THE GRADUATE INSTITUTE GENEVA

INSTITUT DE HAUTES ÉTUDES INTERNATIONALES ET DU DÉVELOPPEMENT
GRADUATE INSTITUTE OF INTERNATIONAL AND DEVELOPMENT STUDIES

Graduate Institute of International and Development Studies

International Economics Department

Working Paper Series

Working Paper No. HEIDWP11-2019

Merchant's Card Acceptance: An extension of the Tourist Test for Developing Countries

Jose Aurazo
Central Reserve Bank of Peru

Jose Vasquez
Central Reserve Bank of Peru

June 2019

Chemin Eugène-Rigot 2
P.O. Box 136
CH - 1211 Geneva 21
Switzerland

Merchant's Card Acceptance: An extension of the Tourist Test for Developing Countries*

Jose Aurazo† Jose Vasquez‡

June, 2019

Abstract

This paper extends the tourist test model proposed by Rochet and Tirole (2011) by incorporating the government in order to take into account informality (understood as tax evasion in cash payments) and the net social cost of cash usage. These two elements are relevant in developing countries, where the shadow economy tends to be large and merchants usually evade taxes in cash transactions. The tourist test aims to determine an interchange fee that does not increase merchants' operating cost of accepting card payments. In the presence of informality, the tax gap between card and cash payments reduces merchants' net operating benefit of accepting card sales, which in turn lowers the interchange fee that passes the tourist test. In addition, the interchange fee resulting from the social welfare maximization exceeds this tourist test threshold while the interchange fee that maximizes the total user surplus is still compatible with the tourist test.

Keywords: Tourist test, card payments, tax evasion, developing countries

JEL Classification: G21, L11, H26

BCC Bilateral Assistance & Capacity Building for Central Banks

This research project was completed under the BCC programme, which is funded by the Swiss State Secretariat for Economic Affairs (SECO) and implemented by The Graduate Institute, Geneva.

*We thank our BCC Coaching Programme supervisor Jean-Charles Rochet for his invaluable guidance and Milton Vega, Deputy Manager of Payments and Financial Infrastructures at the Central Reserve Bank of Peru, for his very helpful comments and suggestions as well as the participants at the seminar at the Graduate Institute of Geneva .The views expressed are those of the authors and should not be interpreted as those of the Central Reserve Bank of Peru or the Graduate Institute of Geneva.

†Central Reserve Bank of Peru. Email: jose.aurazo@bcrp.gob.pe

‡Central Reserve Bank of Peru. Email: jose.vasquez@bcrp.gob.pe

1 Introduction

Payment cards are a two-sided market, where cardholders and merchants participate through a card brand to purchase goods. The most common scheme in this industry is a four-part scheme whereby card brands delegate the issuance function to issuers (typically financial institutions) and the acquisition function to acquirers (specialized firms), which establish contracts with cardholders and merchants, respectively. In this type of schemes, the interchange fee (the fee that acquirers pay to issuers whenever a transaction is done) plays a critical role in balancing the development of each side of the market, managing externalities between cardholders and merchants, and allocating resources efficiently. See Baxter (1983), Schmalensee (2002), Rochet (2003), Wright (2004), Rochet and Tirole (2002, 2003, 2006), and Rochet and Wright (2010), among others.

Due to its crucial role, regulations on the interchange fee set a cap to promote a normal development of the industry.[1] For example, the European Commission reached agreements with Visa and Mastercard allowing multilateral interchange fees of 0.20% for debit cards and 0.30% for credit cards. In the U.S., the Durbin amendment to the Dodd-Frank Act regulated interchange fees for debit cards in 2011. The Reserve Bank of Australia set a cap on the weighted average interchange fee (0.55% for credit cards and 12c for debit cards). In 2014, the South African Reserve Bank set a cap on credit cards (1.41%-1.89%) and debit cards (0.36%-0.53%).

Caps on interchange fees are governed by two methodologies. The first approach is cost-based regulation (applied in Australia, the U.S. and South Africa); i.e., caps on interchange fees must reflect the issuer's total cost of providing the service (security mechanisms, anti-fraud procedures, rewards, etc.). Whenever a card payment is made, issuers must validate the transaction by activating the security mechanisms in place, among others. The second approach, known as the tourist test or the merchant indifference test (Rochet and Tirole, 2011), aims to set a maximum interchange fee that does not increase the merchant's net operating cost when a non-repeat consumer makes a card payment instead of a cash payment; i.e., makes the merchant indifferent between cash or card payments. The European Union (EU) applies this approach.

The issuer's cost approach may establish interchange fees high enough not to pass the tourist test. One reason is that cost-based regulation neglects the two-sidedness of the market for payment cards; i.e., it only focuses on the issuer's side. In contrast, the tourist test takes into account this two-sidedness and aims to prevent consumers from being over-incentivized to use cards. At the same time, in the case of credit cards the tourist test threshold must consider the cost from credit sales and not necessarily the cost of managing cash (Rochet and Wright, 2010). In addition, from a social point of view, the tourist test may be conservative relative to the social optimum if it does not reflect the negative social externalities such as tax evasion in cash payments (Tirole, 2011).

Although the tourist test has been applied to set a cap on interchange fees, it has also been used to analyze the development and competition level of the market for payment cards. In particular, it can be instrumental in establishing to what extent the actual interchange fee departs from the maximum theoretical interchange fee. Research on this matter has been done at the central banks of Canada (Fung et al., 2018) and Poland (Gorka, 2014), among others. Bolt and Chakravorti (2012) suggest that policymakers' motivation to intervene in card markets varies on a case-by-case basis (encouraging use of more efficient means of payment, adopting international standards, improving consumer protection, increasing financial education, etc.) However, they agree that empirical evidence about the real impact of fee regulation on consumers, merchants, financial institutions, etc. is not conclusive enough to justify this kind of

[1] Other policies are prohibiting common card rules such as No Surcharge Rule or Honour All Cards, and encouraging fee transparency, among others.

intervention. In this vein, Ardizzi and Savini (2018) point out that interchange fee regulation seeks to enhance market transparency and competition, which in turn may increase acceptance of payment cards. However, research on the impact of this kind of regulation on the interchange fee, the merchant discount rate, and card payments remains theoretical.

