Jean Tirole, Nobel Prize Winner

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Abstract

The Royal Swedish Academy of Sciences awarded the Nobel Prize in Economic Sciences for 2014 to Jean Tirole, Toulouse School of Economics (TSE), Toulouse, France "for his analysis of market power and regulation." What commonly characterizes Jean Tirole's work is a combination of rigorous scientific analysis of markets and provision of useful scientific insights and policy guidance for regulation and competition policy in such markets. This paper focuses on two of Tirole's papers, both co-written with Jean-Charles Rochet, which probably best exemplify his policy-oriented research. It summarizes and then explains how the theory that these papers develop led to the implementation of a new policy regulating the payment card industry in the European Union.

JEL Codes: G28, L11, L14, L51
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1 Introduction

The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2014 was awarded to Jean Tirole, Toulouse School of Economics (TSE), Toulouse, France. At the Nobel Banquet in the Stockholm City Hall on December 10, 2014,[1] Jean Tirole began his speech with a quote from John Maynard Keynes's 1930 essay *Economic Possibilities for Our Grandchildren*:[2]

> "If economists could manage to get themselves thought of as humble, competent people, on a level with dentists, that would be splendid!"

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[1] The video clip of his Nobel Banquet speech delivered on December 10, 2014 at the Stockholm City Hall is available at:
<http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2014/tirole-speech.html>.

[2] The essay was published in Keynes (1931).

Eighty-five years later, in line with Keynes's wish, we have seen the development of more narrowly specialized fields in the economic sciences. While he has published on a number of topics, Tirole is a specialist in the sense that he has dedicated his research to the task of unveiling the mechanism of how markets work in various industries, and to communicating his research results to regulators. He thereby has raised their understanding of where, when and how they should intervene in markets. In his interview on December 6, 2014, Tirole explained to the Nobel Media that his field is "very diverse and very rich" because "all industries are different" giving, as an example, the fact that the payment card industry doesn't work at all like cement industry or the telecoms industry.[3]

What Keynes might not have expected is that research in such a specialized area can still make a significant difference to the welfare of the society and even deserve a Nobel prize. In his banquet speech Tirole continued as follows:

> "Recognizing that industries are different from each other and evolve rapidly, researchers in industrial organization have patiently built a body of knowledge that has helped regulators to better understand market power and the effects of policy interventions, and helped firms to formulate their strategies. They have thereby contributed to making this world a better world, the economist's first mission."

1.1 Biography of Jean Tirole

Jean Tirole was born on August 9, 1953 in Troyes, France to a father who was a gynecologist and obstetrician and to a mother who was a humanities professor. When he was a high school student, he liked mathematics and social sciences such as history and psychology. He studied mathematics and engineering. Tirole received degrees in engineering from the École Polytechnique, Paris in 1976 and from the École Nationale des Ponts et Chaussées, Paris in 1978. He also received a Doctorat de troisième cycle in decision mathematics from the University Paris IX in 1978.

Tirole encountered economics relatively late, only when he was 21, and he loved it as it has both rigor of math and human aspect of social sciences. In 1978 he came to the United States to study economics at the Massachusetts Institute of Technology (MIT). He wrote a dissertation entitled *Essays in Economic Theory* under the supervision of Eric Maskin and received a Ph.D. in Economics in 1981. His dissertation pieces came out in three separate publications: a 1982 *Econometrica* paper "On the Possibility of Speculation under Rational Expectations," and two *Journal of Economic Theory* papers; "Capital as a Commitment: Strategic Investment to

[3]The video clips of the Nobel Media's interview with Jean Tirole on December 6, 2014 are available at:
<http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2014/tirole-interview.html>.

Deter Mobility" (Fudenberg and Tirole, 1983) and "On the Efficiency of Fixed Price Equilibrium" (Maskin and Tirole, 1984).

From 1984 to 1992, Tirole taught at MIT as an associate professor and then as a full professor. Much of his contribution to oligopoly theory was made with economists such as Eric Maskin and Drew Fudenberg while he was at MIT.

In 1991, he moved to Toulouse to join the Institute of Industrial Economics (IDEI) which was founded by Jean-Jacques Laffont in 1990. IDEI, a research center in the University of Toulouse 1 Capitole, is often referred to as the birthplace of the "Toulouse School of Economics" where Tirole and Laffont wrote several influential papers on procurement contracts. Tirole has described Eric Maskin and Jean-Jacques Laffont as his role models. Laffont passed away on May 1, 2004 at age 57. In the telephone interview with the Nobel Media on October 13, 2014, following the announcement of the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel, Tirole told Dr. Adam Smith, Chief Scientific Officer of Nobel Media, that Laffont "probably would have deserved to be with me today in this prize for regulation and competition policy".[4]

Tirole's work with Laffont corresponded with the rise of privatization of publicly monopolized industries in the 1980s and 1990s in many countries. Tirole explained to the Nobel Media that they "try to understand what regulation should look like in such industries. So, you know, opening access to entrants in a way that is going to keep the infrastructure built. That's actually a difficult task. But it's true that we need competition. That competition doesn't come about easily in such industries by definition, so that's why you need an economic framework to analyse this."[5]

Tirole's work on two-sided markets with Jean-Charles Rochet also started in Toulouse. A two-sided market is a market where one or more intermediaries provide a platform(s) that can enable transactions between two groups.[6] Two-sided markets often exhibit unusually highly skewed fee structures, with one group paying nothing or even being rewarded while the other group pays a high fee. They theoretically analyzed how such skewed pricing patterns could emerge in two-sided markets. Interestingly, unlike the previous study of excessive pricing by large firms with Laffont, the authors concluded that this highly skewed pricing pattern is unrelated to market power. Rather, it stems from the nature of a two-sided market, namely the presence in such a market of network externalities. Rochet and Tirole also found that the resulting fee structure does not reflect a fair cost allocation and then went on to study the optimal regulation of the fees. Their resulting proposal was eventually adopted by the European Commission.

Around the same time, game theory, contract theory, information theory and

[4] A transcript of telephone interview is available at:
<http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2014/tirole-telephone.html>.

[5] The source is the same as the one cited in footnote 4.

[6] Section 2 explains the two-sided market in detail.

theory of mechanism design had rapidly advanced. Jean Tirole is also an expert in these branches of theory. By combining his expertise as a theorist with an in-depth knowledge of industrial organization, Tirole produced a steady stream of contributions to the theory and practice of regulation of both old and new industries.

