offer a selling service of high quality decrease with the total transaction cost ($f_B + c_I$) incurred by consumers and merchants (resp., increase with $c_S$). Indeed, we showed that the merchant's profit decreases with its marginal cost.

Note that in our model, the merchant cannot use the price of the selling service to extract additional surplus from consumers. This is because the selling service is either bundled with the product when the merchant sells through its proprietary selling channel or outsourced to the platform that controls its own price.

### 4.4.3 Case 3: Price discrimination is not allowed

In Lemma 6, we analyze whether the merchant offers both selling services (direct and intermediated) if price discrimination is not allowed, whereas multi-homing is allowed.

**Lemma 5** *Assume that price discrimination is not allowed, whereas multi-homing is allowed.*
*If* $(\lambda^I - \lambda^S)^{-1}(f_B) < \widetilde{y}_S$*, merchants offer either both selling channels (but consumers buy only through the platform) or only the direct channel. The set of merchants offering the intermediated selling channel(resp., direct) is given by* $S_I^1$ *(resp.,* $S_S^1$*).*
*If* $(\lambda^I - \lambda^S)^{-1}((f_B) \geq \widetilde{y}_S$*, merchants offer either both selling channels or through the direct selling channel. The set of merchants selling through the intermediated selling channelis given by* $S_I^2 = \left\{ b_S \in \left[0, \overline{b_S}\right], c_S \geq c_I \right\}$*, whereas the set of merchants selling through the direct selling channel is given by* $S_S^2 = \left\{ b_S \in \left[0, \overline{b_S}\right], c_S < c_I \right\}$.

**Proof.** See Appendix D ■

The merchant's incentives to offer both selling channels when price discrimination is not allowed depends both on the difference in the transaction fees for selling services and the merchant's marginal cost.

If the difference in the transaction fees for selling services is very low, all consumers prefer to buy through the platform selling channel. However, depending on the cost of this selling mode, the merchant may prefer to offer the direct selling channel. Therefore, the merchant trades off between offering only the direct selling channel and offering both, knowing that consumers will only purchase through the selling channel of high quality.

If the difference in the transaction fees for selling services is higher, some consumers prefer to buy through the selling channel of high quality and other through the selling channel of low quality. However, if the cost of selling the high quality is higher than the cost of selling the low one, the merchant never offers the high quality, because he is constrained to set the same retail price, whether his marginal cost is high or low. Therefore, he offers only the selling channel of low quality. If the merchant can save some costs by selling through the selling channel of high quality, he offers both selling channels.

Remark that the situation is very different from the case in which price discrimination is allowed. Indeed, if price discrimination is impossible, the merchant is unable to internalize the consumer's cost of buying through the selling channel of high quality when both qualities are available. Therefore, his decision to sell through both selling channels only depends on his own transaction cost when the difference between consumers' fees is high. ⊂

## 4.5 The linear example

We analyze the merchants' decision to offer the platform's service and the platform's incentives to impose restrictions to sellers with a linear example.

### 4.5.1 A merchant's decision to offer the platform's service

**Case 1: multi-homing is allowed** In our linear example, we find that $S_I^2 = [0, 1]$.

**Case 2: multi-homing is not allowed** In Appendix C (i), we analyze our linear example in two different cases. The first case (case a) corresponds to a situation where the platform does not bring any cost reduction to merchants ($\sigma^I = 0$), whereas a proprietary solution brings high value to merchants. The equation $\pi^I(\widetilde{y}^I) - \pi^S(\widetilde{y}^S) = 0$ admits two solutions and is concave. We denote the highest of these two solutions by $b_S^a$, and we have $(S_I^1)^a = [0, \min(\max(b_S^a, 0), 1)]$, where

$$b_S^a = \frac{1}{\sigma^S}\left((d - \lambda^S v) + \sqrt{\lambda^S/\lambda^I}(\lambda^I v - f_T)\right).$$

The second case (case b) corresponds to a situation where the platform reduces merchants' transaction costs compared to a proprietary selling channel ($\sigma^S = 0$). In case b, we denote the highest of the two solutions of $\pi^I(\widetilde{y}^I) - \pi^S(\widetilde{y}^S) = 0$ by $b_S^b$. We have $(S_I^1)^b = \left[\max(\min(b_S^b, 1), 0), 1\right]$, where

$$b_S^b = \frac{1}{\sigma^I}\left((f_T - \lambda^I v) + \sqrt{\lambda^I/\lambda^S}(\lambda^S v - d)\right).$$

The higher the price charged by the platform and the lower the benefits of the platform's service for merchants, the lower merchants' acceptance of the platform's service. Compared to the multi-homing case, merchant acceptance of the platform's service is reduced under single-homing.

**Case 3: price discrimination is not allowed** In our linear example, the merchant offers the platform's service if and only if $b_S \geq b_S^{npd}$, where $b_S^{npd} \equiv (f_S - d)/(\sigma^I - \sigma^S)$.

## 4.6 The platform's fees if there are no restrictions

If the platform does set any restrictive rules on merchants' activities, the set of merchants that accept the platform's service is $S_I^2$. Since the platform competes with merchants and offers the high quality of service, the demand of consumers who buy through the platform at a merchant of type $b_S$ is $D(\widetilde{y}_I^2)$, provided that $D(\widetilde{y}_I^2) \in [0, 1]$. Therefore, the volume of

transactions is given by

$$\int_{S_I^2} D(\widetilde{y}_I^2) h_S(b_S) db_S,$$

and the platform's profit is

$$\pi^{mh} = (f_B + f_S - c_P) \int_{S_I^2} D(\widetilde{y}_I^2) h_S(b_S) db_S.$$

The platform chooses the fees $f_B$ and $f_S$ that maximize its profit. From (**??**) and (**??**), the platform's profit depends on the total transaction fee $(f_B + f_S)$. We denote the equilibrium total transaction fee under multi-homing by $f^{mh}$ and we assume that there is an interior solution to the maximization of platform's profit.[15] If the platform does not set any restrictive rules on merchants' activities, it makes profit

$$\pi^{mh} = (f^{mh} - c_P) \int_{S_I^2} D(g_2^{-1}(f^{mh} + (\sigma^S - \sigma^I)(b_S) - d)) h_S(b_S) db_S.$$

**An example** In Appendix C(ii), we analyze our linear example. We find that the platform's maximum profit under multi-homing is

$$\pi^{mh} = \frac{1}{32v(\lambda^I - \lambda^S)} (2v(\lambda^I - \lambda^S) + 2d - 2c_P + (\sigma^I - \sigma^S))^2.$$

## 4.7 The platform's fees if multi-homing is not allowed

If the platform imposes single-homing to merchants, it obtains the exclusivity of distribution to consumers when merchants sell through its selling channel. The set of merchants that accepts the platform's service is $S_I^1$. Since the platform does not compete with merchants, the demand of consumers who buy the service through the platform at a merchant of type $b_S$ is $D(\widetilde{y}^I)$ provided that $D(\widetilde{y}^I) \in [0, 1]$. Therefore, the volume of transactions is given by

$$\int_{S_I^1} D(\widetilde{y}^I) h_S(b_S) db_S$$

[15] Remark that the platform can choose a price $f^T$ such that some merchants do not offer the high quality.

and the platform's profit is

$$\pi^{sh} = (f_B + f_S - c_P) \int_{S_I^1} D(\widetilde{y}^I) h_S(b_S) db_S.$$

From (**??**) and (**??**), the platform's profit under single-homing depends on the total transaction fee $f_B + f_S = f^T$. We denote the equilibrium total transaction fee under single-homing by $f^{sh}$ if there is an interior solution. When the platform imposes single-homing to merchants, it makes profit

$$\pi^{sh} = (f^{sh} - c_P) \int_{S_I^1} D(g_I^{-1}(f^{sh} - \sigma^I(b_S))) h_S(b_S) db_S.$$

**An example:**

In our linear example, it is possible to compute analytically the optimal total transaction fees under single-homing in cases (a) and (b). However, the equations are too complex to be reported. A numerical example can be found in Appendix D.