Reducing cash usage vs electronic payments is also a goal of regulation, given the higher costs associated with cash use and the efficiency gains from cashless payments. Ardizzi (2013) and Castellanos et al. (2008) show evidence for developed and developing countries, respectively. The former suggests a positive correlation between cash use and the level of interchange fees in the case of Italy, highlighting that a regulatory framework for the payment card market (specifically on interchange fees) could be effective in diminishing cash at the point of sale (POS). The latter suggests that the anticompetitive effect of high interchange fees may affect POS retail card payments, which remain underdeveloped in Mexico.

The tourist test proposed by Rochet and Tirole (2011) focuses on the operating costs between accepting cash and cards. However, this acceptance may involve other crucial costs in developing countries, where the shadow economy and the share of cash payments are relevant. According to Schneider (2004), developing countries have shown the biggest average size of the shadow economy compared with other regions. He argues that people take part of shadow economic for many reasons related to government actions, mainly taxation and regulation. Most recently, Medina and Schneider (2018) present that OECD countries have shown the lowest size (values below 20%) and the Sub-Saharan African and Latin American countries have shown the highest size of shadow economy (average above 36% during 1991–2015).

This paper extends the tourist test by incorporating the government in order to take into consideration informality (understood as tax evasion in cash payments) and the net social cost of cash usage. The main idea is that, although retail prices include the VAT, merchants usually do not provide an invoice in cash payments, so they keep the VAT. This induces merchants to perceive that cash is less expensive than cards. Against this backdrop, the concept of the tourist test is reformulated such that the maximum interchange fee that merchants could accept now internalizes this 'tax gap between card and cash payments'.

This paper is structured as follows. Section 2 briefly summarizes the model proposed by Rochet and Tirole (2011), known as the "tourist test". Section 3 introduces the net social cost of cash usage and informality by incorporating the government as a fifth agent in the model; and presents the main results and a policy discussion. Section 4 shows some concluding remarks.

Related literature. The paper is based mainly on Rochet and Tirole (2011). Additionally, the authors' understanding of the card industry was enriched by seminal papers about two-sided markets and payment cards, in particular Rochet and Tirole (2002, 2003), Schmalensee (2002), Wright (2004) and Bedre-Defolie and Calvano (2013). These authors state that two-sided markets are characterized by network externalities (membership and usage externalities); and that the price level and price structure are relevant in its optimal pricing. Relevant elements include the elasticity of consumers and merchants, as well as the effects of network externalities, among others. As a common result, the price structure is distorted in favor of cardholders (over-incentives).

There are also empirical papers that assess the impact of government intervention on the interchange fee and estimate empirically the tourist test threshold. Especially, Gorka (2014) estimates the tourist test threshold using Poland data on merchants' private costs; and Fung et al. (2018) and Bolt et al. (2013) apply the tourist test to the Canadian and EU markets for payment cards, respectively.

Literature about informality points out that it arises when the costs of enter legal framework are larger than benefits. Costs of formalization are related to register, taxes, labor benefits,

among other. See Loayza (2008).

While these contributions have considerably influenced this paper, none of them develops the links between card payments, tax evasion, and the net social cost of cash usage. To the authors' best knowledge, this paper is the first that considers these links explicitly and incorporates the government as an extra player in the model (Section 3).

2 The base model

This section describes the model proposed by Rochet and Tirole (2011), its players, its main results and some important definitions. Section 3 shows how informality and the net social cost of cash usage (different from tax evasion) affect the model.

Rochet and Tirole (2011) state that retailers often complain that they are forced to accept card transactions that increase their net costs.[2] To formalize this idea, they propose the following model with four agents: consumers, retailers, issuers and acquirers. The main assumptions are as follows:

- **Consumers.** There is a continuum of consumers (normalized to one) with quasi-linear preferences. They spend their income on a cash good and on one unit of a card good sold by R retailers. The utility from purchasing the card good can differ across consumers, but is large enough so that the aggregate demand for the card good is constant and equal to one. Consumers must decide which store to attend. Whenever a card transaction is done, buyers pay issuers a transaction fee p_b, which can be negative (rewards program). There are no annual fees and all consumers have a card.

  The consumer's convenience cost of paying by cash (equivalent to the convenience benefit of using a card) is a random variable $\widetilde{b_b}$ drawn from cumulative distribution function H:

  $$H(b_b) = Pr(\widetilde{b_b} < b_b)$$

  A card payment is optimal for the consumer whenever $\widetilde{b_b} > p_b$, so the share of card payments at a store that takes cards is:

  $$D_b(p_b) = Pr(\widetilde{b_b} > p_b) = 1 - H(p_b)$$

- **Retailers or Merchants.** The unit cost of the card good for retailers is constant γ. They either find it too costly or are not allowed to charge different prices for transactions settled by card and by cash (No Surcharge Rule).[3] The merchant's convenience benefit, b_s, is assumed to be homogeneous and can be understood as the retailer's cost of a cash payment (since this cost is normalized to zero). Whenever a card transaction is done, merchants pay a transaction fee p_s to their acquirers.

- **Issuers.** They charge a constant mark-up[4] ($m > 0$) above the issuing costs, so the cardholder price is:

  $$p_b = c_b - a + m$$

[2] They analyze this must-take cards argument from an ex-post perspective, because retailers ex-ante can always turn down cards.

