2. THE INTERCHANGE FEES - A COMPARISON BETWEEN OPTIMAL PRIVATE AND SOCIAL LEVELS

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Abstract

In this paper we derived the optimal conditions which allow for a comparison between private and social levels of the interchange fees (IFs). We expand the model developed by Rochet and Tirole (2002) by allowing for several extensions which lead to a more accurate understanding of the determinants of the interchange fees by payment card systems. More specifically, we looked at a card payment system with a for-profit platform, unobservable heterogeneity across merchants and not-fully informed customers. Merchants behave strategically and imperfect competition of both issuers and acquirers is also considered. The simultaneous treatment of these assumptions is the novelty of our work and it is done with the purpose of reflecting more realistically the payment card industry.

Keyword: interchange fee, payment cards, two-sided markets, for-profit platforms, imperfect competition, market structure

JEL Classification: D4, E42, L2

I. Introduction

The paper "Cooperation among competitors: Some economics of payment card associations" by J. C. Rochet and J. Tirole (2002), is one of the seminal contributions on the study of two-sided markets in which network externalities between multiple sides of the market require a specific design of the price structure in order to "get everybody on board". The focus is on payment card systems which act as platforms that provide independent services to two types of users: a cardholder and a merchant.

Research on this topic has been motivated by the specific features of the payment card system. There are mainly two types of such systems: a proprietary (or "closed") network, such as American Express, where the same entity deals with, and sets the fees to merchants and card users, and an association such as Visa and MasterCard (or "open network", since membership is open to multiple banks), when a typical transaction involves two different banks: the cardholder's ("issuer") and the merchant's

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(“acquirer”). The issuer sets the fee to its cardholders (for example, a fee per transaction or, more often, a rebate) and the acquirer sets the fee to its merchants (the “merchant discount” – the transaction amount minus what the merchant receives from the acquirer). The association sets an interchange fee paid by the acquirer to the issuer, which, of course, affects their respective charges to merchants and cardholders.

The peculiarity of markets as the payment card systems lies in the fact that network externalities take place between two sides of the market, which implies that the related pricing policies must not only determine the level of price (the total price for the service) but also its structure (how will the total price be distributed between the two sides of the market). One type of such network externalities is derived from membership. Accordingly, cardholders benefit from their holding a card only if their cards are accepted by a wired range of merchants and merchants benefit from the card only if consumers use it. Therefore, a payment card network can function effectively only if sufficient members of both cardholders and merchants participate in the network. There are also usage externalities to the extent that merchants can only benefit from their clients’ holding a card if the latter use it frequently.

It is thus fundamental for payment networks to find an effective method for balancing the prices on the two sides of the market. For example, the payment platform may skew its price structure by charging a low (perhaps zero or even negative in the case of credit cards) price to one side of the market (buyers) and a high price on the other (sellers). Consequently, the implementation of competition policy must be amended in order to reflect two-sidedness. However, out of a lack of understanding of the structure of a payment system or of special lobbying interests, the magnitude and sometimes even the legitimacy of these interchange fees have been repeatedly questioned.

Rochet and Tirole (2002) provide a first theoretical framework for the analysis of the price structure in the case of the payment system. In this paper, we extend their model by allowing for several extensions which lead to a more accurate understanding of the determinants of the interchange fees by payment card systems with different objectives. This setting will give the opportunity to illustrate a comparison between privately-set and socially optimal interchange fees.

The paper is organized as follows. Section 2 provides a brief literature review, highlighting some important contributions to the theoretical payment card literature. In Section 3 we build on the model developed by Rochet and Tirole (2002) by allowing for strategic behaviour of merchants in a card payment system with a for-profit platform, unobservable heterogeneity across merchants and not-fully informed customers. Imperfect competition of both issuers and acquirers is also considered. The simultaneous treatment of these assumptions is the novelty of this paper and it is done with the purposeof reflecting more realistically the payment card industry. The paper ends with Section 4, where conclusions are provided.

II. Literature Review

The formal economic analysis of the interchange fee was pioneered by Baxter (1983), who showed that the socially optimal fee must reflect the net benefits from card use on both sides of the transaction. However, in Baxter's analysis the association is indifferent between any levels of the interchange fee, because issuers and acquirers are assumed perfectly competitive. Schmalensee (2002) extends Baxter's analysis by allowing issuers and acquirers to exercise market power but still assumes that merchants operate in competitive markets. His results support Baxter's conclusions that the interchange fee balances the demand for payment services by each end-user type and the cost to banks to provide them.