## 4.8 The platform's fees if price discrimination is not allowed

If price discrimination is not allowed, consumer demand for the platform's service is

$$D((\lambda^I - \lambda^S)^{-1}(f_B),$$

and the total volume of transaction is given by

$$D((\lambda^I - \lambda^S)^{-1}(f_B)(1 - H_S((f_S - d)/(\sigma^I - \sigma^S))).$$

We denote by $D_B(f_B) = D((\lambda^I - \lambda^S)^{-1}(f_B)$ the demand of consumers and by $D_S(f_S) = 1 - H_S((f_S - d)/(\sigma^I - \sigma^S))$ the demand of merchants. The platform makes profit

$$\pi^{npd} = D_B(f_B) D_S(f_S)(f_B + f_S - c_P).$$

The profit-maximizing transaction fees depend on the elasticity of consumer demand and merchant acceptance, respectively. Indeed, as in the model of Rochet and Tirole (2003), the

total price is given by

$$\frac{f_B + f_S - c_P}{f_B} = \frac{1}{\varepsilon_B},$$

and

$$\frac{f_B}{f_S} = \frac{\varepsilon_B}{\varepsilon_S},$$

where $\varepsilon_B = -(f_B/D_B)(dD_B/df_B)$ and $\varepsilon_S = -(f_S/D_S)dD_S/df_S$. Therefore, when price discrimination is not allowed, the platform can use the price structure to increase its profit. It can even subsidize the demand on one side of the market to increase it on the other side. On the contrary, in the multi-homing case with price discrimination, both consumer demand and merchants' acceptance depend on the total transaction fee.

## 4.9 Consumer and merchant surplus

In this section, we analyze consumer and consumer surplus when the platform offers the high quality of service. We denote by $CS^j$ and $MS^j$ consumer and merchant surplus, respectively, for $j \in \{mh, sh, npd\}$. Total User Surplus is given by $TUS = CS^j + MS^j$. Social welfare is defined as the sum of total user surplus and the platform's profit, that is, we have

$$W^j = TUS^j + \pi^j.$$

### 4.9.1 Consumer and merchant surplus when multi-homing is allowed

Firstly, we look at consumer surplus when multi-homing is allowed. For merchants that accept the platform's service (i.e., with $b_S \in S_I^2$), consumers such that $y$ belongs to $[y_H^2, v]$ buy through the platform, whereas consumers such that $y$ belongs to $[y_S^2, y_I^2]$ buy from the merchant's selling channel. For merchants that refuse the platform's service (i.e., with $b_S \notin S_I^2$), consumers such that $y$ belongs to $\left[y_L^S, v\right]$ buy from the merchant's selling channel. Since $\lambda^S(y_S^2) = p^S$, $(\lambda^I - \lambda^S)(y_I^2) + \lambda^S(y_S^2) = p^I + f_B$, $\lambda^S(y^S) = p^S$ and $y^S = y_S^2$, consumer surplus under multi-homing can be rewritten as follows

$$
\begin{aligned}
CS^{mh} &= \int_0^{\overline{b_S}} \int_{y_S^2}^{v} (\lambda^S(y) - \lambda^S(y_S^2)) f(y) h_S(b_S) dy db_S \\
&\quad + \int_{b_S \in S_I^2} (\int_{y_I^2}^{v} (\lambda^I(y) - \lambda^I(y_I^2) + \lambda^S(y_I^2) - \lambda^S(y)) f(y) h_S(b_S) dy db_S.
\end{aligned}
$$

This equation can be interpreted in a simple way. All consumers who buy the service (either through the platform or a merchant) obtain at least the same surplus as when a merchant sells only the low quality. For consumers who are able to buy the high quality through the platform when the merchant accepts it, that is, such that $y$ belongs to $[y_I^2, v]$ and $b_S$ belongs to $S_I^2$, there is an additional surplus that is equal to the difference of utility between the high and the low quality. Therefore, consumers always benefit from multi-homing with both qualities compared to the case in which merchants only sell the low quality. The additional surplus that consumers can obtain under multi-homing depends on merchants' acceptance of the platform's service under multi-homing and on the total cost of buying the service that includes the retail price and the transaction fee for buying through the platform.

When the platform offers a high quality of service, merchant surplus under multi-homing is given by

$$
MS^{mh} = \int_{b_S \in S_I^2} \pi^{pd}(\widetilde{y}_I^2, \widetilde{y}_S^2) db_S + \int_{b_S \notin S_I^2} \pi^S(\widetilde{y}^S) db_S.
$$

**See Appendix C(iii) for the linear example.**

### 4.9.2 Consumer and merchant surplus under single-homing

If the platform imposes single-homing to merchants, consumers buy either the high quality through the platform if merchants accept its service or the low quality through the merchant's selling channel otherwise. Since $\lambda_H^I(y_H^I) = p_H^I + f_B$ and $\lambda_L^S(y_L^S) = p_L^S + (f_S)^B$, consumer surplus can be written as

$$
\begin{aligned}
CS^{sh} &= \int_{b_S \in S_I^1} (\int_{y^I}^{v} (\lambda^I(y) - \lambda^I(y^I)) f(y) h_S(b_S) dy db_S \\
&\quad + \int_{b_S \notin S_I^1} (\int_{y^S}^{v} (\lambda^S(y) - \lambda^S(y^S)) f(y) h_S(b_S) dy db_S.
\end{aligned}
$$

Consumer surplus under single-homing depends on merchants' acceptance of the platform's service under single-homing and on the price paid to the merchant and the platform for making a transaction.