[3] The No Surcharge Rule (NSR) is commonly applied by card brands but the enforcement of the prohibition is not uniform. Some jurisdictions have laws which require, allow, regulate or prohibit a merchant imposing a surcharge. As Zenger (2011) points out the tourist test and a perfect surcharge are equivalent. However, even if retailers are allowed to surcharge, they do not do perfectly (e.g. in Australia only 20% of merchants surcharge).

[4] A constant mark-up refers to that any increase or decrease in issuer's costs is perfectly adjusted in the cardholder price.

- **Acquirers.** They are perfectly competitive, so the merchant discount p_s is equal to total acquiring costs $c_s + a$:

$$p_s = c_s + a$$

The total cost of providing this card payment service is denoted by $c = c_b + c_s$

Rochet and Tirole (2011) introduce the concept of the tourist test as follows: suppose the buyer is a tourist, who will never attend the store again in the future and shows up at the cash register with enough cash to pay. The merchant discount passes the tourist test if the retailer is willing to allow the consumer to pay by card, or equivalently if accepting card payments does not increase the retailer's operating costs: $p_s \leq b_s$.

DEFINITION 1. The merchant discount p_s passes the tourist test if and only if accepting the card does not increase the retailer's net operating cost: $p_s \leq b_s$.

The peculiarity of the tourist test resides in the fact that merchants pay no more than their convenience benefit from card payments. Capping the merchant discount at this threshold prevents card payment systems from exploiting the internalization effect to force merchants to accept card payments that they do not want. From an economic point of view, the tourist test implies the absence of overpayment by the merchant, or equivalently the cardholder is not over-incentivized to use the card.

PROPOSITION 1. When issuer's margin is constant,

- The interchange fee that passes the tourist test is $a^T = b_s - c_s$.
- The interchange fee a^W that maximizes the social welfare (consumers, merchants and banks) is $a^W = a^T + m$ and the interchange fee a^{TUS} that maximizes total user surplus (only consumers and merchants) is $a^{TUS} = a^T$.[5]

Proof. See Appendix A. □

3 The base model plus government

Inclusion of the government as fifth player in the base model introduces the net social cost of cash usage and informality (i.e., tax evasion in cash payments), both important issues in developing countries. The government plays two roles in the economy:

1. Supplying cash and protect the public from the risks involved in its use. The net social cost of cash (banknotes and coins) for the government is expressed as $k(1-D_b(p_b))$, where $(1 - D_b(p_b))$ is the share of cash payments and $k > 0$ is the marginal net social cost of cash.[6]
2. Setting a flat-rate tax t on the retail price (e.g. Value Added Tax - VAT); i.e., whenever cardholders purchase goods by cash or card, they always pay VAT to merchants.[7]

The concept of the net social cost of cash is better understood in a scenario where there is no cash (all coins and banknotes are in bank accounts and nobody pays by cash) and thus the risk of robbery or crime, the cost of supplying cash and the benefit of seigniorage are zero.

[5] The reason why authorities usually focus on total user surplus rather than social welfare is discussed in 3.2.2.

[6] This marginal social cost of cash is net of the benefit of seigniorage. Due to tax evasion is explicit in the model, k does not include it.

[7] This idea is consistent with the NSR which states that retail price is the same whether the consumer pays by cash or by card.

Therefore, the higher the share of cash payments, the higher the net social cost of cash usage for the government. The marginal net social cost of cash usage k relates to handling cash for the public and allocating resources to the police department for urban safety, net of the benefit of seigniorage.

Additionally, this paper includes informality in the base model as tax evasion[8] resulting from the fact that merchants do not provide invoices to consumers in some cash payments, then those transactions are not reported and thus merchants do not pay VAT to the government (even though consumers pay it).

Let $\theta \in [0,1]$ be the share of cash payments (and VAT) reported by merchants (i.e., $1-\theta$ is the share of cash payments that evade VAT)[9] and ϕ be the tax gap between card and cash payments ($\phi = (1-\theta)t \geq 0$). The parameter ϕ can also be understood as the marginal net tax benefit that merchants lose when they accept cards (or equivalently, the extra marginal net tax cost of accepting cash payments). The idea behind this is that some merchants do not accept card payments because they would not only have to pay merchant fees to the acquirer, but also VAT to the government. This underreporting of cash transactions implies that tax evasion reduces retailers' convenience cost of cash.

Taking into account tax evasion and the net social cost of cash, the government's net income per merchant is:

$$T = tD_b(p_b) + \theta t(1 - D_b(p_b)) - k(1 - D_b(p_b))$$

Rearranging the first two terms associated with tax revenues, the government's net income is the potential tax revenue (all transactions pay VAT, either settled by cash or card) minus the taxes that merchants evade in cash payments and the net social cost of cash:

$$T = t - \phi(1 - D_b(p_b)) - k(1 - D_b(p_b))$$

where $\phi = (1-\theta)t \geq 0$.

3.1 The tourist test[10]

In this new setting, it is necessary to assume the net convenience benefit of accepting cards net of the tax gap is still positive $b_s - \phi \geq 0$. It is important to notice that, due to tax evasion in cash payments, merchants perceive accepting cash as less expensive than cards in terms of tax compliance, so the tax gap between accepting cards and cash reduces the net convenience benefit of accepting cards (or equivalently reduces the net convenience cost of cash).

In the context of informality, the merchant discount passes the tourist test if retailers are willing to allow tourists to pay by card, or equivalently if accepting cards does not increase retailers' net operating cost net of the tax gap between card and cash payments: $p_s \leq b_s - \phi$.

DEFINITION 2. In the presence of tax evasion, the merchant discount p_s passes the tourist test if and only if accepting cards does not increase retailers' net operating cost net of the tax gap between card and cash payments: $p_s \leq b_s - \phi$.

[8] Informality is broader than tax evasion. According to The World Bank, "informality" is a term used to describe the collection of firms, workers, and activities that operate outside the legal and regulatory systems. It is widespread in the majority of developing countries, the informal sector produces about 35 percent of GDP and employs 70 percent of the labor force.