Professor Tore Ellingsen, a member of the Royal Swedish Academy of Sciences and the Chairman of the Economics Sciences Prize Committee, remarked in his award ceremony speech on December 10, 2014 on a number of regulatory proposals which Tirole has tailored for each uniquely characterized industry:[7]

> "Dear Professor Tirole,
>
> Once upon a time, we sought a magic sword that would cut through any stone. Then, one day a new blacksmith arrived. He forged many swords, each of them stronger and more flexible than any we had seen before, and he showed us which sword cut which sort of stone. Finally, on each sword, he engraved Voltaire's commandment: Un grand pouvoir impose une lourde responsabilité (With great power comes great responsibility).
>
> You are that blacksmith."

To Ellingsen's statement I would add that Tirole's swords are so powerful because he combines a superb command of theory and the institutional knowledge of where best to apply it.

Tirole served as president of the Econometric Society in 1998 and of the European Economic Association in 2001. He has been a foreign honorary member of the American Academy of Arts and Sciences and of the American Economic Association since 1993.

He is currently the chairman of Toulouse School of Economics (TSE), the chairman of the Jean-Jacques Laffont-TSE Foundation, and the scientific director of the Institute for Industrial Economics (IDEI), University of Toulouse Capitole. He also holds a visiting position at the Massachusetts Institute of Technology (MIT).

1.2 Jean Tirole's work

Jean Tirole has made important theoretical contribution in a number of areas in the field of industrial organization. The most important of these may be categorized in the following three areas:[8]

[7] A transcript of presentation speech by Professor Tore Ellingsen, Member of the Royal Swedish Academy of Sciences, Chairman of the Economics Sciences Prize Committee on December 10, 2014 is available at:
<http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2014/presentation-speech.html>.

[8] For a more extensive review of his work, see the scientific background note compiled by the Economic Sciences Prize Committee of the Royal Swedish Academiy of Sciences (2014).

1. *Public regulation of natural monopoly.*[9] The modelling of incentive contracts under asymmetric information (Laffont and Tirole, 1986), regulatory capture (collusion between regulatory agencies and regulated firms) (Laffont and Tirole, 1991), dynamic contracting (Freixas *et al.*, 1985; Laffont and Tirole, 1988; Hart and Tirole, 1988; Laffont and Tirole, 1990a), and regulation of access prices (Laffont and Tirole, 1990b, 1994),

2. *Oligopoly theory and regulation of a dominant firm.* The modeling of strategic investments and R&D races (Fudenberg *et al.*, 1983; Fudenberg and Tirole, 1984; Lerner and Tirole, 2002), dynamic oligopoly (Maskin and Tirole, 1987, 1988a, 1988b), and co-marketing (Lerner and Tirole, 2004),

3. *Regulation of industries with network externalities.* The modeling of two-way access pricing in network competition (Laffont *et al.*, 1998a, 1998b; Laffont and Tirole, 2001) and access pricing in two-sided platform markets (Rochet and Tirole, 2002, 2003, 2006, 2011).

In his Nobel lecture Tirole emphasized that the economist's social responsibility is to "develop a rigorous analysis of how markets work" and to "participate in policy debate."[10] In this paper, I focus on two papers that Tirole wrote with Jean-Charles Rochet (Rochet and Tirole, 2003, 2011) which I believe best exemplify his policy-oriented research.[11] I review how their theoretical contribution and continuous effort for communicating with policymakers helped to shape a new policy to regulate the card payment industry in the European Union.

The paper "Platform Competition in Two-Sided Markets" (Rochet and Tirole, 2003) develops a theory of two-sided market and points out that any two-sided market may generate a pricing pattern that favors one side, and that this may not be fair to the other side. It turns out that the two-sidedness of market can be found in many old and new industries and a number of industries have been studied by other economists in the context of two-sided markets. Unusual pricing patterns are indeed observed in many of these industries, which led to extensive policy debate among regulatory economists and antitrust agencies concerning whether policy intervention is necessary.[12] The most intensely investigated industry is the payment card industry. The paper "Must-Take Cards: Merchant Discounts and Avoided Costs" (Rochet and Tirole, 2011) proposes a methodology called the "tourist test" which provides

[9] Laffont and Tirole (1993) summarizes their work in this area.

[10] The video clip of his Nobel-prize lecture delivered on December 8, 2014 at Aula Magna, Stockholm University and the lecture slides are available at:
<http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2014/tirole-prize-present.html>.

[11] The 2003 paper, cited over 2100 times according to Google Scholar, is among his most highly cited papers.

[12] For example, see the OECD (2009) report of the Policy Roundtable on two-sided markets.

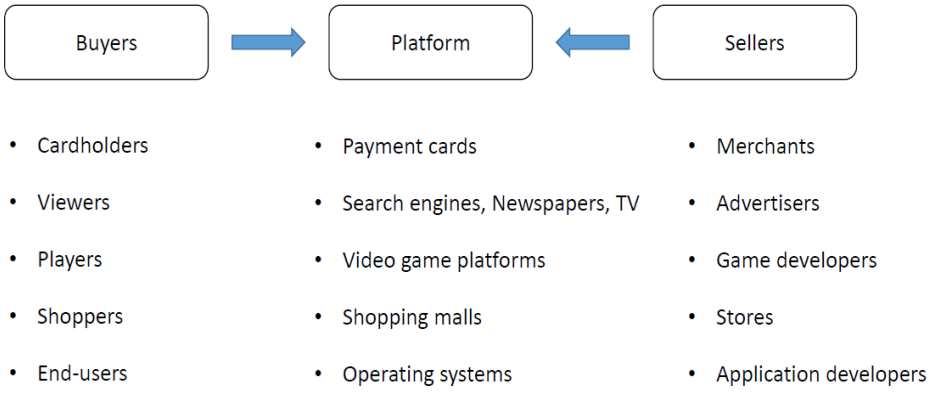


Figure 1: Examples of two-sided markets

practical guidance for assessing the "interchange" fee charged by the payment card industry. The European Commission adopted the tourist test as its benchmark for the regulation of interchange fees charged by Visa and MasterCard.

The rest of the paper is organized as follows: Section 2 briefly introduces the economics of two-sided markets. Section 3 summarizes key features and main results of Rochet and Tirole (2003). Section 4 reviews how its application to the payment card industry and a policy proposal by Rochet and Tirole (2011) helped shape the new regulation. Section 5 concludes the paper.