Merchant surplus under single-homing is given by

$$MS^{sh} = \int_{b_S \in S_I^1} \pi^I(\widetilde{y}^I) db_S + \int_{b_S \notin S_I^1} \pi^S(\widetilde{y}^S) db_S.$$

**See Appendix C(iv) for the linear example.**

### 4.9.3 Consumer and merchant surplus under no price discrimination

If the platform imposes no price discrimination to merchants, consumers buy either the high quality through the platform if merchants accept its service or the low quality through the merchant's selling channel otherwise, and we have

$$\begin{aligned} CS^{npd} &= \int_{b_S \in S_I^{npd}} (\int_{\widehat{y_I}}^{v} (\lambda^I(y) - p^* - f_B) f(y) h_S(b_S) dy db_S \\ &\quad + \int_{b_S \in S_I^{npd}} (\int_{\widehat{y_S}}^{\widehat{y_I}} (\lambda^S(y) - p^*) f(y) h_S(b_S) dy db_S \\ &\quad + \int_{b_S \notin S_I^{npd}} (\int_{\widehat{y_S}}^{v} (\lambda^S(y) - p^*) f(y) h_S(b_S) dy db_S, \end{aligned}$$

where $p^*$ denotes the retail price chosen by the merchant. Merchant surplus under no price discrimination is given by

$$MS^{npd} = \int_{b_S \in S_I^{npd}} \pi^{npd}(\widetilde{y}^S) db_S + \int_{b_S \notin S_I^{npd}} \pi^S(\widetilde{y}^S) db_S.$$

**See Appendix C(v) for the linear example.**

## 4.10 Is the platform's strategy socially optimal?

### 4.10.1 Comparison of the platform's strategy and the socially optimal strategy

We denote the platform' strategy by $i_0 \in \{mh, sh, npd\}$ . For all $(i_1, i_2) \in (\{mh, sh, npd\} \setminus \{i_0\})^2$ and $i_0 \neq i_1 \neq i_2$, the strategy $i_0$ maximizes the platform's profit if and only if

$$\pi^{i_0} \geq \max(\pi^{i_1}, \pi^{i_2}),$$

and it maximizes social welfare if and only if

$$W^{i_0} \geq \max(W^{i_1}, W^{i_2}).$$

We analyze the impact of imposing single-homing on consumer and merchant surplus. First of all, for a given level of transaction fees, the imposition of single-homing decreases merchant surplus because it constrains the merchant's ability to sell different versions of the good. As a matter of fact, merchants are potentially able to enlarge their costumer base under multi-homing. However, in some cases and for some levels of parameters, the transaction fees chosen by the platform under single-homing can be lower than the transaction fees under multi-homing. Therefore, merchant surplus does not systematically decrease under single-homing.

For consumers, the effect of the imposition of single-homing on their surplus is ambiguous as it depends on three effects. Firstly, more consumers may be able to consume the higher quality, and there may be less consumers purchasing the low quality. Secondly, the transaction fees may decrease in some cases under multi-homing. Third, as already mentioned, merchant's acceptance always increases under multi-homing and consumers have a larger choice set under multi-homing.

### 4.10.2 The impact of the degree of differentiation between selling modes on the platform's strategy

We are now able to analyze how the degree of differentiation on each side of the market impacts the platform's incentives to impose single-homing or price parity. The platform's

incentives to impose a restriction to merchants depends on the elasticity of consumer demand or merchant demand to the degree of differentiation, respectively. To see why, consider the linear example. All merchants accept the platform's service under multi-homing, whereas, under single-homing, merchants' acceptance is elastic to the degree of differentiation both on the consumers' side and on the merchants' side.

We denote consumer demand at the equilibrium of stage 1 by $D^i$ for $i \in \{mh, sh, npd\}$. We have

$$D^{mh} = \frac{1}{2} - \frac{b_S \sigma^S - d + f^{mh}}{2v(\lambda^I - \lambda^S)},$$

and

$$D^{sh} = \frac{v\lambda^I - f^{sh}}{2v\lambda^I},$$

and

$$D^{npd} = 1 - \frac{(f_B)^{npd}}{v(\lambda^I - \lambda^S)}.$$

Therefore, for given platform fees, the higher the degree of differentiation between the platform and the merchant's service on the consumers' side, the higher consumer demand under multi-homing and no price discrimination. The higher the value added by the platform on the consumer's side, the higher consumer demand under single-homing. Also, a higher value of the quality of service for direct sales on the merchant side reduces the demand for the platform's service under single-homing.

To understand how a quality (differentiation) parameter $\mu \in \left\{\lambda^I; \lambda^S; \lambda^I - \lambda^S; \sigma^S\right\}$ impacts the platform's incentives to impose single-homing or multi-homing, we take the derivative of $\pi^{sh} - \pi^{mh}$ with respect to $\mu$ when $\sigma^I = 0$. From the envelop theorem, we have that

$$\begin{aligned} \frac{d(\pi^{sh} - \pi^{mh})}{d\mu} &= (f_S - c_P)\left(\int_{b_S^b}^1 \frac{\partial D^{sh}}{\partial \mu} h_S(b_S) db_S - \frac{\partial b_S^b}{\partial \mu} D^{sh}(b_S^b) h_S(b_S^b)\right) \\ &\quad -(f^{mh} - c_P)\int_0^1 \frac{\partial D^{mh}}{\partial \mu} h_S(b_S) db_S. \end{aligned} \tag{11}$$

Therefore, the impact of a quality parameter on the platform's incentives to impose single-homing depends on the relative elasticity of consumer demand both under single-homing

and multi-homing, and on the elasticity of merchants' acceptance under single-homing. For example, if $\mu = \lambda_H^I$ we have

$$\begin{aligned}\frac{d(\pi^{sh} - \pi^{mh})}{d\lambda_H^I} &= (f_S - c_P)\int_{b_S^b}^1 \frac{f^{sh}}{(2v\lambda^I)^2} db_S + \frac{v}{\sigma^I}(1 - \frac{\sqrt{\lambda^S}}{2\sqrt{\lambda^I}})D^{sh}(b_S^b) \\ &\quad -(f^{mh} - c_P)\int_0^1 \frac{f^{mh}}{4v^2(\lambda^I - \lambda^S)^2} db_S.\end{aligned}$$

This example reveals that the choice of the restrictions is not simple and depends on the trade-off for the platform between extracting surplus from consumers and from merchants. We can also use a similar reasoning to analyze the cases $\sigma^I = 0$.

### 4.10.3 Numerical examples

To be more precise, we resort to numerical simulations (See Appendix D). We divide our analysis in two cases. In case a, we have $\sigma^I = 0$, the merchant has no benefit from selling its products via the platform, but draws a benefit by selling it directly. In case b, we have $\sigma^S = 0$ and the merchant has no benefit from selling its products directly to consumers, but draws a benefit by selling it on an online marketplace.

When $\sigma^I = 0$ we show that for high level of differentiation between the platform and the merchant on the consumers' side, the profit-maximizing strategy to allow multi-homing is also welfare maximizing. At the same time, since consumer demand increases under single-homing and transaction price decreases for high level of value added by the platform on the consumer's side, merchant's surplus is maximized under single-homing.

When $\sigma^S = 0$, we show that, for low levels of differentiation between the platform and the merchant benefit on the consumer side, the optimal strategy for the platform is to impose price parity clauses to merchants. This strategy is also optimal for consumers as the platform sets negative transaction fees for them. Moreover merchants' acceptance is relatively high as merchants retrieve a higher benefit from selling via the platform than from selling directly. Nevertheless, merchants' surplus is reduced under price parity, and the optimal strategy for them would have been to multi-home. This happens because they are charged a relatively high transaction fee from the platform, and they cannot adjust upwards the retail price to

recover from the increase in marginal cost. In general, social welfare is maximized by the imposition of the price parity clause because the positive effect on consumers and on the platform is stronger than the negative effect on merchants. On the contrary, when there is a high level of differentiation between the platform and the merchant on the consumers' side, the welfare maximizing strategy is to impose single-homing. This occurs because the higher the value added by the platform on the consumer's side the higher the consumer demand under single-homing. Moreover, merchants' acceptance is almost total.