[9] θ is supposed to be an idiosyncratic parameter which depends on the country level of education, literacy, development, institutions, etc. Also, it can be understood as tax education.

[10] Hereafter, we add the term TE (tax evasion) to all the notations of key variables in order to differentiate the results of the model plus government from the base model.

The merchant discount p_s is equal to the net benefit of accepting cards b_s net of the tax gap ϕ. Since acquirers are perfectly competitive, the merchant discount p_s is equal to the total acquiring costs $c_s + a$:

$$b_s - \phi = p_s = c_s + a$$

As issuers have a constant margin m, the cardholder price is $p_b = c_b - a + m$. Therefore, the interchange fee a passes the tourist test if and only if:

$$a \leq a^{TE} = b_s - c_s - \phi \iff p_b \geq p_b^{TE} = c - b_s + m + \phi \tag{1}$$

It is important to note that this tax gap is an externality for merchants whenever they accept cards instead of cash, and thus cardholders should internalize it in their price. Additionally, when there is no tax evasion in cash payments ($\theta = 1 \rightarrow \phi = 0$), the result is the same as in Section 2 ($a^T = a^{TE} = b_s - c_s$).

In understanding the importance of the tax gap between card and cash payments in the tourist test, it is helpful to consider a model of two countries with the same characteristics except for their tax gaps. In country 1 the share of cash payments reported by merchants is higher than in country 2 ($\theta_1 > \theta_2$) which implies that the tax gap in country 1 is lower than in country 2 ($\phi_1 < \phi_2$). Therefore, applying the tourist test according to equation (1) implies that the interchange fee that passes the tourist test will be higher in country 1 than in country 2.

3.2 Socially Optimal Interchange Fees

This section proposes a model for the payment card industry and assesses the impact of the interchange fee on prices p_b and p_s, and ultimately on social welfare, total user surplus, and the government's objective. The latter maximization is a consequence of including the government in the base model. The setup is simplified by assuming that acquirers are perfectly competitive and issuers have a constant margin (variable issuers' margin are assumed later).

3.2.1 Social Welfare

With an inelastic final demand, the different components of the social welfare are:

Consumer's surplus

$$CS = u - p - p_b D_b(p_b) - \int_{-\infty}^{p_b} b_b \cdot dH(b_b)$$

Where u is the utility of a good for consumers, p is the retail price, p_b is the issuer's price (reward program) and $\int_{-\infty}^{p_b} b_b \cdot dH(b_b)$ represents the expected convenience cost of cash payment.

Retailer's profit

$$RP = p - \gamma - (p_s + t)D_b(p_b) - (b_s + \theta t)(1 - D_b(p_b))$$

Where γ is unit cost, p_s is the merchant discount, b_s is the net convenience benefit of accepting cards and θ is the share of cash payments that the merchant reports.

Bank's profit

$$\Pi_b = (p_b + p_s - c)D_b(p_b) = mD_b(p_b)$$

Where c is the total cost of cards (issuers c_b plus acquirers c_s).

Government's net income

$$T = tD_b(p_b) + \theta t(1 - D_b(p_b)) - k(1 - D_b(p_b))$$

Where k is the marginal net social cost of cash usage (different from tax evasion).

Adding these four components, social welfare is equal (up to a constant) to:

$$W = u - \gamma + \int_{p_b}^{\infty} (b_b + b_s - c + k) \cdot dH(b_b)$$

Note that the marginal net social cost of cash increases social welfare W because whenever a consumer pays by card instead of cash, the government saves k. The final expression of the social welfare does not take into account tax evasion because the amount of VAT that the government does not collect is the same amount of VAT that merchants keep (both cancel each other out).[11]

The welfare is a single-peaked function of p_b reaching a maximum at:

$$p_b^{WTE} = c - b_s - k \tag{2}$$

The first-best price p_b^{WTE} induces consumers to internalize perfectly the externality associated with the decision of paying by card. Indeed, the social cost of a card payment includes the marginal cost c_i of the buyer's bank, the externality $c_s - b_s$ on the seller's side and the positive externality k on the government.

The interchange fee that maximizes social welfare takes into account the issuer's mark-up and the marginal net social cost of cash usage.

$$a^{WTE} = c_b - p_b^{WTE} + m \rightarrow a^{WTE} = b_s - c_s + m + k \tag{3}$$

Comparing (2) and (3) with (1), we see that the cardholder price p_b that corresponds to the tourist test threshold is equal to the sum of p_b^{WTE}, issuers' margin m, the tax gap ϕ and the marginal net social cost of cash usage k:

$$p_b^{TE} = p_b^{WTE} + \phi + m + k$$

Furthermore the socially optimal interchange fee does not pass the tourist test:

$$a^{WTE} = b_s - c_s + m + k > a^{TE} = b_s - c_s - \phi$$

It is worth noting that even if issuers are perfectly competitive ($m = 0$), the socially optimal interchange fee is still higher than the tourist test threshold due to the presence of tax evasion and the net social cost of cash ($\phi > 0$ and $k > 0$). Indeed, even if there is no tax evasion in cash payments ($\theta = 1 \rightarrow \phi = 0$) both interchange fees are not equal because of the marginal net social cost of cash.

[11] This result could be modified if we consider the cost of public funds $\lambda > 0$ in the tax revenue. This parameter represents the marginal welfare gain when the government's revenue is reduced by one marginal unit. Laffont (2005) suggests that λ may be approximately 0.3 in developed countries and above 1 in developing countries. See Appendix B for a social optimum interchange fee with cost of public funds.