2 The Economics of Two-Sided Markets

This section gives a brief introduction to the economics of two-sided markets.[13]

2.1 What is a two-sided market?

A two-sided market is a market where one or more intermediaries provide a platform(s) that can enable transactions between sellers (S) and buyers (B). An intermediary of a platform may then charge both sides a fee for accessing its platform. Figure 1 lists some well-known examples of two-sided markets. In general, provision of such platforms can be viewed beneficial to both sides as it can make transaction between sellers and buyers more efficient by reducing search and transaction costs.

What makes a two-sided market different from a single-sided market is that participation of one side of the market is influenced by participation of the other side of the market. In other words, in a two-sided market there are *network externalities*. The benefit from participating in a platform stems from the transactions that arise.

[13]Rysman (2009) discusses the rapid growth in the number of studies of two-sided markets and their policy implications.

For a transaction to occur, both sides must be on the platform. The platform owner's pricing strategy therefore aims to "bring both sides on board."

Given such a pricing strategy, the resulting fee structure in a two-sided market can look unusually skewed either towards the seller side or towards the buyer side. In some markets, the platform demands a positive fee from sellers, but a zero or even a negative fee from buyers. In other markets, the seller side pays low fees and the buyer side pays high fees. Table 1 shows some examples of the two different pricing patterns. One question naturally arises: What explains these skewed pricing patterns?

Platform	Buyer side (Loss-leader/ break-even segment)	Seller side (Profit-making segment)
Credit cards	Cardholders	Merchants
Serach engines, Newspapers, TV	Viewers	Advertisers
Video game platforms	Players	Game developers
Shopping Malls	Shoppers	Stores

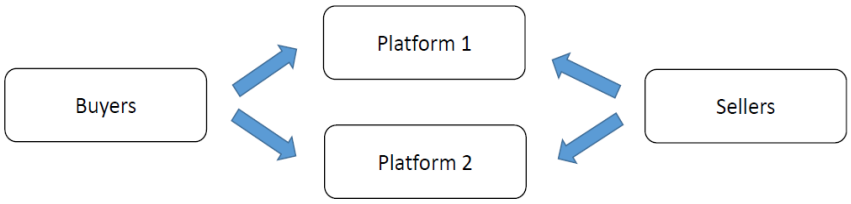
(a) Business models that favor buyer side

Platform	Buyer side (Profit-making segment)	Seller side (Loss-leader/ break-even segment)
Debit cards	Cardholders	Merchants
Operating systems	End-users	Application developers

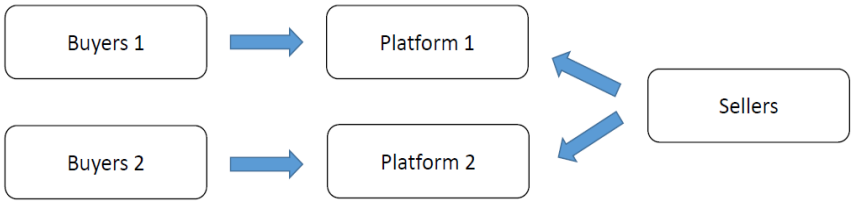
(b) Business models that favor seller side

Table 1 Patterns of pricing strategy

Rochet and Tirole (2003) is a pioneering work in this field; it theoretically investigates the fees that a platform should optimally set for the two sides of the market. The authors study the above-stated question of why different patterns of pricing strategy



(a) Multihoming buyers



(b) Singlehoming buyers

Figure 2: Singlehoming/ Multihoming buyers

are observed in two-sided markets and what factors affect the pricing strategy. They show that the presence of marquee buyers and captive buyers on the one hand, and multihoming (a term that will be defined below) on the other, can give rise to a very skewed pricing patterns and therefore can explain different patterns in fee structures.

Rochet and Tirole (2003) also analyzes how the optimal fee structure is affected by platform governance (for-profit or not-for-profit) and by market structure (monopoly or duopoly). To understand the platform's strategic pricing behavior in the case of competition, the following two concepts become very important:

- *Multihoming/ Singlehoming.* – When two platforms compete, sellers and buyers may participate in a single platform to "singlehome" or participate in both platforms to "multihome." Rochet and Tirole (2003) introduces an index, $\sigma \in [0, 1]$, which measures the loyalty of buyers and call it the "singlehoming index". To understand the nature of this index, Figure 2 depicts two extreme cases ($\sigma = 0$ and 1). As shown in Figure 2 (a), if all buyers are multihoming, buyers' demand is independent of the seller's platform participation. In this case, the singlehoming index is $\sigma = 0$. On the other hand, as shown in Figure 2 (b), if no buyers are multihoming, all buyers of platform 1, for example, are lost when the seller stops participating in platform 1. In this case the singlehoming index is $\sigma = 1$.

- *Steering.* – A platform owner can strategically increase demand for its own platform service in two ways: By setting a lower fee to sellers, it can attract additional sellers from the lower fee, induce some sellers to stop participating in the rival's platform and singlehome on its platform. The latter strategy of undercutting the rival's platform is known as "steering". The effectiveness of steering depends negatively on the singlehoming index, σ. That is, when more buyers singlehome (a high σ), sellers have less incentive to stop participating in the rival's platform even if the rival's platform is more expensive because getting off that platform leads to a immediate loss of buyers who singlehome only with that platform. The effectiveness of steering is zero when $\sigma = 1$ and the effectiveness of steering is infinite when $\sigma = 0$.

2.2 When does a policy problem arise?

In a two-sided market, an owner of a private platform may charge and arbitrarily allocate the cost to either side. This can possibly lead to a very skewed pricing. Often, the singlehoming side is treated favorably and may even receive a subsidy instead of paying a fee. This is because the fee structure in a two-sided market aims at "getting both sides on board" but not at "allocating costs fairly." Interestingly, this principle of "getting both sides on board" holds even if a platform is managed by a Ramsey planner. Of course, Ramsey pricing differs from the private fee structure in the sense that it takes care of the average surplus generated on the other side of the market but neither a private nor a Ramsey fee structure need reflect a fair cost allocation.

A fair cost allocation should reflect the value of the transactional benefits that the participation in the platform generates for each side of the market. Rochet and Tirole (2011) developed a methodology called the "tourist test" for the assessment of fees set by a platform in the payment card industry. The European Commission has adopted this methodology for regulating open system of Visa and MasterCard.

3 Rochet and Tirole (2003)

Rochet and Tirole (2003) first analyze how the fee structure is affected by platform governance (for-profit or not-for-profit) and by market structure (monopoly or duopoly). They then study determinants of the fee structure.