# 5 Conclusion

In this article, we contribute to the debate on price parity clauses and exclusive arrangements by analyzing competition between a platform and merchants to market a product, when the platform can impose these restrictions on merchants. We analyze whether this may reduce competition and social welfare. We find that, for some level of differentiation between the quality of the service offered by the merchant and the platform, the strategy chosen by the platform is socially optimal. Therefore, regulators should analyze for each specific market, the type of platform and the quality that is provided by the latter to both merchants and consumers, in their decision to forbid restrictive clauses. For example, if the platform brings a high benefit to merchants, social welfare is always maximized by the imposition of price parity. In this case, to forbid price parity may leave the platform out of the market and therefore reduce consumers' choice.

What is left for future research is to study the case in which the platform also offers two qualities of the service, that is a high and low version of the service. Moreover, another interesting case would be to look at a situation where there are three selling channels competing, that is the case in which the merchant can market the product either by its own website, directly in the physical shop or via the platform. Finally, it would be also relevant to endogenize investments in quality.

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## 5.1 Appendix

**Appendix A: Proof on Lemma 1** The indifferent consumer $y_H$ between buying through a given selling channel is given by $u_H(y_H) = u_L(y_H)$. From (1), since the retail price is identical in both selling channels, we have $(\lambda^I - \lambda^S)(y_H) = f_B$. Since $\lambda^I - \lambda^S$ is strictly increasing by assumption, it admits a reciprocal function $(\lambda^I - \lambda^S)^{-1}$, and we have $y_H = (\lambda^I - \lambda^S)^{-1}(f_B)$.

The indifferent consumer between buying and not buying $y_S$ is given by $u_S(y_S) = 0$. From (1), we have $\lambda_S(y_S) = p$.

If $y_H \geq y_L$, the merchant's profit of selling through both selling channels when price discrimination is not allowed is given by

$$\pi^{npd} = \pi_S(y_S) + D(y_I)(c_S - c_I). \tag{12}$$

We denote by $\widehat{y}_j$ the indifferent consumer at the profit-maximizing price when price discrimination is not allowed for $j \in \{L, H\}$. Since $y_H$ does not depend on $p$, we have that $\widehat{y}_H = (\lambda^I - \lambda^S)^{-1}(f_B)$. From the first-order condition of profit-maximization, from (12), we

have that $(\pi_S)'(\widehat{y_S}) = (\pi^{npd})'(\widehat{y_S}) = 0$. Since $\pi_S$ reaches its maximum at $\widetilde{y}_S$, we have that $(\pi_S)'(\widehat{y_S}) = 0$. This implies that $\widehat{y}_S = \widetilde{y}_S$. Replacing for $\widehat{y}_L$ and $\widehat{y}_H$ into (12) gives (6).

**Appendix B: Proof on Lemma 2** Assume that the merchant sells through two different selling channels and is allowed to price discriminate. The indifferent consumer $y_H^2$ between the selling channel of high and low quality is given by $u_I(y_I^2) = u_S(y_I^2)$. From (1), we have $\lambda_I(y_I^2) - p_I - f_B = \lambda_S(y_I^2) - p_S$. The indifferent consumer $y_S^2$ between buying through the selling channel of low quality and not buying is given by $u_S(y_S^2) = 0$, that is, we have $\lambda^S(y_S^2) = p_S$. When he is allowed to price discriminate, the merchant makes profit

$$\pi^{pd} = D(y_H^2)(p_I - c_I) + (F(y_I^2) - F(y_S^2))(p_S - c_S),$$

provided that $y_I^2 \geq y_S^2$. Replacing for the prices according to the indifferent consumers $y_S^2$ and $y_I^2$ given above, the merchant's profit when he sells both qualities is given by

$$\pi^{pd} = \pi_S(y_S^2) + \pi_I(y_I^2) - \pi_S(y_I^2).$$

We denote by $\widetilde{y}_I^2$ and $\widetilde{y}_S^2$ the indifferent consumers at the profit-maximizing prices. We start by determining the indifferent consumer between buying the low quality and not consuming at the equilibrium prices. Since $(\pi^{pd})'(y_S^2) = (\pi_S)'(y_S^2)$ and $(\pi^{pd})'(\widetilde{y}_S^2) = 0$, we have $(\pi_S)'(\widetilde{y}_S^2) = 0$. Therefore, $\pi_S$ reaches its maximum at $\widetilde{y}_S^2$ and we have

$$\widetilde{y}_S^2 = \widetilde{y}_S. \tag{13}$$

Therefore, at the equilibrium prices, the indifferent consumer between buying the low quality and not buying is identical whether or not the high quality is offered by the merchant. We now determine the indifferent consumer between the high and the low quality when both qualities are available at the profit-maximizing prices. Since $(\pi^{pd})'(\widetilde{y}_I^2) = 0$ and $(\pi^{pd})'(y_I^2) = (\pi_I)'(y_I^2) - (\pi_S^k)'(y_I^2)$, we have $(\pi_I)'(\widetilde{y}_I^2) = (\pi_S)'(\widetilde{y}_I^2)$. Replacing for $(\pi_I)'$ and $(\pi_S)'$, we find that $\widetilde{y}_I^2 = g_2^{-1}(f_B + c_I - c_S)$.

**Appendix C: Proof of Lemma 4** If multi-homing is not allowed, a merchant offers the high quality through the intermediated selling channel rather than the low quality through the direct selling channel if and only if

$$\pi_I(\widetilde{y}_I) \geq \pi_S(\widetilde{y}_S). \tag{14}$$

Replacing for $\pi_I(\widetilde{y}_I)$ and $\pi_S(\widetilde{y}_S)$ given by (5) into (14), we obtain (10).

**Appendix D: Proof of Lemma 5** If $(\lambda^I - \lambda^S)^{-1}(f_B) < \widetilde{y}_S$, from Lemma 1, all consumers prefer to buy through the intermediated selling channel when it is available. Therefore, the merchant trades off between offering the selling channel of high quality and the only the selling channel of low quality. The result of this trade off is identical to (10). If $(\lambda^I - \lambda^S)^{-1}(f_B) \geq \widetilde{y}_S$, some consumers would like to buy through the selling channel of high quality and other through the selling channel of low quality. If $c_S < c_I$, from (12), the merchant's profit is lower when he offers both selling channels than when he offers only the selling channel of low quality. Therefore, he only sells through the direct selling channel and makes profit $\pi_S(\widetilde{y}_S)$. If $c_S \geq c_I$, from (12), the merchant sells through both selling channels and makes profit $\pi^{npd}(\widetilde{y}_S)$.

