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Card Payment Market and Retail Prices: an Empirical Analysis of the Effects of the Interchange Fees on the Price Levels in Spain

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Card Payment Market and Retail Prices:

An Empirical Analysis of The Effects of The Interchange Fee on Price Levels in Spain

Bita Shabgard*

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Abstract

The present paper examines how changes in the interchange fee affect retail prices. The interchange fee is a payment from the merchant's bank (called the acquirer) to the cardholder's bank (called the issuer) per card transaction. This is a fundamental fee that affects the card payment usage by a cardholder and the card acceptance by a merchant. By considering the two sidedness nature of this market, the paper investigates the short- and long-run relationships between the interchange fee and retail prices in Spain from the first quarter of 2008 to the fourth quarter of 2019. The paper finds that in the long-run, retail prices decrease as a result of declining interchange fee as had been expected by regulatory authorities.

Key words: Interchange fee regulation, Payment card, Retail prices, Two-sided market.

JEL Classification: D23, E310, L50, L140.

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Introduction

In the euro area, 55% of the total amount of non-cash payments[1] belonged to card payments in 2017. On the global level, this share was 69% (Capgemini, 2019). The widespread use of card payment has drawn the attention of antitrust authorities to investigate the behaviuor of card payment networks (as for example Visa and MasterCard). Their main concern was the level of the interchange fee (henceforth IF). This fee is generally set by card networks and is an important component of the cost of accepting cards by merchants. Antitrust authorities have argued that the level of the IF has gone against competition principles. They have claimed that card networks set arbitrarily high IF that harms cardholders and merchants. In this regard, they have intervened in the card payment market by capping the IF. For example, the antitrust cases in Australia, the United States, the European Union, and also regulatory changes in countries like Spain, have limited the power of card networks to set arbitrarily high IF.

The present paper aims to address a specific policy question regarding how changing in the IF affects retail prices. In this respect, I consider the two sides of the card payment network and investigate the effect of IF changes from the merchant side and the cardholder side. On the merchant side, I study the extent to which IF changes affects the cost of accepting cards. Then, I analyse the effect of the change in this cost on retail prices. On the cardholder side, I study the extent to which IF changes affect card payment usage, and then, I analyse the relationship between card payment usage and retail prices. In the last step, I compute the total effect of IF changes on retail prices by aggregating the effects of two sides from the two former steps.

The econometric method used in this paper is the dynamic heterogeneous panel data technique proposed by Pesaran et al. (1999), which is based on the autoregressive distributed lag (ARDL) model. This technique allows me to study the short- and long-run effects of IF changes on retail prices. The importance of studying the short- and long-run relationships is due to the price stickiness in the short-run. An extensive literature argues that it is plausible that merchants do not rapidly adjust their prices in response to a change in their cost in the short-run.

I consider the Spanish card payment market as a case study. The data is obtained from two main sources: the Bank of Spain and the National Statistics Institute of Spain and mainly consists of the card payment market information aggregated at quarterly level and the consumer price index (CPI) at sector level. This is complemented with other data such as the total household expenditure among different merchant sectors from 2008:1 to 2019:4.

The main results are as follows. In the long-run, results of the merchant side indicate that a decrease in the IF leads to a reduction in the cost of accepting card as had been predicted by the antitrust authorities. I find strong evidence suggesting that merchants pass a reduction in the cost of accepting cards to cardholders by decreasing retail prices. On the cardholder side, I find that the IF reduction results in a decrease in card payment usage, which leads to a reduction in retail prices. Therefore, the total effect is a reduction in retail prices in the long-run which I am able to quantify. This result is in line with what had been expected by regulatory authorities. In the short-run, a decline in the IF has a significant effect on retail prices neither on the merchant side nor on the cardholder side.

[1]Non-cash payments include card payment, credit transfer, direct debit, and check.