3.1 Pricing in a two-sided market

Throughout the analysis, the authors maintain the following assumptions:

A1. Buyers and sellers are heterogeneous. Their benefits from transacting vary and are private information.

A2. The buyers' expected demand D^B for the platform service,

$$D^B\left(p^B\right) = \Pr(b^B \geq p^B),$$

is independent of the sellers' expected demand D^S for the platform service,

$$D^S\left(p^S\right) = \Pr\left(b^S \geq p^S\right).$$

Here p^B and p^S are the fees charged by the platform owner, and b^B and b^S are the buyers' and sellers' benefits of using the platform for their transaction. These benefits are exogenous, independently distributed.

A3. D^B and D^S are log concave.

A4. The matching process between buyers and sellers is taken as given. A proportion of such matches result in a transaction. The resulting volume of transactions is specified to be

$$D^B\left(p^B\right) D^S\left(p^S\right).$$

A5. The marginal costs of serving a buyer and a seller are constant and equal to $c^B \geq 0$ and $c^S \geq 0$ respectively. The platform's total marginal cost of transactions is $c = c^B + c^S \geq 0$.

I shall now describe four different types of platforms. Each has its own optimal fee structure.

3.1.1 I. Monopolized for-profit platform

A monopoly platform maximizes its profit π by choosing $\left(p^B, p^S\right)$:

$$\max_{p^B, p^S} \pi = \left(p^B + p^S - c\right) D^B\left(p^B\right) D^S\left(p^S\right). \tag{1}$$

From the first-order necessary conditions, the equilibrium fee structure of a monopolized for-profit platform is characterized by the ratio of elasticities,

$$\frac{p^B}{\eta^B\left(p^B\right)} = \frac{p^S}{\eta^S\left(p^S\right)} = p^B + p^S - c, \tag{2}$$

where

$$\eta^B \equiv -\frac{p^B D^{B\prime}}{D^B} \text{ and } \eta^S \equiv -\frac{p^S D^{s\prime}}{D^S} \tag{3}$$

are the price elasticities of demand on the buyer side and the seller side respectively.[14]

[14] Eq. (2) also implies that the total price, $p = p^B + p^S$, is determined by the standard Lerner formula,

$$\frac{p - c}{p} = \frac{1}{\eta},$$

where $\eta = \eta^B + \eta^S$.

3.1.2 II. Monopolized not-for-profit association

A monopoly association's problem is to maximize its transaction volume by choosing $\left(p^B, p^S\right)$:

$$\max_{p^B, p^S} Q = D^B\left(p^B\right) D^S\left(p^S\right), \tag{4}$$

subject to

$$p^B + p^S = c + m, \tag{5}$$

where $m = m^B + m^S$ is the total margin and m^B and m^S are constant in light of the following assumption:

A6. Intraplatform competition results in constant equilibrium margins charged by members on downstream markets.

From the first-order necessary conditions, the equilibrium fee structure of a monopolized not-for-profit association is characterized by

$$\frac{p^B}{\eta^B\left(p^B\right)} = \frac{p^S}{\eta^S\left(p^S\right)}, \tag{6}$$

and

$$p^B + p^S = c + m. \tag{7}$$

3.1.3 III. Competing for-profit platforms

To analyze competition between two platforms (i and j), additional assumptions are introduced:

A7. The buyers' expected demand D_i^B for Platform i's service when the seller is affiliated only with Platform i is

$$D_i^B\left(p_i^B\right) = \Pr(b_i^B \geq p_i^B),$$

and the buyers' expected demand d_i^B for Platform i's service when the seller is affiliated with both platforms is

$$d_i^B\left(p_1^B, p_2^B\right) = \Pr\left[b_i^B - p_i^B > \max\left(0, b_j^B - p_j^B\right)\right].$$

A8. d_i^B is log concave.

A9. $d_i^B \leq D_i^B \leq d_1^B + d_2^B$ is satisfied.

Rochet and Tirole (2003) also introduce an index, σ_i, called the "singlehoming index" of platform i. The index $\sigma_i \in [0,1]$ reflects the degree of buyers' loyalty to platform i and is denoted as

$$\sigma_i\left(p_1^B, p_2^B\right) \equiv \frac{d_1^B\left(p_1^B, p_2^B\right) + d_2^B\left(p_1^B, p_2^B\right) - D_j^B\left(p_j^B\right)}{d_i^B\left(p_i^B\right)} \quad \text{for } i,j = 1,2;\ i \neq j. \tag{8}$$

If all buyers on platform i are lost when the seller stops affiliating with platform i, i.e., if $D_j^B = d_j^B$, the index is then $\sigma_i = 1$. In this case, the effectiveness of steering is zero. On the other hand, if buyers' demand is independent of the seller's platform affiliation, i.e., if $d_1^B + d_2^B = D_j^B$, the index is $\sigma_i = 0$. In this case, the effectiveness of steering is infinite.

A proprietary platform i maximizes its profit π_i by choosing $\left(p_i^B, p_i^S\right)$:

$$\max_{p_i^B, p_i^S} \pi_i = \left(p_i^B + p_i^S - c\right) Q_i\left(p_i^B, p_i^S\right) \tag{9}$$

where, by focusing on the analysis of a symmetric equilibrium ($p_1^S = p_2^S = p^S$ and $p_1^B = p_2^B = p^B$), the total expected volume of transaction on the platform i is

$$Q_i = d_i^B\left(p^B, p^B\right) D^S\left(p^S\right) \text{ for } i = 1,2. \tag{10}$$

From the first-order necessary conditions, the equilibrium fee structure of competing for-profit platforms is characterized by

$$\frac{p^B}{\eta_o^B} = \frac{p^S}{(\eta^S/\sigma)} = p^B + p^S - c, \tag{11}$$

where

$$\eta_o^B \equiv -\frac{\partial Q_i}{\partial p_i^B}\frac{p_i^B}{Q_i} \text{ and } \frac{\eta^S}{\sigma} \equiv -\frac{\partial Q_i}{\partial p_i^S}\frac{p_i^S}{Q_i} \tag{12}$$

are the own-brand price elasticities of demand on the buyer side and the seller side respectively.