Appendix A: Proof on Lemma 1

From (**??**), we have $\widetilde{y}_I^2 \geq \widetilde{y}_I$ if and only if $g_2^{-1}(f_B + c_I - c_S) \geq g_I^{-1}(f_B + c_I)$. Since $\widetilde{y}_S^2 = \widetilde{y}_S$, total consumer demand is identical whether one or two qualities are available, and consumer demand for the low quality is reduced when both qualities are available.

### 5.1.1 Appendix B: Proof of Lemma 2

We start by analyzing whether a merchant makes more profit by offering both qualities rather than only the high quality. A merchant offers both the high quality through the intermediated selling channel and the low quality through the direct selling channel if and only if

$$\pi^{pd}(\widetilde{y}_I^2, \widetilde{y}_S) \geq \max(\pi_S(\widetilde{y}_S), \pi_I(\widetilde{y}_I)).$$

From (7) and (13), we have $\pi^{pd}(\widetilde{y}_I^2, \widetilde{y}_S^2) = \pi^{pd}(\widetilde{y}_I^2, \widetilde{y}_S)$. Since $\pi^{pd}$ reaches a maximum at $(\widetilde{y}_I^2, \widetilde{y}_S^1)$, we have $\pi^{pd}(\widetilde{y}_I^2, \widetilde{y}_S) \geq \pi^{pd}(\widetilde{y}_I, \widetilde{y}_S)$. From (7), we have $\pi^{pd}(\widetilde{y}_I, \widetilde{y}_S) - \pi_I(\widetilde{y}_I) = \pi_S(\widetilde{y}_S) - \pi_S(\widetilde{y}_I)$. Since $\pi_S$ reaches its maximum at $\widetilde{y}_L$, we have $\pi_L(\widetilde{y}_L) - \pi_L(\widetilde{y}_H) \geq 0$. Therefore, we have $\pi^{pd}(\widetilde{y}_I, \widetilde{y}_S) - \pi_I(\widetilde{y}_I) \geq 0$. This implies that $\pi^{pd}(\widetilde{y}_I^2, \widetilde{y}_S) \geq \pi_I(\widetilde{y}_I)$ and $\pi^{pd}(\widetilde{y}_I^2, \widetilde{y}_S^2) \geq \pi_I(\widetilde{y}_I)$. Hence, a merchant always makes more profit by offering both qualities than only the high quality.

We analyze whether a merchant makes more profit by offering both qualities rather than only the low quality. From (7) and (13), we have that

$$\pi^{pd}(\widetilde{y}_I^2, \widetilde{y}_S^2) - \pi_S(\widetilde{y}_S) = \pi_I(\widetilde{y}_I^2) - \pi_S(\widetilde{y}_I^2).$$

Replacing for $\pi_I$ and $\pi_S$ into the equality above, we find that

$$\pi^{pd}(\widetilde{y}_I^2, \widetilde{y}_S^2) - \pi_S(\widetilde{y}_S) = D(\widetilde{y}_I^2)((\lambda^I - \lambda^S)(\widetilde{y}_I^2) - f_B + c_S - c_I).$$

Since $D(\widetilde{y}_I^2) \geq 0$, we have that $\pi^{pd}(\widetilde{y}_I^2, \widetilde{y}_S^2) - \pi_S(\widetilde{y}_S) \geq 0$ if and only if (**??**) holds.

### 5.1.2 Appendix C: Linear example

In this Appendix, we will look at the example of a linear distribution in the various cases.

**(i) Case 2: multi-homing is not allowed.** In our linear example, $\pi^I(\widetilde{y}^I) - \pi^S(\widetilde{y}^S)$ is a polynomial function of $b_S$. The coeffi cient of $b_S^2$ is $\lambda^S(\sigma^I)^2 - \lambda^I(\sigma^S)^2$. If $\lambda^S(\sigma^I)^2 > \lambda^I(\sigma^S)^2$ (resp., $< 0$), the polynomial function is convex (resp., concave). Note that the convexity of the function $\pi^I(\widetilde{y}^I) - \pi^S(\widetilde{y}^S)$ depends on the relative differentiation between the platform's

service and the merchant's service on the consumers' side with respect to the merchants' side. If the platform's advantage is relatively higher on the merchants' side than on the consumers' side, the function $\pi^I(\widetilde{y}^I) - \pi^S(\widetilde{y}^S)$ is convex, whereas it is concave otherwise. To simplify the computations, we focus on two polar cases, that is $\sigma^I = 0$ and $\sigma^S > 0$ (case a), and $\sigma^I > 0$ and $\sigma^S = 0$ (case b).

The first case (case a) corresponds to a situation where the platform does not bring any cost reduction to merchants ($\sigma^I = 0$), whereas a proprietary solution brings high value to merchants. The equation $\pi^I(\widetilde{y}^I) - \pi^S(\widetilde{y}^S) = 0$ admits two solutions and is concave. We denote the highest of these two solutions by $b_S^a$, and we have $(S_I^1)^a = [0, \min(\max(b_S^a, 0), 1)]$, where

$$b_S^a = \frac{1}{\sigma^S}\left((d - \lambda_L^S v) + \sqrt{\lambda_L^S/\lambda_H^I}(\lambda_H^I v - f_T)\right).$$

The higher the total price charged by the platform or the benefits of a proprietary solution on the merchants' side, the lower merchants' acceptance of the platform's service.

The second case (case b) corresponds to a situation where the platform reduces merchants' transaction costs compared to a proprietary selling channel ($\sigma^S = 0$). In case b, we denote the highest of the two solutions of $\pi^I(\widetilde{y}^I) - \pi^S(\widetilde{y}^S) = 0$ by $b_S^b$. We have $(S_I^1)^b = \big[\max(\min(b_S^b, 1), 0), 1\big]$, where

$$b_S^b = \frac{1}{\sigma^I}\left((f_T - \lambda^I v) + \sqrt{\lambda^I/\lambda^S}(\lambda^S v - d)\right).$$

The higher the price charged by the platform and the lower the benefits of the platform's service for merchants, the lower merchants' acceptance of the platform's service. Compared to the multi-homing case, merchant acceptance of the platform's service is reduced under single-homing.

**(ii) Case 3: price discrimination is not allowed.** In our linear example, the merchant offers the platform's service if and only if $b_S \geq b_S^{npd}$, where $b_S^{npd} \equiv (f_S - d)/(\sigma^I - \sigma^S)$.

**The platform's fees if there are no restrictions.** In our linear example, the profit-

maximizing total transaction fee is given by

$$f^{mh} = \frac{1}{4}(2v(\lambda^I - \lambda^S) + 2d + 2c_P + (\sigma^I - \sigma^S)).$$

The total transaction fee increases with the degree of differentiation between the platform's service and the merchant's service on the consumers' side ($\lambda_H^I - \lambda_L^S$) and with the benefits that are brought by the platform compared to a proprietary solution ($\sigma^I - \sigma^S$) for the merchant.