The remainder of the paper is organised as follows. In section 1, I provide a general view of the open payment card network and discuss how this market is consistent with the two-sided market theory. Research background is presented in section 2. I review the antitrust policy and main regulations regarding the IF in Spain. Then I present the main empirical studies related to the consequences of capping the IF. Description of data and definition of variables are outlined in section 3. The methodology is presented in section 4. I describe the fee structure in the open payment card network and explain the empirical strategy and the ARDL model. Section 5 discusses the results of the IF changes on retail prices from the cardholder side and the merchant side. Finally, section 6 offers some concluding remarks. The appendix reports the Schwarz Bayesian Criterion test.

1. Open Payment Card Networks.

The focus of this section is to define open payment card networks. In this regard, it is first necessary to describe the key players and their roles in an economic transaction whose payment is carried out by means of card (or 'card transaction') as follows.

The cardholder is a customer who uses a card to make a purchase at a merchant or withdraw money from an automated teller machine (ATM). The cardholder is often an individual, but it can also be a business.

The merchant is a business that accepts a card payment at the checkout counter or allows the cardholder to pay with a card via the Internet. The merchant can be a store, a supermarket, a pharmacy, or any business that sells what a cardholder buys. It is equipped with payment processing terminals such as Point-Of-Sale (henceforth POS) [2] or software (in the case of online shopping) by its bank. All merchants have a unique identification number to identify them when communicating with payment processors.

Acquirers are banks that provide transaction processing to merchants. They hold merchant accounts and provide devices (such as POS terminal or software) to the merchants. Thus, merchants are enabled to accept card payment and acquire the payment amount. Acquirers compete with each other to attract more merchants.

Issuers are banks that issue cards to cardholders on behalf of a card network. They act as a go-between for the cardholder and the card network by holding the cardholder accounts and checking whether he has sufficient funds in order to execute a payment. Issuers compete with each other to attract more cardholders.

Card networks supply the electronic networks and connect all the players described above in order to execute payments. In general, the card networks are in charge of transferring information between an issuer and an acquirer, verifying card details, and monitoring the settlement of transactions. They also brand the cards, which provide them with recognition. The specific brand denotes that the card payment transaction is executed under that card network. Both issuer and acquirer need to be members of the card network.

Figure 1 shows components of the open payment card network. Economides (2009) identifies the three sequential markets that are formed by any card transaction in an open card network as follows.

Market 1 is formed between a cardholder and an issuer, where the issuer supplies a card as the payment instrument. The issuer incurs a cost of c_I for providing services per cardholder. The cardholder pays a membership fee to the issuer (f) that is typically a fixed monthly or annual fee, whereas the issuer offers some benefits to the cardholder (henceforth b_B) such as cash-back, travel insurance, and loyalty rewards to encourage them to substitute card payment for cash.

Market 2 is formed between a merchant and an acquirer, where the acquirer supplies the merchant with payment services such as clearing electronic payments and settlement guarantees for POS. The acquirer incurs a cost of c_A for providing those services per transaction. The merchant obtains some conveniences and transaction benefits from accepting a card payment (henceforth b_S) such as security, protection against fraud and theft, guarantees that the payment will be received quickly. The merchant must pay a fee to the card network for receiving payment services which is a percentage of the amount of each card transaction and is known as a merchant service charge (henceforth MSC)[2]. The MSC is set as a result of a negotiation between the card network and the merchant, so that its level can depend on the volume and value of the merchant's POS transactions.

Market 3 is formed between an acquirer and an issuer as they deal through an open payment card network. In this market, the issuer transfers to the acquirer the amount of the purchase or transaction between the cardholder and the merchant which was carried out by means of a card. Besides, the issuer receives the IF from the acquirer per card transaction. Generally, the IF is a percentage of each card transaction amount but it could be a flat-rate per transaction. For example, in 2007, the maximum IF level for Visa debit card in Europe was €0.28 per payment.

The IF is the main and critical feature of the open payment card network. This fee may be reached by bilateral agreement between issuers and acquirers. In the absence of general agreements between parties, it is set by the open payment card network. The amount of the IF tends to be highly variable depending on a combination of several factors such as the card's type and the merchant's sector. It is worth emphasising that in the open payment card network, the payment is guaranteed by the issuer against fraud and cardholder default. Therefore, the IF exists to compensate for the risk and cost associated with the card payment that the issuer entails. In other words, the IF covers some costs on the issuing side with the acquiring side. Generally, the IF is passed through to the merchants by the acquirer and comprises a large fraction of the MSC. The MSC follows the structure of the IF in terms of the card's type and merchant's sector. Issuers often use a portion of IF revenue to offer rewards to cardholders. These rewards are generally increased by card usage.