3.1.4 IV. Competing not-for-profit associations

Association i's problem is to maximize its transaction volume by choosing the fees $\left(p_i^B, p_i^S\right)$.given the fees $\left(p_j^B, p_j^S\right)$ of the rival association's platform:

$$\max_{p^B, p^S} Q_i\left(p_i^B, p_i^S\right), \tag{13}$$

subject to

$$p_i^B + p_i^S = c + m. \tag{14}$$

From the first-order necessary conditions, by focusing on the analysis of a symmetric equilibrium, the equilibrium fee structure of competing not-for-profit associations is characterized by

$$\frac{p^B}{\eta_o^B} = \frac{p^S}{\eta^S/\sigma}, \tag{15}$$

and

$$p^B + p^S = c + m. \tag{16}$$

Table 2 summarizes equilibrium fee structures by market structure and platform governance:

	I	II	III	IV
Market Structure	Monopoly	Monopoly	Duopoly $i = 1,2$	Duopoly $i = 1,2$
Governance of Platform	For-profit	Not-for-profit Association	For-profit	Not-for-profit Associtions
Platform's Problem	$Max.\ \pi$	$Max.Q$	$Max.\pi_i$	$Max.Q_i$
Fee Structure	$\frac{p^B}{\eta^B} = \frac{p^S}{\eta^S} = p^B + p^S - c$	$\frac{p^B}{\eta^B} = \frac{p^S}{\eta^S};\ p^B + p^S = c + m$	$\frac{p^B}{\eta_o^B} = \frac{p^S}{\eta^S/\sigma} = p^B + p^S - c$	$\frac{p^B}{\eta_o^B} = \frac{p^S}{\eta^S/\sigma};\ p^B + p^S = c + m$

Table 2. Equilibrium fee structures by market structure and platform governance

Remark 1 *Different governance forms (for-profit and not-for profit) have the same fee structure in the sense that they generate the same fees for a given fee-level target* [15] $p = p^B + p^S$.

Remark 2 *Different market structures (monopoly and duopoly) have the same fee structure except the demand elasticities,* η^B *and* η^S*, are replaced by the own-brand elasticities,* η_o^B *and* η^S/σ*, on the buyer side and the seller side respectively.*

The Ramsey planner's problem is studied next to compare its pricing with private pricing.

[15] By "target" the authors mean an exogenously set total fee.

3.1.5 Ramsey planner pricing

The Ramsey fee structure maximizes the two-end users' welfare:

$$\max_{p^B,p^S} W = V^S\left(p^S\right) D^B\left(p^B\right) + V^B\left(p^B\right) D^S\left(p^S\right), \tag{17}$$

subject to

$$p^B + p^S = c, \tag{18}$$

where

$$V^S\left(p^S\right) = \int_{p^S}^{+\infty} D^S\left(t\right) dt \text{ and } V^B\left(p^B\right) = \int_{p^B}^{+\infty} D^B\left(t\right) dt, \tag{19}$$

are the net surpluses of an average transaction on the seller side and buyer side respectively.

From the first-order necessary conditions, Ramsey pricing is characterized by

$$\frac{p^B}{\eta^B}\left[\frac{V^B}{D^B}\right] = \frac{p^S}{\eta^S}\left[\frac{V^S}{D^S}\right], \tag{20}$$

and

$$p^B + p^S = c. \tag{21}$$

Comparing Ramsey pricing, given by eqs. (20) and (21), to the private outcomes listed in Table 2, we find the following:

Remark 3 *Pricing of not-for-profit associations (monopoly or duopoly) does not coincide with Ramsey pricing even when downstream markets are perfectly competitive (i.e., $m = 0$). This is because the associations do not internalize the end-users surpluses.*

Remark 4 *Ramsey fee structure, p^B/p^S, is not proportional to the relative net surpluses, V^B/V^S, of two end-users.*

3.2 Patterns of pricing strategy

As discussed in Section 2, a unique feature of a two-sided market is that a platform usually treats one side as a profit-making segment and the other as a loss-leader. This is shown in Table 1 in Section 2. Why are different pricing strategies observed in two sided markets? What are the determinants of these pricing strategies? Rochet and Tirole (2003) offer answers to these questions. They show that the presence of marquee buyers and captive buyers can affect the platform owner's pricing strategy. The same is true when there is a change in the single homing index of buyers. In their model, these exogenous changes in the market environment are captured by a parameter θ.

3.2.1 Marquee buyers

Marquee buyers can boost the seller's surplus. Thus the presence of these buyers can be captured by a demand-shift parameter θ, i.e.,

$$D^S\left(p^S, \theta\right) = D^S\left(p^S - \theta\right).$$

Monopolized for-profit platform: The presence of marquee buyers in the monopolized for-profit platform changes the equilibrium fee structure, eq. (2), as follows:

$$\lambda^B\left(p^B\right) = \lambda^S\left(p^S, \theta\right) = \frac{1}{p^B + p^S - c}, \tag{22}$$

where

$$\lambda^B\left(p^B\right) \equiv -\frac{\left(D^B\right)'}{D^B} \text{ and } \lambda^S\left(p^S, \theta\right) \equiv -\frac{\left(D^S\right)'}{D^S}. \tag{23}$$

Demands are assumed to be log-concave, i.e.,

$$\frac{\partial \lambda^B}{\partial p^B} > 0, \frac{\partial \lambda^S}{\partial p^S} > 0, \text{ and } \frac{\partial \lambda^S}{\partial \theta} < 0. \tag{24}$$

Comparative static analysis with respect to θ thus yields

$$\frac{dp^B}{d\theta} = \frac{1}{\det|D|}\left(\frac{\partial \lambda^S}{\partial \theta}\right)\left(\frac{1}{(p-c)^2}\right) < 0, \tag{25}$$

and

$$\frac{dp^S}{d\theta} = \frac{-1}{\det|D|}\left(\frac{\partial \lambda^S}{\partial \theta}\right)\left(\frac{\partial \lambda^B}{\partial p^B} + \frac{1}{(p-c)^2}\right) > 0, \tag{26}$$

where $\det|D| > 0$.[16]

Monopolized not-for-profit association: The presence of marquee buyers in the monopolized not-for-profit association changes the equilibrium fee structure, eqs. (6) and (7), as follows:

$$\lambda^B\left(p^B\right) - \lambda^S\left(c + m - p^B, \theta\right) = 0. \tag{27}$$

Using the implicit function theorem and eq. (24), we obtain

$$\frac{dp^B}{d\theta} = \frac{\partial \lambda^S / \partial \theta}{\left(\partial \lambda^B / \partial p^B\right) + \left(\partial \lambda^S / \partial p^S\right)} < 0. \tag{28}$$

[16] The definition of D is

$$D \equiv \begin{bmatrix} \frac{\partial \lambda^B}{\partial p^B} + \frac{1}{(p-c)^2} & \frac{1}{(p-c)^2} \\ \frac{1}{(p-c)^2} & \frac{\partial \lambda^S}{\partial p^S} + \frac{1}{(p-c)^2} \end{bmatrix},$$

and thus from eq. (24) $\det|D| > 0$.