The platform's profit under multi-homing is

$$\pi^{mh} = \frac{1}{32v(\lambda^I - \lambda^S)}(2v(\lambda^I - \lambda^S) + 2d - 2c_P + (\sigma^I - \sigma^S))^2.$$

The platform's profit increases with the degree of differentiation between the platform and the merchant on the selling benefit. The impact of the degree of differentiation on the consumers' side depends on $\lambda^I - \lambda^S$. For $\lambda^I - \lambda^S \leq (2d - 2c_P + \sigma^I - \sigma^S)/(2v)$, $\pi^{mh}$ is decreasing with $\lambda^I - \lambda^S$ and then it is increasing with $\lambda^I - \lambda^S$. $\pi^{mh}$ reaches a minimum when the degree of differentiation on the consumers' side equals $(2d - 2c_P + \sigma^I - \sigma^S)/(2v)$. In this case, the platform makes profit

$$\pi^{mh} = \frac{\sigma^I - \sigma^S + 2d - 2c_P}{4}.$$

**(iii) Consumer and merchant surplus when multi-homing is allowed.** In our linear example, since $S_I^2 = [0, 1]$, $y$ is uniformly distributed on $[0, v]$ and $b_S$ uniformly distributed on $[0, 1]$, we have

$$CS^{mh} = \frac{\lambda^S}{v}\int_0^1 \int_{y_S^2}^v (y - y_L^2)dydb_S + \frac{(\lambda^I - \lambda^S)}{v}\int_0^1 \int_{y_I^2}^v (y - y_I^2)dydb_S.$$

Merchant surplus is given by

$$MS^{mh} = \int_{b_S \in S_I^2} \pi^{pd}(\widetilde{y}_I^2, \widetilde{y}_S^2)db_S + \int_{b_S \notin S_I^2} \pi_S^S(\widetilde{y}_S^1)db_S,$$

where

$$\pi^{pd}(\widetilde{y}_I^2, \widetilde{y}_S^2) = \frac{(v\lambda^S + \sigma^S b_S - d)^2}{4v\lambda^S} + \frac{(v(\lambda^S - \lambda^I) + f_S + f_B - d + \sigma^S b_S)^2}{4v(\lambda^I - \lambda^S)},$$

and

$$\pi^S(\widetilde{y}^S) = \frac{(v\lambda^S + \sigma^S b_S - d)^2}{4v\lambda^S}.$$

**(iv) Consumer and merchant surplus under single-homing** To simplify our computations in our linear example, we can restrict our analysis to cases (a) and (b). In case (a), we have $(S_I^1)^a = [0, b_S^a]$. Therefore, in case (a), we have

$$CS^{sh} = \frac{\lambda^I}{v}\int_0^{b_S^a}(\int_{y_I^I}^{v}(y - y^I)dydb_S + \frac{\lambda^S}{v}\int_{b_S^a}^{1}\int_{y^S}^{v}(y - y^S)dydb_S.$$

In case (b), we have $(S_I^1)^b = \left[b_S^b, 1\right]$. Therefore, in case (b), we have

$$CS^{sh} = \frac{\lambda^I}{v}\int_{b_S^b}^{1}\int_{y^I}^{v}(y - y^I)dydb_S + \frac{\lambda^S}{v}\int_0^{b_S^b}\int_{y^S}^{v}(y - y^S)dydb_S.$$

**(v) Consumer and merchant surplus under no price discrimination.** In our linear example, for merchants that accept the platform's service (i.e., with $b_S > b_S^{npd}$), consumers such that $y$ belongs to $[\widehat{y}_I, v]$ buy through the platform, whereas consumers such that $y$ belongs to $[\widehat{y}_S, \widehat{y}_I]$ buy from the merchant's selling channel. For merchants that refuse the platform's service (i.e., with $b_S < b_S^{npd}$), consumers such that $y$ belongs to $[\widehat{y}_S, v]$ buy from the merchant's selling channel. Therefore, consumer surplus is given by

$$\begin{aligned} CS^{npd} &= \frac{1}{v}\int_0^{b_S^{npd}}\int_{\widehat{y}_S}^{v}(\lambda^S y - p^*)dydb_S + \frac{1}{v}\int_{b_S^{npd}}^{1}\int_{\widehat{y}_S}^{v}(\lambda_H y - p^* - f_B)dydb_S \\ &\quad + \frac{1}{v}\int_{b_S^{npd}}^{1}\int_{\widehat{y}_S}^{\widehat{y}_I}(\lambda^S y - p^*)dydb_S. \end{aligned}$$

## Appendix D Low quality on the merchant's side: $\sigma^I = 0$.

By using the following set of parameters $(d = 0.1;\ v = 8.)$, we analyze the case in which there is high quality platform on the consumer side and $\sigma_I = 0$. In this case, for $\sigma^S = 4$,

and $\lambda^I = 0.9, \lambda_L^S = 0.8$. Consumer demand under multi-homing is such that $0 < D^{mh} < 1$, where $D^{mh} = \frac{1}{2} - \frac{p^{mh} - d + b_S(\sigma^S - \sigma^I)}{2v(\lambda^I - \lambda^S)}$. A the equilibrium of stage 1, the platform may choose a total user price such that this condition does not hold. In this case, merchants' acceptance under multi-homing is reduced and the indifferent merchant between accepting the platform's service and not accepting it is given by: $b_S^{\text{lim}} = (v(\lambda^I - \lambda^S) - p^{mh})/(\sigma^S - \sigma^I)$. Given this indifferent merchant and with this set of parameters, no merchants will accept the platform's service under multi-homing. Moreover, no merchant accepts neither single-homing nor price parity clauses.

| $\sigma^S = 4$ | $\lambda^I = 0.9, \lambda^S = 0.8$ | $\lambda^I = 2, \lambda^S = 0.1$ |
|---|---|---|
| $\pi^{mh}$ | 0 | 1.45 |
| $p^{mh}$ | 0 | 6.65 |
| $\pi^{sh}$ | 0 | 0.75 |
| $p^{SH}$ | 0 | 4.73 |
| $b_S^{sh}$ | 0 | 0.45 |
| $\pi^{npd}$ | 0 | 0 |
| $p_B^{npd}$ | 0 | 0 |
| $p_S^{npd}$ | 0 | 0 |
| $b_s^{npd}$ | 0 | 0 |
| | | **MH** |
| $CS^{mh}$ | 0 | 1.67 |
| $CS^{sh}$ | 0 | 1.59 |
| $CS^{npd}$ | 0 | 0 |
| | | **MH** |
| $MS^{mh}$ | 0 | 2.94 |
| $MS^{sh}$ | 0 | 3.19 |
| $MS^{npd}$ | 0 | 0 |
| | | **SH** |
| $SW^{mh}$ | 0 | 6.06 |
| $SW^{sh}$ | 0 | 5.53 |
| $SW^{npd}$ | 0 | 0 |
| | | **MH** |

**High quality on themerchant's side: $\boldsymbol{\sigma^S = 0}$.**

Secondly, by using the same set of parameters $(d = 0.1;\ v = 8.)$,we look at the case in which the merchant has no benefit from selling its products directly to consumers, but draws a benefit by selling it on an online marketplace.