Rochet and Tirole (2002), unlike previous analysis, consider strategic behavior of merchants in payment interactions. In their model, issuers have market power, but purchasers operate in competitive markets and, therefore, any increases in interchange fee are passed on to merchants completely. This framework allows for a comparison between the privately optimal interchange fee and the socially optimal one. Furthermore, the authors derive the demand for payment card transactions from individual consumer preferences and endogenize merchants' demand, which allows for the identification of the determinants of merchant resistance and the analysis of the impact of the no-surcharge rule.

Rochet and Tirole (2003) extend their previous work by considering network competition. Their primary focus is on the price structure or balance between consumers and merchants in a three-party network. They do not explicitly model the interchange fee but study the impact of competition on the structure of prices. Under a set of plausible assumptions they find that the price structures for a monopoly network and competing platforms are the same, this price structure in the two environments generates the highest welfare under a balanced budget condition.

Wright (2003) extends Rochet and Tirole (2002) to consider the effects of no-surcharge rules when merchants are monopolists or Bertrand competitors. The author finds that no-surcharge rule generate higher welfare than when monopolist merchants are allowed to set prices based on the payment instrument used. Wright (2004) extends Rochet and Tirole (2002) by considering a continuum of industries where merchants in different industries receive different benefits from accepting cards. Other key differences are that purchasers are allowed to be imperfectly competitive, and the card fee (which can be negative to represent rebates and other loyalty points) is set per transaction rather than per card. Unlike the findings of Rochet and Tirole's model, the socially optimal interchange fee in this paper involves a trade-off between getting consumers to face the right price signal to use cards and merchants to face the right price signal to accept cards. In general, the model demonstrates that the privately set interchange fee can be higher or lower than the socially optimal one and can involve more or fewer card transactions.

Guthrie and Wright (2007) extend Rochet and Tirole (2003) by assuming that consumers are able to hold one or both payment cards and that merchants are motivated by "business stealing" in deciding whether to accept payment cards in a four-party network. They only consider networks that provide identical payment services, and they find that network competition results in higher interchange fees than those that would be socially optimal. Competition results in both networks charging the same interchange fee or in all transactions occurring on one network.

Rochet and Tirole (2008) develop further previous models of the payment card industry by introducing two types of cards (debit cards and credit cards) and two competing not-for-profit networks. Network 1 offers only a debit card, while network 2 offers both a debit card and a credit card. The two debit cards are perfectly substitutes for both cardholders and merchants. In this framework, they analyze the impact of the honor-all-cards (HAC) rule. By looking at the no-HAC-rule benchmark, the authors conclude that the interchange fee on the card subject to platform competition is socially too low, and the IF on the card protected from competition is either optimal or too high. In either case, the HAC rule not only benefits the multi-card platform but also raises social welfare, due to a rebalancing effect.

More recent contributions include Rochet and Wright (2010) who modify the previous framework to allow a separate role for the credit functionality of credit cards, thereby leading to a discussion on credit card interchange fees specifically. The results show that a monopoly card network always selects an interchange fee that exceeds the level that maximizes consumer surplus. If regulators only care about consumer surplus, the authors suggest that a conservative regulatory approach is to cap interchange fees based on retailers' net avoided costs from not having to provide credit themselves. In the model, this always raises consumer surplus as compared to the unregulated outcome, often to the point of maximizing consumer surplus.

Finally, Rochet and Tirole (2011) look more in depth at the argument that merchants cannot reasonably turn down payment cards and, therefore, must accept excessively high merchant discounts. First, the paper gives some operational content to this notion of must-take card through the avoided-cost test or tourist test: would the merchant want to refuse a card payment when a non-repeat customer with enough cash in her pocket is about to pay at the cash register? It analyzes its relevance as an indicator of excessive interchange fees. Second, it identifies four key sources of potential social biases in the payment card systems' determination of interchange fees and compares the industry and social optima both in the short term (fixed number of issuers) and the long term (in which issuer offerings and entry respond to profitability).