3.2.2 Total User Surplus

Rochet and Tirole (2011) point out that competition authorities focus on final users (cardholders and merchants) and do not include banks' profits in their maximization. Furthermore, since retail prices are not a good measure of consumer surplus, as they do not account for transaction costs, the authorities usually maximize the Total User Surplus (TUS), defined as the sum of the consumer's surplus and retailer's profit, and expressed by the following function ω:

$$\omega \equiv u - \gamma - t + (b_s - p_s - \phi)D_b(p_b) + \int_{p_b}^{\infty}(b_b - p_b) \cdot dH(b_b)$$

$$\omega = u - \gamma - t + \int_{p_b}^{\infty}(b_b + b_s - p_b - p_s - \phi) \cdot dH(b_b)$$

Focusing on the term for card payments and using the definitions of p_b and p_s:

$$\omega = \int_{p_b}^{\infty}(b_b + b_s - c - m - \phi) \cdot dH(b_b)$$

Then,

$$\omega^{'}(p_b) = 0 \rightarrow p_b^{TUSTE} = c - b_s + m + \phi \tag{4}$$

The interchange fee that corresponds to this maximization internalizes the tax gap between card and cash payments:

$$a^{TUSTE} = b_s - c_s - \phi \tag{5}$$

The price that maximizes the total user surplus exceeds the p_b^{WTE}:

$$p_b^{TUSTE} = c - b_s + m + \phi > p_b^{WTE} = c - b_s - k$$

Or conversely, socially optimal interchange fee exceeds that interchange fee that maximizes the TUS:

$$a^{WTE} = b_s - c_s + m + k > a^{TUSTE} = b_s - c_s - \phi$$

Notice that this cardholder price (interchange fee) is equal to the tourist test threshold $p_b^{TUSTE} = p_b^{TE}$ ($a^{TUSTE} = a^{TE}$). Rochet and Tirole (2011) point out that this result relies on three assumptions: i) constant issuer's margin, ii) given number of issuers, and iii) homogeneous retailers. In section 3.3 a variable issuer's margin is assumed.

3.2.3 Government's objective

The government is concerned about its net income (tax revenue minus the net social cost of cash usage); therefore, it aims to maximize the sum of the TUS and its net income, as described by the following function z:

$$z \equiv u - \gamma + (b_s - p_s - \phi)D_b(p_b) + \int_{p_b}^{\infty}(b_b - p_b) \cdot dH(b_b) - (\phi + k)(1 - D_b(p_b))$$

$$z = u - \gamma + \int_{p_b}^{\infty}(b_b + b_s - p_b - p_s + k) \cdot dH(b_b)$$

Focusing on the term for card payments and using the definitions of p_b and p_s:

$$z = \int_{p_b}^{\infty} (b_b + b_s - c - m + k) \cdot dH(b_b)$$

Therefore, z is maximized when:

$$z^{'}(p_b) = 0 \rightarrow p_b^G = c - b_s + m - k \tag{6}$$

The interchange fee that corresponds to this maximization internalizes the marginal net social cost of cash usage:

$$a^G = b_s - c_s + k \tag{7}$$

Whenever cardholders pay by card, the government saves the marginal net social cost of cash usage, this positive externality must be added to the interchange fee. The resulting interchange fee exceeds the tourist test threshold and is lower than the interchange fee that maximizes social welfare:

$$a^{WTE} > a^G = b_s - c_s + k > a^{TE}$$

The behavior of functions W, ω and z is represented in Figure 1. The social welfare is the largest because it internalizes all the distortions in the market (issuer's mark-up, tax gap between card and cash payments and marginal net social cost of cash usage), while TUS only takes into account the consumer's surplus and the retailer's profit. The government objective is between these two functions.

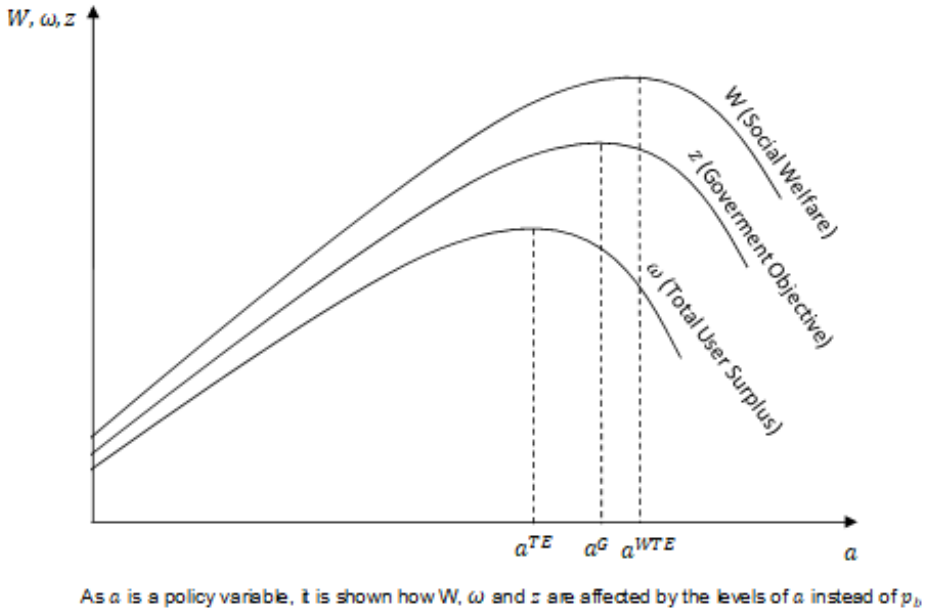

Figure 1: Social Welfare (W), Total User Surplus (ω) and Government Objective (z)

PROPOSITION 2. When the issuer's margin is constant, there is tax evasion in cash payments and there is a net social cost of cash usage:

- The interchange fee that passes the tourist test internalizes the tax gap between card and cash payments:

$$a^{TE} = b_s - c_s - \phi$$

- The interchange fee that maximizes the social welfare exceeds a^{TE} even if banks are perfectly competitive:
$$a^{WTE} = b_s - c_s + m + k > a^{TE}$$
- The interchange fee that maximizes the government objective is higher than a^{TE} and lower than a^{WTE}:
$$a^{WTE} > a^G = b_s - c_s + k > a^{TE}$$
- The interchange fee that maximizes the TUS is equal to a^{TE}.