Since the total fee is fixed ($p^B + p^S = c + m$), the result in eq. (28) implies

$$\frac{dp^S}{d\theta} > 0. \tag{29}$$

Competing not-for-profit associations: When two not-for-profit associations compete, the presence of marquee buyers changes the symmetric equilibrium fee structure, eqs. (15) and (16), as follows:

$$\lambda_o^B\left(p^B\right)\sigma\left(p^B\right) - \lambda^S\left(c + m - p^B, \theta\right) = 0. \tag{30}$$

The implicit function theorem and eq. (24) imply that

$$\frac{dp^B}{d\theta} = \frac{\partial\lambda^S/\partial\theta}{\partial\left[\text{lhs of eq. (30)}\right]/\partial p^B} < 0, \tag{31}$$

where the denominator is assumed to be positive (a regularity condition).

Since the total fee is fixed at $p^B + p^S = c + m$, eq. (31)implies that

$$\frac{dp^S}{d\theta} > 0. \tag{32}$$

Thus, we find that:

Remark 5 *The presence of marquee buyers leads to a higher fee to sellers and a lower fee to buyers in all cases studied above.*

3.2.2 Captive buyers

Captive buyers are loyal to their platform independently of fees. Their presence can be captured by an *additive* demand-shift parameter θ as follows:

$$d_i^B\left(p_1^B, p_2^B, \theta\right) = d_i^B\left(p_1^B, p_2^B\right) + \theta, \tag{33}$$

$$D^B\left(p^B, \theta\right) = D^B\left(p^B\right) + \theta, \tag{34}$$

and

$$\hat{D}^B\left(p^B, \theta\right) = \hat{D}^B\left(p^B\right) + \theta, \tag{35}$$

where $\hat{D}^B\left(= D_1^B = D_2^B\right)$ denotes the buyers' demand for Platform $i = 1, 2$ when the fee structure is symmetric ($p_1^S = p_2^S = p^S$ and $p_1^B = p_2^B = p^B$).

Monopolized for-profit platform: The presence of captive buyers in the monopolized for-profit platform changes the equilibrium fee structure, eq. (2), as follows:

$$\lambda^B\left(p^B, \theta\right) = \lambda^S\left(p^S\right) = \frac{1}{p^B + p^S - c}. \tag{36}$$

A comparative static analysis with respect to θ yields

$$\frac{dp^B}{d\theta} = \frac{-1}{\det|D|}\left(\frac{\partial\lambda^B}{\partial\theta}\right)\left(\frac{\partial\lambda^S}{\partial p^S} + \frac{1}{(p-c)^2}\right) > 0, \tag{37}$$

and

$$\frac{dp^S}{d\theta} = \frac{1}{\det|D|}\left(\frac{\partial\lambda^B}{\partial\theta}\right)\frac{1}{(p-c)^2} < 0, \tag{38}$$

where $\det|D| > 0$ and $\partial\lambda^B/\partial\theta < 0$.[17]

Monopolized not-for-profit association: The presence of captive buyers in the monopolized not-for-profit association changes the equilibrium fee structure, eqs. (6) and (7), as follows:

$$\lambda^B\left(p^B,\theta\right) - \lambda^S\left(c+m-p^B\right) = 0. \tag{39}$$

The implicit function theorem and eq. (24) imply that

$$\frac{dp^B}{d\theta} = -\frac{\partial\lambda^B/\partial\theta}{\left(\partial\lambda^B/\partial p^B\right) + \left(\partial\lambda^S/\partial p^S\right)} > 0. \tag{40}$$

Since the total fee is fixed at $p^B + p^S = c + m$, the result in eq. (40) implies that

$$\frac{dp^S}{d\theta} < 0. \tag{41}$$

Competing not-for-profit associations: The presence of captive buyers in competition between two not-for-profit associations changes the symmetric equilibrium fee structure, eqs. (15) and (16), as follows:

$$\lambda_o^B\left(p^B,\theta\right)\sigma\left(p^B,\theta\right) - \lambda^S\left(c+m-p^B\right) = 0, \tag{42}$$

where the single-homing index of buyers in the symmetric equilibrium is now

$$\sigma\left(p^B,\theta\right) \equiv 2 - \frac{\hat{D}^B\left(p^B\right)+\theta}{d^B\left(p^B\right)+\theta}. \tag{43}$$

Using the implicit function theorem, we obtain

$$\frac{dp^B}{d\theta} = -\frac{\sigma\left(p^B,\theta\right)\left(\partial\lambda_o^B/\partial\theta\right) + \lambda_o^B\left(p^B,\theta\right)\left(\partial\sigma/\partial\theta\right)}{\partial\left[\text{lhs of eq. (42)}\right]/\partial p^B} > 0, \tag{44}$$

[17] Note that

$$\frac{\partial\lambda^B\left(p^B,\theta\right)}{\partial\theta} = \frac{\left(D^B\right)'}{\left[D^B\left(p^B\right)+\theta\right]^2} < 0.$$

where $\partial\lambda_o^B/\partial\theta < 0$, $\partial\sigma/\partial\theta > 0$,[18] and where the denominator is positive from the regularity condition.

Since the total fee is fixed ($p^B + p^S = c + m$), the result in eq. (44) implies that

$$\frac{dp^S}{d\theta} < 0. \tag{45}$$

Thus, we find that:

Remark 6 *The presence of captive buyers leads to a lower fee to the seller and a higher fee to the buyer in all cases studied above.*

3.2.3 Singlehoming of buyers

An exogenous change in singlehoming of buyers can be captured by a shift of the singlehoming index, σ, and can be represented by the parameter θ as follows:

$$\sigma\left(p^B, \theta\right) = 2 - \frac{D^B\left(p^B, \theta\right)}{d^B\left(p^B\right)}, \tag{46}$$

where σ is increasing in θ.