III. Analysis of the Model

In the present model, when a buyer purchases a good at price *p*, the issuing bank will debit the amount $p + p^B$ from his account, where p^B represent the card holder fee. The issuer transfers $p - a^B$ to the network, which in turn transfers $p - a^S$ to the acquiring bank. We will denote with a^B and a^S the interchange fee on the buyer's, respectively seller's side. Afterwards, the acquirer will credit the seller's account with the amount $p - p^S$, where p^S represent the merchant fee or discount (see Appendix 1).

The hypotheses of the model are as follows:

1. the market is characterized by the NSR (no surcharge rule);
2. the network is a for-profit one, which means that $a^B \leq a^S$; its profit is given by:

3. $\pi^N = a^S - a^B$
4. the buyer's gross convenience benefit for a card versus alternative payment $\left(b^B\right)$ is continuously distributed; the cumulative distribution function is $H\left(b^B\right)$, and the probability density function is $h\left(b^B\right)$;
5. the seller's gross convenience benefit for a card versus alternative payment $\left(b^S\right)$ is continuously distributed; the cumulative distribution function is $G\left(b^S\right)$, and the probability density function is $g\left(b^S\right)$;
6. the issuers and purchasers compete imperfectly and each of them has a constant margin of profit;

As results from the hypotheses of our model, we extend the analysis of Rochet and Tirole (2002) by treating the case where the network is a for-profit joint venture. Thus, the network operator keeps a margin $\left(a^S - a^B\right)$ on each transaction[2]. This assumption is similar to that of Rochet and Tirole (2008) and the subsequent literature.

We also introduce the assumptions of:

1. unobservable heterogeneity across merchants;
2. strategic behaviour of merchants;
3. not-fully informed customers;
4. imperfect competition of *both* issuers and purchasers;

In Rochet and Tirole (2002) the fee paid by the buyer is considered to be a fixed fee, paid ex-ante by the cardholders. This implies that some buyers do not hold cards. In conformity with the subsequent literature we will assume that there is no fixed fee and that p^B is paid only when the buyer uses his card. Therefore, all the buyers hold a card but use it if and only if $b^B \geq p^B$.

The timing of the model is as follows:

- The two IFs, a^B and a^S, are set (either by a platform or by a social planner);
- Issuers set fees for their customers (buyers). Purchasers set fees for their costumers (merchants), who decide whether to accept payment cards. Merchants set their retail prices.
- Consumers observe retail prices and which shops accept cards. They decide where to buy and which means of payment to use for their purchase.

The models which consider homogeneity across merchants (they all have the same gross convenience benefit b^B for a card versus alternative payment), while buyers

[2] *This situation was motivated by the fact that from 2003 and 2006, respectively, MasterCard and Visa are for-profit associations. In Rochet and Tirole (2002),* $a^B = a^S = a$.

have different valuations, introduce an asymmetry between buyers and merchants. That is because when a seller accepts card payments, the payment mode is chosen by the buyers. With the assumption of heterogeneous sellers, the decision of card acceptance by the merchants becomes elastic.

As in Rochet (2003) we will take as given the matching process between buyers and merchants and focus on the proportion *Q* of trades that is settled by a card payment (*Q* represent the demand of the card transaction). A card transaction takes place if and only if the buyer wants to use his card $\left(b^B \geq p^B\right)$ and the seller accepts card payments $\left(b^S \geq p^S\right)$. For expositional simplicity, we will assume that the buyer and the seller are independently drawn from their respective populations (this implies the independence between b^B and b^S) which leads to the multiplicative specification of the card transaction demand:

$$D\left(p^B, p^S\right) = D^B\left(p^B\right)D^S\left(p^S\right) \tag{1}$$

In equation (1), $D^B\left(p^B\right)$ and $D^S\left(p^S\right)$ represent the buyers, and the merchants' "quasi-demand" functions, respectively[3]. The proportion of buyers with $b^B \geq p^B$ (or quasi-demand for cards on buyer side) is:

$$D\left(p^B\right) \equiv 1 - H\left(p^B\right) = \int_{p^B}^{+\infty} h\left(b^B\right)db^B \tag{2}$$

The proportion of sellers with $b^S \geq p^S$ (or quasi-demand for cards on buyer side) is:

$$D\left(p^S\right) \equiv 1 - G\left(p^S\right) = \int_{p^S}^{+\infty} g\left(b^S\right)db^S \tag{3}$$

The assumption of strategic behaviour of merchants is opposite to the one in Baxter (1983), where the merchants' acceptance decision is influenced only by the direct costs and benefits (they will accept card payments as long as $b^S \geq p^S$). If merchants act strategically, they are afraid to lose customers when they refuse the card. Taking into account the increase in store attractiveness generated by card acceptance, a merchant will rationally accept the card if and only the sum of his own gross benefit b^S and the average net benefit of the buyer $v^B\left(p^B\right)$ is greater than the merchant fee p^S. So, he will accept card payments if and only if $b^S + v^B\left(p^B\right) \geq p^S$.