| $\sigma^I = 4$ | $\lambda^I = 0.8; \lambda^S = 0.7$ | $\lambda^I = 3; \lambda^S = 0.1$ |
|---|---|---|
| $\pi^{mh}$ | 1.31 | 3.44 |
| $p^{mh}$ | 1.45 | 12.65 |
| $\pi^{sh}$ | 0.44 | 10.78 |
| $p^{sh}$ | 1.74 | 8.03 |
| $b_S^{sh}$ | 0.3 | 0.98 |
| $\pi^{npd}$ | 1.36 | 0 |
| $p_B^{npd}$ | -0.83 | 0 |
| $p_S^{npd}$ | 2.46 | 0 |
| $b_s^{npd}$ | 0.59 | 0 |
| | **NPD** | **SH** |
| $CS^{mh}$ | 0.51 | 0.68 |
| $CS^{sh}$ | 0.5 | 5.12 |
| $CS^{npd}$ | 1.35 | 0 |
| | **NPD** | **SH** |
| $MS^{mh}$ | 2.42 | 1.89 |
| $MS^{sh}$ | 1.86 | 6.39 |
| $MS^{npd}$ | 2.15 | 0 |
| | **MH** | **SH** |
| $SW^{mh}$ | 4.24 | 6.01 |
| $SW^{sh}$ | 2.8 | 22.29 |
| $SW^{npd}$ | 4.86 | 0 |
| | **NPD** | **SH** |

| $\sigma^I = 15$ | $\lambda_H^I = 0.8; \lambda_L^S = 0.7$ | $\lambda_H^I = 4.1; \lambda_L^S = 4$ |
|---|---|---|
| $\pi^{mh}$ | 11.025 | 11.025 |
| $p^{mh}$ | 4.2 | 4.2 |
| $\pi^{sh}$ | 0.67 | 1.56 |
| $p^{sh}$ | 2.8 | 6.62 |
| $b_S^{sh}$ | 0.15 | 0.41 |
| $\pi^{npd}$ | 12.41 | 12.41 |
| $p_B^{npd}$ | -4.5 | -4.5 |
| $p_S^{npd}$ | 9.8 | 9.8 |
| $b_s^{npd}$ | 0.65 | 0.65 |
| | **NPD** | **NPD** |
| $CS^{mh}$ | 0.39 | 3.18 |
| $CS^{sh}$ | 2.8 | 4.68 |
| $CS^{npd}$ | 6.88 | 10.18 |
| | **NPD** | **NPD** |
| $MS^{mh}$ | 12.72 | 19.32 |
| $MS^{sh}$ | 5.61 | 9.36 |
| $MS^{npd}$ | 9.18 | 15.78 |
| | **MH** | **MH** |
| $SW^{mh}$ | 24.135 | 33.55 |
| $SW^{sh}$ | 9.08 | 15.6 |
| $SW^{npd}$ | 28.47 | 38.37 |
| | **NPD** | **NPD** |

# General Conclusion

In this last section of the thesis, I will resume the main findings from this thesis and the policy implications, and drive some ideas for future research.

**In the first chapter, I analyze how innovations impact competition in retail banking, by looking at competitive dynamics between banks and between banks and non-banks.** What emerges from the first article, *Innovation and Competition in the Retail Banking Industry: An Industrial Organization Perspective*, is that regulation and competition can help to influence or discourage the incentives to propose innovative financial tools. Regulators have the difficult task to maintain the balance between financial stability, competition and innovation. The industrial organization literature can indeed help them to frame these complex dynamics.

In the second article of this chapter, *Competition for Lending in the Internet Era: the case of Peer-to-Peer Lending Marketplaces in the USA*, I look at the competitive strategies of the two main peer-to-peer lending platforms in the USA and find that LendingClub seems to attribute more weight to the presence of risks and therefore adopts a stricter selection process, while Prosper maximizes the probability of possible matches. Nevertheless, they offer a very similar product: the loan amount per borrower, the interest rates, the individual characteristics of the users, the speed to process the origination are very similar. Moreover, these platforms use similar strategies to exploit network effects, to reduce information asymmetries and to manage risks. Therefore these two platforms are facing a frontal competition with each other. Also from the analysis, it emerges that American peer-to-peer lending market is shifting from a consumer-centered to a small-business centered market for lending, and is therefore transitioning from being a complement to potentially being a substitute of bank's consumer lending.

**The second chapter studies the determinants of the diffusion of a new technology, by studying the example of peer-to-peer lending platforms in the USA.** In the article *What Drives the Expansion of Peer-to-Peer Lending?* I look at the drivers of the expansion of peer-to-peer lending in the USA. Peer-to-peer lending first arrived in the USA

in 2006, therefore the period of expansion coincided with the subprime crisis and the diffusion of Internet related technologies and smartphones. It was, therefore, difficult to disentangle the various forces which caused the diffusion of this new technology. This is why we exploited the geographical heterogeneity of each county to identify the effects of three main hypothesis which may have triggered the usage of peer-to-peer lending: the lack of competition in the brick-and-mortar banking sector and the presence of switching costs to online lenders, the financial crisis and the credit crunch, and the internet expansion. We also accounted for spatial effects and socio-economic and demographic characteristics. We find that there are spatial spillovers within contingent counties, that counties with minorities, that are richer and with a higher average of educated people adopt more peer-to-peer lending. Also, higher propensity to innovate plays a crucial role: counties with a higher production of patents are keener to adopt new technologies. Nevertheless, Internet speed and adoption do not play a role as Internet was already widely diffused in the year 2006. Moreover, in counties with a more concentrated banking market, peer-to-peer lending was less developed. This may be the result of a strong brand loyalty. Also, our findings suggest that the financial crisis did not affect the diffusion of this new technology.

To conclude, at least until the year 2013, peer-to-peer lending has been a tool for people belonging to the middle-high class who simply were over-indebted. It remains to understand whether these platforms will serve the unbanked part of the American population in the future. Moreover, as times goes by, we will be able to understand whether peer-to-peer lending is to be considered as a transactional or a relationship form of lending. Since borrowers can ask a loan several times, the platform could learn from the past experience in the platform their characteristics and be able to better predict their default risk.

**The third chapter is dedicated to the topic of regulation, in order to understand whether regulating innovative retail banking services is optimal for the society.** In the first article of this chapter, *The Role of Merchants' Pass-Through in Payment Platform Markets*, we relax the common assumption that the product market is covered and we look at the effect of the interchange fee when merchant pass-through and merchant internalization occur. We conclude that the profit-maximizing interchange fee is not systematically biased

towards one side, nor is it systematically too high to maximize social welfare. This result is a contribution to the debate on the bias of interchange fees and it suggests that authorities should not only take into account the issuing and the acquiring markets for the assessment of the optimal interchange fee, but also the market structure on the product market. As a matter of fact, the pass-through rate of interchange fees is determined by the market structure of each specific retail product, and it is crucial for the optimal allocation of surplus between the various actors.

In the second article of this chapter Competition between a platform and merchants for selling services we contribute to the debate on price parity clauses and exclusive arrangements by analyzing competition between a platform marketplace and merchants to market a product, when the platform can impose different restrictions to merchants: price parity clauses and exclusive restrictions. We find that, for some level of differentiation between the quality of the service offered by the merchant and the platform, the strategy chosen by the platform is socially optimal and all actors are aligned in their interests. This article is related to the issue of competition and innovation in retail banking because merchants have, for example, incentives to issue their own payment method and bypass the rules of traditional payment platforms, such as Visa or MasterCard. Following the prediction of the model, their incentives may differ according to the degree of differentiation between the existing card platforms and new payment solutions and platforms' rules.