Proof. See preceding discussion. □

3.3 Variable issuer's margin

This section assumes that the issuer's margin is variable and assesses the implications for the results obtained above. The idea of a variable issuer's margin is that any change of cost is not passed perfectly to cardholders (in the previous sections, any increase or decrease in issuer's costs is adjusted perfectly by $p_b = c_b - a + m$).

The cardholder price $p_b(c_i)$ increases by c_i and the bank's profit $\Pi(p_b(c_i))$ decreases by c_i (recall that the issuer's costs are $c_i = c_b - a$.) The issuer's mark-up is denoted by:
$$m(p_b(c_i)) = p_b(c_i) - c_i$$
There is cost amplification if for an increase or decrease in costs, the price is adjusted more than proportionally ($p_b^{'} > 1 \rightarrow \mathrm{m}^{'} > 0$); and there is cost absorption if the price is adjusted less than proportionally ($p_b^{'} < 1 \rightarrow \mathrm{m}^{'} < 0$). When the price is perfectly adjusted, there is a perfect pass-through or constant margin ($p_b^{'} = 1 \rightarrow \mathrm{m}^{'} = 0$).

The issuer's price that maximizes total user surplus and the interchange fee are defined implicitly by:
$$p_b^{TUSTE} = c - b_s + \phi + m + \frac{m^{'} D_b}{D_b^{'}} \iff a^{TUSTE} = a^{TE} - \frac{m^{'} D_b}{D_b^{'}}$$
In addition, the issuer's price that maximizes the government objective and the interchange fee is defined by:
$$p_b^{G} = c - b_s - k + m + \frac{m^{'} D_b}{D_b^{'}} \iff a^{G} = a^{TE} + \phi + k - \frac{m^{'} D_b}{D_b^{'}}$$

PROPOSITION 3. When there is cost amplification ($m^{'} > 0$), both interchange fees are higher than the tourist test threshold $a^{TUSTE} > a^{TE}$ and $a^G > a^{TE}$. In the case of cost absorption, a^{TUSTE} is always lower than a^{TE}, while a^G can be higher, lower or equal to a^{TE} when $\phi + k > \frac{m^{'} D_b}{D_b^{'}}$, $\phi + k < \frac{m^{'} D_b}{D_b^{'}}$ or $\phi + k = \frac{m^{'} D_b}{D_b^{'}}$, respectively. In both cases (cost amplification and cost absorption), a^{WTE} is higher than a^{TE}.

Proof. See Appendix C. □

Assuming that the tax gap between card and cash payments and the marginal net social cost of cash usage are higher in developing countries than in developed ones, a^G passes the tourist test in developed countries, while a^G exceeds a^{TE} in developing ones. In developing countries, where informality and the net social cost of cash usage are considerable, the interchange fee resulting from the government's objective maximization reflects the higher positive externality that cardholders make whenever they pay by cards.

3.4 Policy discussion

Whenever cardholders pay by cards, they exert a positive externality on the government. A higher share of card payments implies a lower net social cost of cash usage and a lower tax evasion which in turn increase tax revenues; this leads to an increase in the government's net revenue. According to the model presented in this paper, the government has two policy tools: the share θ of cash payments that merchants report (e.g. policies geared to increase tax education) and the tax rate t (determined by the government). These two instruments aims to reduce the tax gap between card and cash payments.

PROPOSITION 4. Higher tax compliance in cash payments θ always benefits the government while a higher VAT t increases the government's net revenues if and only if $D_b(p_b) + \theta(1 - D_b(p_b)) < -[(1-\theta)t + k](1-\theta)D_b^{'}$.

Proof. See Appendix D. □

International experiences in developing countries include the case of Uruguay, where tax incentives were established for card payments. The idea behind this policy is to reduce VAT for card transactions. This policy links both sides of the market for payment cards by stimulating cardholder use and encouraging card acceptance through formal merchants. Therefore, merchants have incentives to formalize because they can increase their market share if they offer consumers a VAT reduction via accepting cards. This policy has increased card payments and the number of formal merchants. Additionally, in Peru the tax authority (SUNAT) and local governments are introducing rewards for responsible consumers who request purchase invoices. However, it is yet too soon to assess the results of this initiative.

4 Conclusion

This paper extends the theoretical tourist test model proposed by Rochet and Tirole (2011) to introduce the government as a fifth agent. The advantage of this approach is the possibility of considering the informality (understood as tax evasion in cash payments) and a net social cost of cash usage. These two elements are relevant in developing countries, where the shadow economy tends to be large. Taking these features into consideration, the paper determines theoretically the interchange fee that passes the tourist test.

Tax evasion in cash payments implies that merchants perceive accepting cash as less expensive than cards in terms of tax compliance, thus the tax gap between card and cash payments reduces the net operating benefit of accepting cards (or equivalently reduces the net operating cost of cash). Therefore, the tourist test must take into consideration this tax gap.

As Rochet and Tirole (2011), this paper shows that the interchange fee that passes the tourist test is compatible with the interchange fee that maximizes the sum of the consumer's surplus and retailer's profit, known as the total user surplus. Additionally, the interchange fee resulting from the social welfare maximization is higher than the tourist test threshold. From a social point of view, the interchange fee must reflect all the agent's costs, including the net social cost of cash usage. However, this level exceeds the tourist test threshold, and thus, merchants are less prone to accept card sales.

This paper also analyzes the interchange fee resulting from the government's objective defined as the sum of the government's net income (tax revenues minus the net social cost of cash usage) and the final user's surplus. This interchange fee exceeds the tourist test threshold because

it internalizes the positive externality on the government whenever cardholders make a card payment. This higher level of the interchange fee aims to incentivize cardholders to use their cards and the government saves the net social cost of cash usage and the tax loss. However, this level increases merchants' net operating costs which in turn reduces their willingness to accept card payments.