The average net benefit of a buyer generated by card transactions is:

$$v^B\left(p^B\right) \equiv E\left[b^B - p^B \mid b^B > p^B\right] \tag{4}$$

Similarly, the average net surplus of the sellers generated by card transactions is given by:

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[3] *The notion of "quasi-demand function" is used to reflect that, in a two-sided market, actual demand depends on the decisions of both types of users (here, buyers and merchants).*

$$v^S\left(p^S\right) \equiv E\left[b^S - p^S \mid b^S > p^S\right] \tag{5}$$

Let $E\left[b^B \mid b^B > p^B\right] \equiv \dfrac{\int_{p^B}^{+\infty} b^B h\left(b^B\right) db^B}{1 - H\left(p^B\right)}$. Thus, using the equations (2) and (4) we obtain:

$$v^B\left(p^B\right) = E\left[b^B - p^B \mid b^B > p^B\right] = E\left[b^B \mid b^B > p^B\right] - p^B$$

$$v^B\left(p^B\right) + p^B = \frac{\int_{p^B}^{+\infty} b^B h\left(b^B\right) db^B}{1 - H\left(p^B\right)} = \frac{\int_{p^B}^{+\infty} b^B h\left(b^B\right) db^B}{D^B\left(p^B\right)}$$

The assumption of not-fully informed customers means that only a proportion $\alpha \le 1$ of customers are informed about which merchants accept the card before they select a store (or similarly customers are informed for only a fraction α of their purchases). In this case, merchants will accept cards if and only if

$$b^S + \alpha v^B\left(p^B\right) \ge p^S \tag{6}$$

For $\alpha = 0$, we are in Baxter (1983), where the buyers are fully uninformed (or, equivalently, merchants are not strategic).

The issuers (respectively the purchasers) have the unit costs c^B (respectively c^S) for processing a card transaction. The variable *c* denotes the total cost of a card payment for the two banks which provide the payment service:

$$c = c^B + c^S$$

In the model, the issuers and purchasers compete imperfectly on their market. We reflect this assumption by considering the case of *constant margins*:

$$p^B = c^B - a^B + \pi^B \tag{7}$$

$$p^S = c^S - a^S + \pi^S \tag{8}$$

- ***Privately Optimal Interchange Fees***

We will consider the case of a for-profit network and derive the conditions for the setting of the optimal interchange fees. First, we need to specify the objective function of the network.

Because the platform included in our model is a for-profit one, it will retain a margin equal to $a^S - a^B$ on each card transaction. Thus, its profit is given by:

$$\Pi^N = \left(a^S - a^B\right) D^B\left(p^B\right) D^S\left(p^S\right)$$

From equations (7) and (8) we get:

$$a^S - a^B = p^B + p^S - c^B - c^S - \pi^B - \pi^S$$

Therefore, the platform's profit can be written as:

$$\Pi^N = \left(p^B + p^S - c^B - c^S - \pi^B - \pi^S\right)D^B\left(p^B\right)D^S\left(p^S\right)$$

If the network is a joint-venture, its pricing policy can take into account not only the profit of the network itself, but also the profits of the banks that form the network (issuers and purchasers). There are also others types of networks as, for example, a network which is led by issuers, purchasers and independent parts.

Here, *we treat the case when the network is a for-profit joint venture*. Let us consider that the issuers have an influence over the platform's board of directors, which is equal to y^B, and the purchasers' influence is y^S. For simplicity, we will assume that y^B and y^S represent the percentages of voting rights within the platform's board of directors. Obviously, in this case, we have $y^B + y^S = 1$.