Competing not-for-profit associations: A exogenous shift in the single-homing index of buyers changes the symmetric equilibrium fee structure, eqs. (15) and (16), as follows:

$$\lambda_o^B\left(p^B\right)\sigma\left(p^B, \theta\right) - \lambda^S\left(c + m - p^B\right) = 0. \tag{47}$$

By taking total differentials in eq. (47), we obtain

$$\frac{dp^B}{d\theta} = -\frac{\lambda_o^B\left(p^B\right)\left(\partial\sigma/\partial\theta\right)}{\partial\left[\text{lhs of eq. (47)}\right]/\partial p^B} < 0, \tag{48}$$

where the denominator is positive from the regularity condition and where, in the numerator, the term $\partial\sigma/\partial\theta$ is positive by the results described in footnote 18.

[18] An increase in θ has two opposing effects:

$$\frac{\partial\lambda_o^B\left(p^B, \theta\right)}{\partial\theta} = \frac{-\lambda_o^B}{d^B\left(p^B\right) + \theta} < 0,$$

i.e., reducing the elasticity of buyer, which leads to a higher buyer price, and

$$\frac{\partial\sigma\left(p^B, \theta\right)}{\partial\theta} = -\frac{d^B\left(p^B\right) - \hat{D}^B\left(p^B\right)}{\left[d^B\left(p^B\right) + \theta\right]^2} > 0,$$

where $d^B - \hat{D}^B < 0$ by assumption, i.e., more singlehoming of buyers, which leads to a higher seller price. The first effect dominates the second and thus the buyer price increases.

Since the total fee is fixed at $p^B + p^S = c + m$, the result in eq. (48) implies that

$$\frac{dp^S}{d\theta} > 0. \tag{49}$$

Thus, we find that:

Remark 7 *More singlehoming (multihoming) on the buyer side leads to a higher (lower) fee to the seller and a lower (higher) fee to the buyer in the case of competition between two not-for-profit associations.*

3.3 Implications of the main results

Let us now summarize the findings described in the six remarks we listed in the above subsections. We group the first three separately from the last three.

From *Remarks* 1-4, we find that the fee structures derived from a two-sided market have the following features:

1. *The price-elastic side is treated even more favorably in a market with network externalities.* A standard result is that a monopolist will charge lower markups when the demand curve is more elastic. The new result here is that there is an *additional* effect stemming from the network externality from which the inelastic side benefits when the participation of the elastic traders rises. To "get both sides on board," the platform owner finds it optimal to treat the elastic side of the market more generously. This is optimal because the resulting rise in participation of the elastic side makes it profitable for the inelastic side to raise its participation, because of the network externalities. The platform can then increase its revenue by charging high fees to the inelastic side.

2. *Ramsey fee structures internalize the average surpluses on the other side of the market.* This is the only difference between private pricing and Ramsey pricing.

3. *Neither private nor Ramsey pricing necessarily leads to a fair cost allocation.* By 'fair', we mean that the fee structure is proportional to the benefits that the two end-users enjoy from platform usage.

From *Remarks* 5-7, we find that the pricing strategy in a two-sided market is also influenced by some exogenous factors in the market:

4. *The buyer side is treated favorably when there are marquee buyers.* The presence of marquee buyers increases the sellers' expected demand for a platform service. Thus a platform charges a higher fee to the sellers.

5. *The seller side is treated favorably when there are captive buyers.* The presence of captive buyers increases the buyers' expected demand for a platform service. Thus a platform can charge a higher fee to buyers.

6. *Singlehoming side is treated favorably.* When more buyers are multihoming, sellers are more likely to transact only with a cheaper platform. Therefore, the platform's strategy to undercut the rival's platform ("steering") becomes more effective.

4 Application to the Payment Card Industry: Policy Debate and a New Regulation

The two-sidedness of market is now recognized in many old and new industries. Although a number of industries have been studied in the context of two-sided market, the most studied industry is probably the payment card industry. As is often the case in two-sided markets, the payment card industry has also observed a very skewed pricing pattern that favors cardholders over merchants. This has led to a large policy debate among regulatory economists and antitrust agencies concerning whether policy intervention is necessary and, if so, how it should be done. "Mini case studies" in Rochet and Tirole (2003, in Chapter 7) provide an analysis of a two-sided markets in the context of the payment card industry.

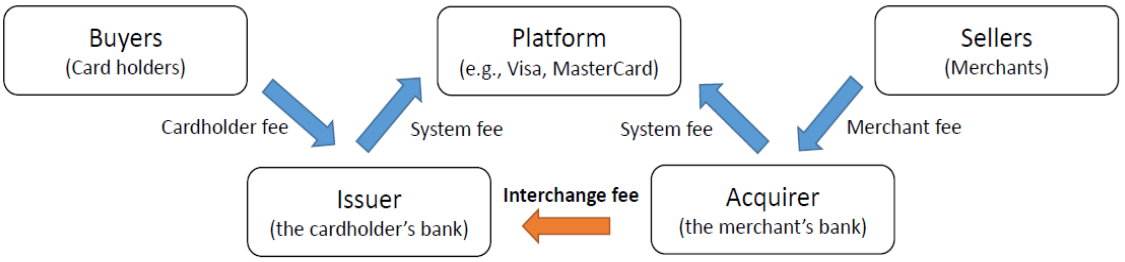
I shall first summarize how their model's main results explain pricing patterns observed in the payment systems of Visa, MasterCard, American Express, and PIN debit cards. I shall then review how a policy proposal by Rochet and Tirole (2011) helped to shape new regulations of the payment card industry in the European Union.

4.1 Explaining pricing practice in the payment card industry

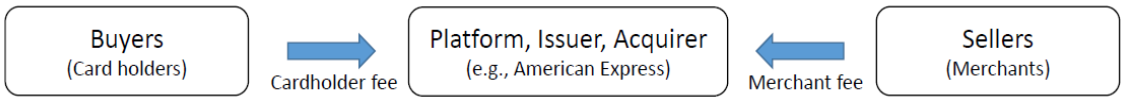
Visa and MasterCard

Visa and MasterCard have a four-party payment system where four entities (buyers, sellers, issuer, acquirer) are interconnected through a platform. In a four-party payment system, any card transaction between buyers (cardholders) and sellers (merchants) are mediated by the member banks. For each card transaction, the member bank pays a system fee to the platform. The merchants' bank (the acquirer) also pays an "interchange fee" to the cardholders' bank (the issuer). These fees are chosen by the platform. Because the system fee is not essential in later discussion, we ignore it to simplify the analysis.

The only strategic decision for platform i (= Visa, MasterCard) is to choose the interchange fee, a_i. Then the issuer's net marginal cost of serving a cardholder is $c^B - a_i$ and the acquirer's net marginal cost of serving a merchant is $c^S + a_i$.