## Future research

Many questions regarding the issues of innovation in retail banking are worth being deepened.

Firstly, it is still a priority to systematically gather data on interchange fees at the European level to see the effects of the regulatory caps which were recently imposed, and to test the predictions of the theoretical models. For example, it could be interesting to test whether banks were incentivized to invest in the production of innovative financial tools to cover the loss of profits coming from the reduction in the interchange fees in the Euro Area. Another issue would be to empirically identify the banks' and merchants' pass-through of interchange fees into higher or lower retail prices for final consumers. These data can be retrieved online in some publications of the ECB, but they are usually at aggregated level,

and moreover they are spot data with some years missing. Nevertheless, the European Commission gathers such data but they are considered too sensitive to be divulgated for research purposes.

Furthermore, there is a need to better categorize different online platforms, and to better understand their role in the society. What emerges from the article on competition between a platform and merchants on the provision of a marketing service, is that the quality offered by the platform with respect to that offered by merchants plays a crucial role on the effect of restrictive clauses on social welfare. Also, material for future research would be to study the impact of the competition between a merchant and a platform on incentives to invest in quality of selling services.

Additionally, there are many strands to be developed in the literature on peer-to-peer lending platforms as they have just diffused. Foremost, the literature so far has focused on the American platforms, and in particular on the Prosper dataset. It would be interesting to enrich this literature with the European example by understanding the drivers of expansion of this new technology, in order to explain the heterogeneity of diffusion within European member states.

Moreover, there is still a need of creating a regulatory level playing field for new entrants in Europe, and to understand what are the instruments to improve regulation, to understand whether we need a bottom-up approach or a top-down one, whether it would be better to regulate by entity or by function, and what would be the optimal level of capital requirements and leverage for these platforms. Furthermore, there are other important aspects that still need to be studied. For example, whether online investors are efficient in screening borrowers to solve problems of adverse selection, and in particular, whether information about social network together with other soft information would help to better predict borrower failure. Also, it still remains unknown how peer-to-peer platforms' algorithms to model risk work, and whether online lending platform help to alleviate ex-post information asymmetries by serving as a signal for the traditional investors.

## Policy implications

Regulators face the trade-off between intervening ex-ante and ex-post in regulating retail banking. With ex-ante regulation, such as the setting of standards to enhance compatibility and to ensure the soundness of the system, regulators on one hand reduce the uncertainties of the financial market and assure stability. But, on the other hand, setting too costly ex-ante rules deters entry of new actors in the market and therefore reduces innovation. Also, the banking sector is already characterized by a oligopolistic structure due to the presence of high switching costs and brand loyalty behaviors. As it appears in the article on the diffusion of peer-to-peer lending, these factors already contribute to raise barriers for entrants.

On the contrary, regulators could leave ex-post the power of intervention to banking supervisors and competition authorities. This type of regulation could in principle enhance competition and innovation but could potentially undermine financial stability.

One of the most important implication arising from the article on pass-through rates in payment platform markets is that the market structure on both sides of the market matters for the optimal regulation of interchange fees. Moreover, our finding that the pass-through rate of merchants' fees impacts the choice of the welfare-maximizing interchange fee implies that the regulation of interchange fees may affect retail markets differently according to the market power of retailers. This suggests that a regulatory approach should be ideally complemented by an anti-trust approach.

In the article on competition between merchants and a platform on the provision of selling services, it appears that, again, regulators should analyze for each specific market, the type of platform and the quality that is provided by the latter to both merchants and consumers, in their decision to forbid restrictive clauses. For example, if the platform brings a high benefit to merchants, social welfare is always maximized by the imposition of price parity. In this case, to forbid price parity may leave the platform out of the market and therefore reduce consumers' and merchants' choice.

To conclude, what emerges in my thesis is that, for each regulatory issue, there should be a case-by-case approach, which takes into account the specificities of each relevant market.

## Résumé

L'industrie de la finance a connu une multiplication d'innovations qui peuvent bouleverser les services financiers traditionnels. Elles brouillent les frontières entre banques et start-ups, accélérèrent les transactions, démocratisent l'accès au crédit, tout en imposant aux régulateurs le défi de construire un cadre réglementaire qui rééquilibre le compromis entre stabilité financière, concurrence et innovation. Dans cette thèse, d'abord je reponde à cette question : comment les innovations influencent-elles la concurrence dans la banque de détail ? Un premier enjeu consiste à comprendre pourquoi certains de ces services innovants sont offerts par les plateformes non-bancaires, et comment les banques peuvent rivaliser avec des participants qui appliquent un modèle d'affaire différent. Après, je regarde quels sont les facteurs d'adoption de l'innovation par les consommateurs. Pour répondre à cette question, j'étudie à l'aide d'outils d'analyse empirique l'exemple des deux principales plateformes de prêts peer-to-peer aux USA, Prosper et LendingClub. Pour terminer, je me demande si la réglementation de l'innovation est nécessaire. Est-il optimal pour la société de réglementer les fournisseurs de services innovants? Je propose deux modèles théoriques qui s'inscrivent dans les débats bien connus sur le niveau optimal des interchanges dans les systèmes de cartes de paiement et des clauses de parité des prix et d'exclusivité sur les plateformes en ligne.



## Mots Clés

Banques, non-banques, banque de détail, concurrence, innovation, marché biface, plateformes, frais d'interchange, paiements, prêts peer-to-peer, clauses d'exclusivité, clauses de parité des prix.



## Abstract

During the last years, the finance industry has experienced a proliferation of innovations which may disrupt traditional financial services. They blur the boundaries between banks and financial start-ups, speed up transactions, democratize the access to credit, revise how we can purchase goods and how merchants can sell their products, while imposing regulators the challenge for a new level playing field which balances the trade-off between financial stability, competition and innovation. In this thesis, I try to answer to three main issues related to the topic of innovation in retail banking. Firstly, how do innovations impact competition in retail banking. One first issue is to understand why some of these innovative services are offered by non-bank platforms and how can banks compete with entrants that do not have the same business model. Secondly, I look at what the drivers of the adoption of innovation by consumers in retail banking are. What determines the diffusion of a new financial technology despite all the financial risks related to it? To answer to these questions, I will look empirically at the example of the two main peer-to-peer lending platforms in the USA, Prosper and LendingClub. Third, I address the question on whether regulation of innovation is necessary. Is it optimal for the society to regulate the providers of innovative retail banking services? To answer to these questions, I address, in two theoretical models, the well-known debates on the optimal level of interchange fees in payment card systems and the imposition of exclusivity arrangements and price parity clauses in contracts between platforms and merchants.



## Keywords

Banks, non-banks, competition, innovation, retail banking, two-sided markets, platforms, interchange fees, payments, peer-to-peer lending, price parity clauses, exclusive arrangements.