Other important elements for the analysis are the issuers and purchasers quotas over the platform's cash flow rights. I will denote by λ^B, respectively λ^S, the quotas of the issuers, and of the purchasers, respectively . Evidently, $\lambda^B + \lambda^S = 1$.

Now, we are able to define the network's objective function, which is the maximization of a weighted sum of the three profits: network's profit $\left(\Pi^N\right)$, issuers' profit $\left(\Pi^B\right)$ and purchasers' profit $\left(\Pi^S\right)$. Because of possible differences between issuers and purchasers in ownership and cash-flow rights on the platform, the objective function of the platform may diverge from the total industry profit.

$$\Pi = \left(y^B\Pi^B + \lambda^B\Pi^N\right) + \left(y^S\Pi^S + \lambda^S\Pi^N\right) = \Pi^N + y^B\Pi^B + y^S\Pi^S$$

$$\Pi = \left(p^B + p^S - c^B - c^S - \pi^B - \pi^S\right)D^B\left(p^B\right)D^S\left(p^S\right) + y^B\pi^B D^B\left(p^B\right)D^S\left(p^S\right) + \\ + y^S\pi^S D^B\left(p^B\right)D^S\left(p^S\right)$$

$$\Pi = \left[p^B + p^S - c - \left(1 - y^B\right)\pi^B - \left(1 - y^S\right)\pi^S\right]D^B\left(p^B\right)D^S\left(p^S\right) \tag{9}$$

Let us denote by $\delta \equiv \left(1 - y^B\right)\pi^B + \left(1 - y^S\right)\pi^S$ the correcting term that appears in the above formula. Because $y^B + y^S = 1$, we get $\delta = y^S\pi^B + y^B\pi^S$.

As we have already mentioned, if the *merchants act strategically* they are willing to pay in order to attract customers. We also consider that *customers are imperfectly informed about card acceptance*. Thus, if p^{S*} is the price that merchants are willing to pay when they act strategically and p^S is the price that they are willing to pay when their acceptance decision is influenced only by direct costs and benefits, we have:

$$p^{S*} \equiv p^S + \alpha v^B\left(p^B\right) \tag{10}$$

We can interpret p^{S*} as the price paid by a marginal seller. In order to attract the customers of others merchants, the marginal seller is willing to pay to the acquirer an additional price equal to the buyer's net benefit. Because the buyers are not completely informed about which merchants accept card payments, this additional value is equal with $\alpha v^B\left(p^B\right)$.

Therefore, the platform's objective function (9) can be rewritten as follows:

$$\Pi = \left(p^B + p^{S*} - c - \delta\right)D^B\left(p^B\right)D^S\left(p^{S*}\right)$$

The first order condition for the maximization of Π is:

$$\frac{\partial \Pi}{\partial p^B} = \frac{\partial \Pi}{\partial p^{S*}} = 0$$

$$\frac{\partial \Pi}{\partial p^B} = \left(1 + \frac{\partial p^{S*}}{\partial p^B}\right)D^B D^S + \left(p^B + p^{S*} - c - \delta\right)\dot{D}^B D^S = 0$$

Since $\frac{\partial p^{S*}}{\partial p^B} = \alpha \dot{v}^B\left(p^B\right)$ we obtain:

$$p^B + p^{S*} - c - \delta = -\frac{D^B\left(1 + \alpha \dot{v}^B\left(p^B\right)\right)}{\dot{D}^B} \tag{11}$$

$$\frac{\partial \Pi}{\partial p^{S*}} = D^B D^S + \left(p^B + p^{S*} - c - \delta\right)D^B \dot{D}^S = 0$$

$$p^B + p^{S*} - c - \delta = -\frac{\dot{D}^S}{D^S} \tag{12}$$

From (10), (11) and (12) we obtain the condition for the determination of the privately optimal interchange fees:

$$\frac{p^B\left(1 + \alpha \dot{v}^B\right)}{\eta^B} = \frac{p^S + \alpha v^B}{\eta^S} = \alpha v^B + \left(a^S - a^B\right) - y^B \pi^B - y^S \pi^S \tag{13}$$

where: $\eta^k = -\frac{p^k \dot{D}^k}{D^k}$ $\left(k = B, S\right)$ denotes the elasticity of quasi-demands.