(a) Four-party payment system



(b) Three-party payment system

Figure 3: Credit card payment systems

When a cardholder uses a payment card to buy from a merchant, the merchant must pay a "merchant fee" to the acquirer to receive the sales price. A large part of the merchant fee is explained by the interchange fee. This is because, due to competition among banks, the interchange fee, a_i, is almost fully passed through to merchants (in the form of a higher merchant's fee) and to cardholders (in the form of lower card fees and higher card benefits). Figure 3 (a) shows the relationship of the four entities.

The merchant fee, p_i^B, then is

$$p_i^B = c^B - a_i + m^B, \tag{50}$$

and the cardholder fee, p^S, is

$$p_i^S = c^S + a_i + m^S, \tag{51}$$

where m^B and m^S are constant equilibrium margins charged by member banks on the buyer and seller side respectively.

Notice that

- An increase in a_i results in a higher p^S and a lower p^B, i.e., a reallocation of the cost from the buyer side to the seller side, and that
- Even a negative p_i^B can arise for a sufficiently high a_i.

Since the platform's choice of a_i determines the two end-user fees, the platform's problem can be written as a choice of $\left(p_i^B, p_i^S\right)$ as studied in Chapter 3.

The credit card industry typically sets a high merchant fee and a low (or negative) cardholder fee. That is, the platform treats buyers favorably by setting a very high interchange fee. This pricing pattern can be explained by the presence of price-elastic cardholders and price-inelastic merchants (**Implication 1**, Subsection 3.3) because a low cardholder fee (and raising the merchant fee) can bring more elastic-cardholders on board with minimal harm done to the participation of merchants.

American Express

American Express has a three-party payment system where the owner of the platform, the issuer, and the acquirer are a single entity as shown in Figure 3 (b). The platform's problem can be written as a choice of the two end-user fees $\left(p_i^B, p_i^S\right)$ as studied in Chapter 3. American Express also treats the cardholder side favorably but it has traditionally charged a substantially higher merchant fee than Visa or MasterCard have charged. American Express's even more highly skewed pricing pattern can be explained by merchants' common perception that American Express cardholders are marquee buyers (**Implication 4**). In the early 1990s, however, there was a decline in the merchant fee charged by the American Express. This can be explained by the fact that at around the same time, numerous Visa and MasterCard are offered and as a result more American Express cardholders became also a Visa card and MasterCard holders, i.e., more multihoming occurred on the buyer side, (**Implication 6**).

PIN debit card

Unlike credit cards, the online debit card has a relatively low merchant fee and a positive cardholder fee. Why does it adopt a different pricing strategy? Debit cards are usually linked to the cardholder's bank account. Therefore, debit cardholders remain on the platform as a price-inelastic portion of the demand for the platform's service. We may call them captive buyers and their presence leads to an upward pressure on the cardholder fee (**Implications 5**). On the other hand, the merchant side is price elastic because it must install a costly PIN pad to accept online debit card (**Implication 1**). These points explain why the online debit card platform treats the merchant side favorably.

The application to the payment card industry provides a deeper and a clearer understanding of the logic behind the industry's pricing strategy. At the same time, however, it suggests that the pricing of the fees set by the industry does not necessarily reflect a fair cost allocation between cardholders and merchants but that it instead simply reflects the industry's desire to bring more participation from both sides (**Implications 1 and 2**). This has raised a further question to regulatory economists and antitrust agencies, namely the question *What is a fair pricing?*

4.2 What is a fair pricing?

There has been intense antitrust and regulatory investigation of a high interchange fee set by Visa and MasterCard.[19] Recall that a high interchange fee generates a highly skewed pricing pattern, i.e., a combination of a high merchant fee and a negative or zero cardholder fee. A regulator who does not understand the nature of two-sided markets may wrongly accuse the payment card industry of setting a predatory price on the low-fee side or of levying an excessive fee on the high-price side, despite the fact that such a fee structure can arise regardless of its market power even in a small or an entering platform.

Rochet and Tirole (2002) point out that a high merchant fee in the payment industry stems from the welfare that the cardholder does not internalize when choosing the payment method. To correct this problem, Rochet and Tirole (2011) develop a methodology called "tourist test" to find the level of interchange fee that induces the two end-users to internalize the externalities.

The tourist test considers a customer who is at the cash register and wishes to make a purchase regardless of the means of payment (such as card, cash, or check) and who will make no repeat purchase (like a tourist) so that card acceptance by the merchant does not affect his or her willingness to return to the merchant in future. The hypothetical tourist test reveals the merchant's "convenience" benefit, b^S, of the net cost-savings.

Most importantly, the merchant's willingness to pay for a card can exceed b^S since, by accepting a card payment, the merchant receives an additional benefit of attracting customers – an "attractiveness" benefit. The payment platform can therefore charge the merchant more than b^S in the absence of a regulation. The idea of the tourist cost test is to cap the interchange fee at the merchant's convenience level, b^S, so that the customers internalize the second benefit which stems from the convenience of a card payment for themselves.

Let p^S be the merchant fee, let a be the interchange fee, and let c^B be the acquirer's net marginal cost of serving a merchant. Then we say that "p^S passes the tourist test" if

$$p^S \leq b^S,$$

or alternatively that "a passes the tourist test" if

$$a \leq b^S - c^B.$$

The European Commission adopted the tourist test proposed by Rochet and Tirole (2011) as its benchmark for the regulation of interchange fee charged by Visa and

[19] See Tirole (2011) for a study of payment card regulation in the European Union, the UK, and Australia in the last decade.

MasterCard.[20] On the other hand regulators in the US, and Australia have adopted the issuer-cost-based approach to compute the cap on the interchange fee. Unlike the tourist test, the issuer-cost-based approach is not backed by rigorous economic reasoning. Tirole (2011) states that their approach "unfortunately bears little relationship with the theoretically correct level, which focuses on the acquirer/merchant side rather than on the issuer side".

5 Conclusions

Of the many important theoretical contributions that Jean Tirole has made, I have focused on the ones that have had a significant impact on policy, namely the study of two-sided markets which was done together with Rochet. This work exemplifies how an economist can raise the level of debate among policymakers and thereby lead them to improve their policies. While containing high quality theory, the work recognizes the important institutional features of the markets under study. The combination of these two qualities has led to the work having an important policy impact. Thus, the Nobel Prize that has been awarded to Jean Tirole is richly deserved.

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