This extension of the tourist test model can be a useful tool in developing countries for estimating a cap on interchange fees. Unlike developed countries, developing countries are characterized by high shadow economy and high tax evasion in cash payments. Therefore, the application of the tourist test must consider the tax gap between card and cash payments. It can be expected that, interchange fees resulting from the tourist test are higher in developed countries than in developing ones.

Appendix A: Proof of Proposition 1

The merchant discount p_s is equal to the net benefit of accepting cards b_s. Since acquirers are perfectly competitive, the merchant discount p_s is equal to the total acquirer's costs $c_s + a$:

$$b_s = p_s = c_s + a$$

As issuers have a constant margin, the cardholder price is $p_b = c_i - a + m$. Therefore, the interchange fee a passes the tourist test if and only if:

$$a \leq a^T = b_s - c_s \iff p_b \geq p_b^T = c - b_s + m$$

The second result related to the interchange fees that maximize the social welfare and total user surplus are described below:

1. **Social Welfare.** The welfare is the sum of the consumer's surplus (CS), retailer's profit (RP) and bank's profit (Π).

   $$CS = u - p - p_b D_b(p_b) - \int_{-\infty}^{p_b} b_b \cdot dH(b_b)$$

   Where u is the utility of a good for consumers, p is the retail price, p_b is the issuer's price (reward program) and $\int_{-\infty}^{p_b} b_b \cdot dH(b_b)$ represents the expected convenience cost of cash payment.

   $$RP = p - \gamma - (p_s)D_b(p_b) - (b_s)(1 - D_b(p_b))$$

   Where γ is marginal cost of production, p_s is the merchant discount and b_s is the net convenience benefit of accepting cards.

   $$\Pi_b = (p_b + p_s - c)D_b(p_b) = mD_b(p_b)$$

   Where c is the total cost of cards (issuers c_b plus acquirers c_s).

   Adding these three components, , social welfare is equal (up to a constant) to:

   $$W = u - \gamma + \int_{p_b}^{\infty} (b_b + b_s - c) \cdot dH(b_b)$$

   Welfare is a single peaked function of p_b reaching its maximum at:

   $$W^{'}(p_b) = 0 \rightarrow p_b^W = c - b_s$$

   And the interchange fee that maximizes the social welfare is:

   $$a^W = c_b - p_b^W + m = b_s - c_s + m$$

2. **Total user surplus (TUS).** The TUS only focuses on the final users, thus it is the sum of the consumer's surplus and the retailer's profit.

   Adding these two components, the TUS is:

$$\omega = u - \gamma + \int_{p_b}^{\infty} (b_b + b_s - p_b - p_s) \cdot dH(b_b)$$

   Then,

$$\omega^{'}(p_b) = 0 \rightarrow p_b^{TUS} = c - b_s + m = p_b^T$$

   And the interchange fee that corresponds to this maximization:

$$a^{TUS} = b_s - c_s = a^T$$

Appendix B: Social optimum IF with cost of public funds

Now, the government's net income is characterized by:

$$T = (1 + \lambda)[tD_b(p_b) + \theta t(1 - D_b(p_b))] - k(1 - D_b(p_b))$$

Where $\lambda > 0$ is the cost of raising funds for the government.

Thus, the social welfare is described by:

$$W = u - \gamma + \lambda t + \int_{p_b}^{\infty} (b_b + b_s - c + \lambda\phi + k) \cdot dH(b_b)$$

Notice that $\lambda\phi$ in the social welfare refers to the welfare loss in the market caused by VAT that government does not collect.

The welfare is a single peaked function of p_b reaching its maximum at:

$$W^{'}(p_b) = 0 \rightarrow p_b^W = c - b_s - \lambda\phi - k \tag{8}$$

And the interchange fee that maximizes the social welfare is:

$$a^W = c_b - p_b^W + m = b_s - c_s + m + k + \lambda\phi \tag{9}$$

When $\lambda < 1$ as is the case of developed countries, the interchange fee that maximizes social welfare exceeds the tourist test threshold. In the case of developing countries (probably $\lambda > 1$), the social optimal interchange fee is even higher.

Appendix C: Proof of Proposition 3

The total profit of card associations (only banks have extraordirnary benefit, acquirers are perfectly competitive) is:

$$\Pi_b = m(p_b)D_b(p_b)$$

The interchange fee a passes the tourist test if and only if

$$a \leq a^{TE} \equiv b_s - c_s - \phi \iff p_b \geq p_b^{TE} \equiv c - b_s + \phi + m(p_b^{TE})$$

Since $m^{'} < 1$, p_b^{TE} is uniquely defined.

Similarly, the socially optimal interchange fee is:

$$a^{WTE} = c_b - p_b^{WTE} + m(p_b^{WTE})$$

where $p_b^{WTE} = c - b_s - k$. Thus

$$a^{WTE} = b_s - c_s + k + m(p_b^{WTE}) > a^{TE}$$

Now, total user surplus is described as follows:

$$\omega = \int_{p_b}^{\infty} (b_b + b_s - c - m(p_b) - \phi) \cdot dH(b_b)$$

First Order Condition implies:

$$\omega^{'}(p_b) = 0 = [p_b + b_s - c - m - \phi]D_b^{'} - m^{'}D_b$$

Thus,

$$p_b^{TUSTE} = c - b_s + \phi + m + \frac{m^{'}D_b}{D^{'}} = p_b^{WTE} + \phi + k + \frac{(mD_b)^{'}}{D_b^{'}}$$