- ***Socially Optimal Interchange Fees***

Let us suppose a social planner who selects the interchange fees so as to maximize total welfare. The critical value of b^S (the point at which merchants are indifferent between accepting cards or not) is denoted by b_m^S, so that a marginal merchant with $b^S \geq b_m^S$ will accept card payments and one with $b^S < b_m^S$ will refuse card payments. By the same reasoning, but this time for the buyers, a marginal customer will pay with the card if $b^B \geq b_m^B$ and with cash (or other alternative method) if $b^B < b_m^B$. Using the relation (6), we have:

$$b_m^B = p^B$$
$$b_m^S = p^S - \alpha v^B \left(b_m^B\right)$$

The welfare represents the difference between the total benefit and the total cost from the system. Therefore the welfare function is defined as:

$$W\left(b_m^B, b_m^S\right) = \int_{b_m^B}^{+\infty} \int_{b_m^S}^{+\infty} \left(b^B + b^S - c^B - c^S\right) g\left(b^S\right) h\left(b^B\right) db^S db^B \tag{14}$$

which is equivalent to (a detailed demonstration is provided in the Appendix 2):

$$W\left(b_m^B, b_m^S\right) = \left[b_m^B + b_m^S + v^B\left(b_m^B\right) + v^S\left(b_m^S\right) - c\right] D^B\left(b_m^B\right) D^S\left(b_m^S\right)$$

The socially optimal interchange fees are characterized by the first order conditions:

$$\frac{\partial W}{\partial b_m^B} = \frac{\partial W}{\partial b_m^S} = 0$$

As in the case of the privately optimal interchange fees, we determine the condition for the socially optimal interchange fees:

$$\frac{p^B v^B \left(1 + \alpha \dot{v}^B\right)}{\eta^B} = \frac{v^S \left(p^S + \alpha v^B\right)}{\eta^S} \tag{15}$$

- ***The Comparison Privately Optimal IFs – Socially Optimal IFs***

First, for performing such a comparison, we have to assume a specific form for the quasi-demands functions. As in Rochet (2003) and Rochet and Tirole (2003), we will assume that quasi demands functions are log-concave:

If D^k is a log-concave function:

$\left(\log D^k\right)'' < 0 \Rightarrow \left(\log D^k\right)'$ is a decreasing function $\Rightarrow \dfrac{\dot{D}}{D}$ is a decreasing function

$$\left(k = B, S\right)$$

As $\dfrac{p^k}{\eta^k} = -\dfrac{D^k}{\dot{D}^k}$, it results that $\dfrac{p^k}{\eta^k}$ is a decreasing function

Proposition 1 When sellers are strategic and buyers are not-fully informed, the socially optimal interchange fees are lower than the privately optimal interchange fees if and only if the average net surplus of buyers exceeds the average net surplus of sellers: $v^B > v^S$.

Looking at the equations (7) and (8), we observe that the cases where the socially optimal interchange fees are lower than the privately optimal interchange fees correspond to the cases where $p^B_{network} < p^B_{planner}$, respectively $p^S_{network} > p^S_{planner}$.

From relations (13) and (15) we obtain:

$$\frac{p^B_{planner}}{\eta^B_{planner}} = \frac{1}{\eta^S}\frac{p^S + \alpha v^B}{1+\alpha\dot{v}^B}\frac{v^S}{v^B}$$

$$\frac{p^B_{network}}{\eta^B_{network}} = \frac{1}{\eta^S}\frac{p^S + \alpha v^B}{1+\alpha\dot{v}^B}$$

Since $\frac{p^k}{\eta^k}$ is a decreasing function,

$$p^B_{network} < p^B_{planner} \Leftrightarrow \frac{p^B_{network}}{\eta^B_{network}} > \frac{p^B_{planner}}{\eta^B_{planner}} \Leftrightarrow v^B > v^S .$$

Also, from relations (13) and (15) we obtain:

$$\frac{p^S_{planner}}{\eta^S_{planner}} = p^B\left(1+\alpha\dot{v}^B\right)\frac{1}{\eta^B}\frac{v^B}{v^S} - \alpha v^B$$

$$\frac{p^S_{network}}{\eta^S_{network}} = p^B\left(1+\alpha\dot{v}^B\right)\frac{1}{\eta^B} - \alpha v^B$$

We have $p^S_{network} > p^S_{planner} \Leftrightarrow \frac{p^S_{network}}{\eta^S_{network}} < \frac{p^S_{planner}}{\eta^S_{planner}} \Leftrightarrow v^B > v^S$.

The conclusions of Proposition 1 are similar to those of Rochet (2003), but we included the assumptions of for-profit platform, strategic sellers and not fully informed buyers.

Proposition 2 When sellers are not strategic (or buyers are not-informed), the socially optimal interchange fees are lower than the privately optimal interchange fees if and only if the average net surplus of buyers exceeds the average net surplus of sellers: $v^B > v^S$.

In the case that sellers are not strategic (or buyers are not-informed), we have $\alpha = 0$. Then, the formulas (13) and (15) become:

$$\frac{p^B_{planner}}{\eta^B_{planner}} = \frac{p^S}{\eta^S}\frac{v^S}{v^B}$$

$$\frac{p^B_{network}}{\eta^B_{network}} = \frac{p^S}{\eta^S}$$

Since $\frac{p^k}{\eta^k}$ is a decreasing function,

$$p^B_{network} < p^B_{planner} \Leftrightarrow \frac{p^B_{network}}{\eta^B_{network}} > \frac{p^B_{planner}}{\eta^B_{planner}} \Leftrightarrow v^B > v^S .$$

Regarding the seller's side:

$$\frac{p^S_{planner}}{\eta^S_{planner}} = \frac{p^B}{\eta^B}\frac{v^B}{v^S}$$

$$\frac{p^S_{network}}{\eta^S_{network}} = \frac{p^B}{\eta^B}$$

We have $p^S_{network} > p^S_{planner} \Leftrightarrow \frac{p^S_{network}}{\eta^S_{network}} < \frac{p^S_{planner}}{\eta^S_{planner}} \Leftrightarrow v^B > v^S$.

III. Conclusions

We performed an in-depth analysis of the initial model developed in Rochet and Tirole (2002), by relaxing several assumptions. We solved the model by including extensions that have been suggested in several articles but have not been analysed together. Thus, the model presented here reflects more realistically the payment card industry.

Generally, the related literature focuses on asymmetric models (in which merchants are homogeneous, while the buyers are heterogeneous). The model presented here allows for strategic behaviour of merchants in a card payment system with a for-profit platform, unobservable heterogeneity across merchants and not-fully informed customers. In addition, we considered imperfect competition of *both* issuers and purchasers. Due to the inclusion of all these assumptions, we do not obtain an explicit form for the IFs, but only optimality conditions which allow for a comparison between private and social levels.

The setting we presented is not exhaustive and other important improvements can be added. More specifically, the model could be extended by allowing the comparison between debit and credit cards or by considering competing platforms, but keeping all the others assumptions of our model.

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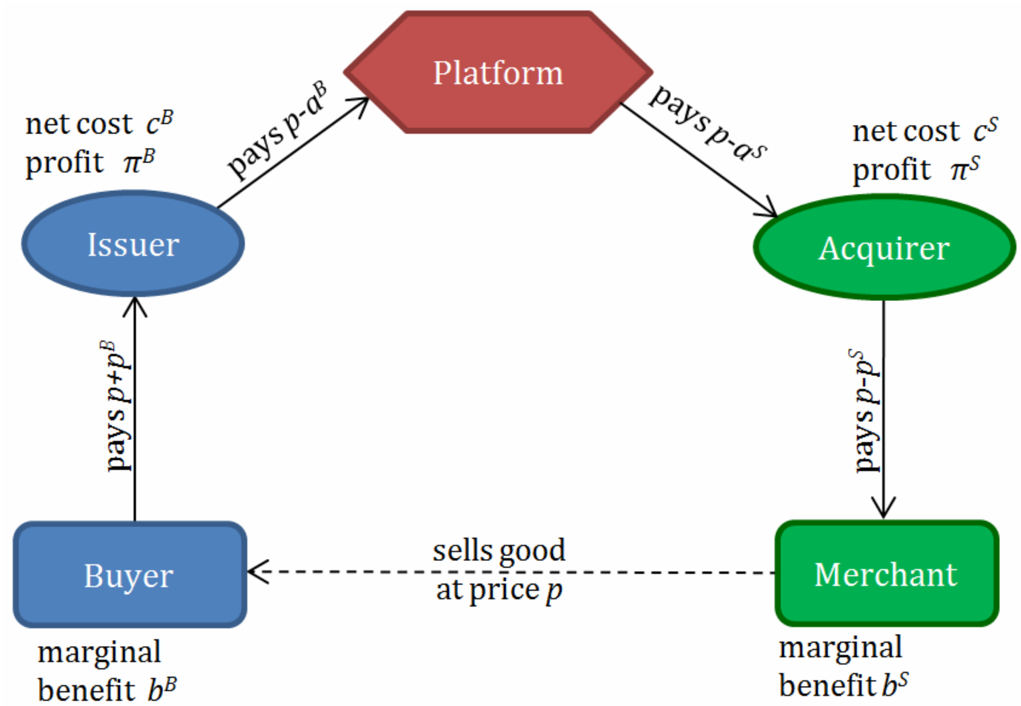
Appendix 1