Since $(mD_b)^{'} < 0$ and $D_b^{'} < 0$, p_b^{TUSTE} exceeds p_b^{WTE}. Now, the corresponding interchange fee a^{TUSTE} is given by:

$$a^{TUSTE} = c_b - p_b^{TUSTE} + m(p_b^{TUSTE}) = b_s - c_s - \phi - \frac{m^{'}D_b}{D_b^{'}} = a^{TE} - \frac{m^{'}D_b}{D_b^{'}}$$

In the case of government objective:

$$z = \int_{p_b}^{\infty} (b_b + b_s - c - m(p_b) + k) \cdot dH(b_b)$$

Then,

$$z^{'}(p_b) = 0 = [p_b + b_s - c - m + k]D_b^{'} - m^{'}D_b$$

Thus,

$$p_b^{G} = c - b_s - k + m + \frac{m^{'}D_b}{D^{'}} = p_b^{WTE} + \frac{(mD_b)^{'}}{D_b^{'}}$$

Since $(mD_b)^{'} < 0$ and $D_b^{'} < 0$, p_b^{G} exceeds p_b^{WTE}. Now, the corresponding interchange fee a^{G} is given by:

$$a^{G} = c_b - p_b^{G} + m(p_b^{G}) = b_s - c_s + k - \frac{m^{'}D_b}{D_b^{'}} = a^{TE} + \phi + k - \frac{m^{'}D_b}{D_b^{'}}$$

Appendix D: Proof of Proposition 4

Let's define

$D^{'} = \frac{\partial D_b}{\partial p_b} < 0$; $\frac{\partial \phi}{\partial t} = (1 - \theta) > 0$; $\frac{\partial D_b}{\partial t} = (1 - \theta)D^{'} < 0$; $\frac{\partial \phi}{\partial \theta} = -t < 0$; $\frac{\partial D_b}{\partial \theta} = -tD^{'} > 0$

The government's net income is:

$$T = t - \phi(1 - D_b(p_b)) - k(1 - D_b(p_b))$$

Derivative with respect to tax compliance in cash payments θ:

$$\frac{\partial T}{\partial \theta} = t(1 - D_b(p_b)) - [(1-\theta)t + k]tD_b' > 0$$

Derivative with respect to VAT:

$$\frac{\partial T}{\partial t} = D_b(p_b) + \theta(1 - D_b(p_b)) + [(1-\theta)t + k](1-\theta)D_b' \gtreqless 0$$

References

Ardizzi, G. (2013). Card versus cash: empirical evidence of the impact of payment card interchange fees on end users' choice of payment methods. Bank of Italy Working Paper.

Ardizzi, G. and Savini, M. (2018). The impact of the interchange fee regulation on merchants: evidence from italy. Bank of Italy Working Paper.

Baxter, W. (1983). Bank interchange of transactional paper: Legal perspectives. *Journal of Law and Economics*, 26:541–588.

Bedre-Defolie, O. and Calvano, E. (2013). Pricing payment cards. *American Economic Journal: Microeconomics*, pages 206–231.

Bolt, W. and Chakravorti, S. (2012). Pricing in retail payment systems: Apublic policy perspective on pricing of payment cards. In Payment Systems: Design, Governance and Oversight, ed: Bruce Summers, Risk Books.

Bolt, W., Jonker, N., and Plooij, M. (2013). Tourist test or tourist trap? unintended consequences of debit card interchange fee regulation. DNB Working Paper.

Castellanos, S., Cordella, T., Medina, R., Mendoza, A., Negrín, J.and Rochet, J.-C., and Solís, F. (2008). The role of interchange fees in mexico retail payment system: from theory to practice. In M. Guadamillas (Coordinator), Balancing cooperation and competition in retail payment systems, Lessons from Latin America case studies (pp. 161-206). Word Bank.

Fung, B., Huynh, K. P., Nield, K., and Welte, A. (2018). Merchant acceptance of cash and credit cards at the point of sale. *Journal of Payments Strategy Systems*, 12(2):150–165.

Gorka, J. (2014). Merchant indifference test application – a case for revising interchange fee level in poland. Bundesbank Working Paper.

Laffont, J.-J. (2005). *Regulation and Development*. Cambridge University Press.

Loayza, N. (2008). Causas y consecuencias de la informalidad en el Perú. *Revista de Estudios Economicos - BCRP*, (15):43–64.

Medina, L. and Schneider, F. (2018). Shadow economies around the world: What did we learn over the last 20 years?. IMF Working Paper WP/18/17.

Rochet, J.-C. (2003). The theory of interchange fees: A synthesis of recent contributions. *Review of Network Economics*, 2(2):97–124.

Rochet, J.-C. and Tirole, J. (2002). Cooperation among competitors: Some economics of payment card associations. *The RAND Journal of Economics*, 33(4):549–570.

Rochet, J.-C. and Tirole, J. (2003). Platform competition in two-sided markets. *Journal of the European Economic Association*, 1(4):990–1029.

Rochet, J.-C. and Tirole, J. (2006). Two-sided markets: A progress report. *The RAND Journal of Economics*, 37:645–667.

Rochet, J.-C. and Tirole, J. (2011). Must-take cards: Merchant discounts and avoided costs. *Journal of the European Economic Association*, 9(3):462–495.

Rochet, J.-C. and Wright, J. (2010). Credit card interchange fees. *Journal of Banking and Finance*, 34(8):1788–1797.

Schmalensee, R. (2002). Payment systems and interchange fees. *Journal of Industrial Economics*, 50(2):103–122.

Schneider, F. (2004). The size of the shadow economies of 145 countries all over the world: First results over the period 1999 to 2003. The Institute for the Study of Labor in Bonn/IZA DP. N 1431.

Tirole, J. (2011). Payment card regulation and the use of economic analysis in antitrust. *Competition Policy International*.

Wright, J. (2004). The determinants of optimal interchange fees in payment systems. *The Journal of Industrial Economics*, 52(1):1–26.

Zenger, H. (2011). Perfect surcharging and the tourist test interchange fee. *Journal of Banking and Finance*, 35(10):2544–2546.