The working of the payment card industry



Appendix 2

The welfare function $W\left(b_m^B, b_m^S\right)$ is given by:

$$W\left(b_m^B, b_m^S\right)=\int_{b_m^B}^{+\infty}\int_{b_m^S}^{+\infty}\left(b^B+b^S-c\right)g\left(b^S\right)h\left(b^B\right)db^S\,db^B$$

We rewrite it as follows:

$$W\left(b_m^B, b_m^S\right)=\int_{b_m^B}^{+\infty}\left[\int_{b_m^S}^{+\infty}\left(b^B+b^S-c\right)g\left(b^S\right)db^S\right]h\left(b^B\right)db^B$$

$$W\left(b_m^B, b_m^S\right)=\int_{b_m^B}^{+\infty}\left[b^B\int_{b_m^S}^{+\infty}g\left(b^S\right)db^S+\int_{p^S}^{+\infty}\left(b^S-c\right)g\left(b^S\right)db^S\right]h\left(b^B\right)db^B$$

$$W\left(b_m^B, b_m^S\right)=\int_{b_m^B}^{+\infty}\left\{b^B h\left(b^B\right)\left[\int_{b_m^S}^{+\infty}g\left(b^S\right)db^S\right]+h\left(b^B\right)\left[\int_{b_m^S}^{+\infty}\left(b^S-c\right)g\left(b^S\right)db^S\right]\right\}db^B$$

Because $v^S\left(b_m^S\right)+b_m^S=\dfrac{\int_{b_m^S}^{+\infty}b^S g\left(b^S\right)db^S}{D^S\left(b_m^S\right)}$, we have:

$$\int_{b_m^S}^{+\infty}\left(b^S-c\right)g\left(b^S\right)db^S=\int_{b_m^S}^{+\infty}b^S g\left(b^S\right)db^S-c\int_{b_m^S}^{+\infty}g\left(b^S\right)db^S$$

$$=\left[b_m^S+v^S\left(b_m^S\right)\right]D^S\left(b_m^S\right)-cD^S\left(b_m^S\right)$$

$$=\left[b_m^S+v^S\left(b_m^S\right)-c\right]D^S\left(b_m^S\right)$$

Therefore, we obtain:

$$W\left(b_m^B, b_m^S\right)=\int_{b_m^B}^{+\infty}\left[b^B h\left(b^B\right)D^S\left(b_m^S\right)+h\left(b^B\right)\left(b_m^S+v^S\left(b_m^S\right)-c\right)D^S\left(b_m^S\right)\right]db^B$$

$$W\left(b_m^B, b_m^S\right)=D^S\left(b_m^S\right)\int_{b_m^B}^{+\infty}b^B h\left(b^B\right)db^B+D^S\left(b_m^S\right)\left(b_m^S+v^S\left(b_m^S\right)-c\right)\int_{b_m^B}^{+\infty}b^B h\left(b^B\right)db^B$$

$$W\left(b_m^B, b_m^S\right)=D^B\left(b_m^B\right)D^S\left(b_m^S\right)\left[b_m^B+v^B\left(b_m^B\right)\right]+D^B\left(b_m^B\right)D^S\left(b_m^S\right)\left[b_m^S+v^S\left(b_m^S\right)-c\right]$$

$$W\left(b_m^B, b_m^S\right)=D^B\left(b_m^B\right)D^S\left(b_m^S\right)\left[b_m^B+b_m^S+v^B\left(b_m^B\right)+v^S\left(b_m^S\right)-c\right]$$