In order to have a more comprehensive view, I also define the goods and services market as Market 4 where the transaction between cardholder and merchant takes place, i.e. the merchant supplies its products or services and the cardholder purchases them at POS or via the Internet.

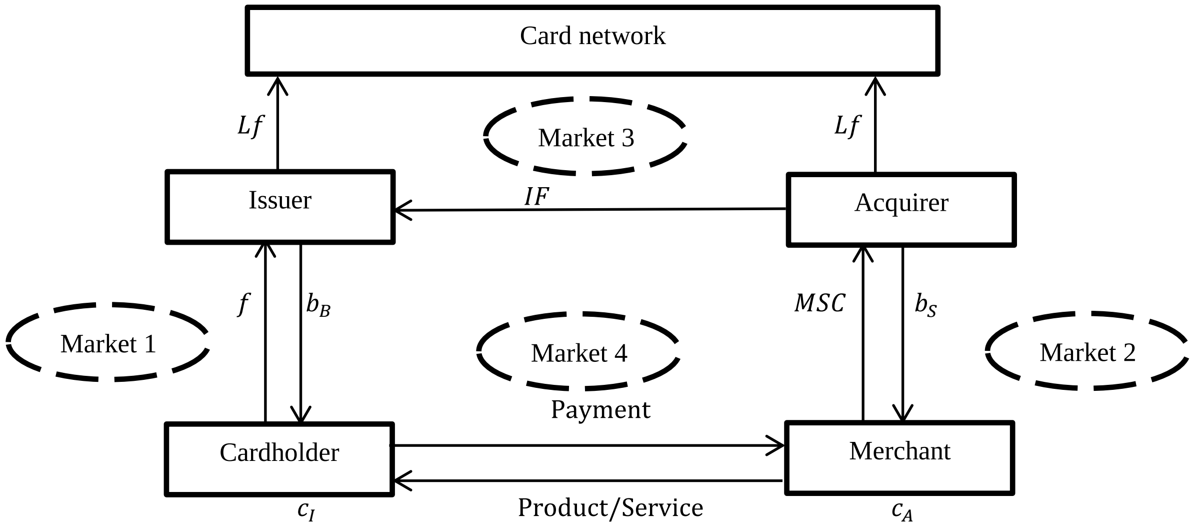
In figure 1, the Lf is a fee that the open card network charges the acquirer and the issuer banks in order to allow the transactions through its system. The Lf is generally set based on the number of cards issued or/and the number of transactions made.

Many different authors have used the concept of the two-sided market to study the card payment networks (See Rochet and Tirole, 2002, 2003, 2006; Wright, 2004; Armstrong, 2006; Chang

[2] In Europe, this cost is known as the merchant service charge, while in America it is known as the discount fee.

et al., 2005; Bedre-Defolie and Calvano, 2013; Carbo-Valverde et al., 2016, Manuszak and Wozniak, 2017; among others). In the following, I explain how open payment card network is characterised as the two-sided market.

Figure 1. Open payment card network



1.1. Open Payment Card Network as a Two-Sided Market.

Rochet and Tirole (2003) define the two-sided market as follows.

> A market with network externality is two-sided when ‘‘it is characterised by the presence of two distinct sides whose ultimate benefit stems from interacting through a common platform’’[3].

The two distinct parties in the card network are the cardholder and the merchant that transact through the card network (platform) to which their banks belong: the issuer and the acquirer. A card transaction occurs when the cardholder uses his card to pay to the merchant. It is noteworthy that the customer tends to join a card network if many merchants accept it and the merchant is willing to join the card network if many cardholders use the network’s card. In other words, the participation of the cardholder depends on the participation of the merchant on the network and vice versa. Rochet and Tirole (2006) define this feature as the membership externality. To attract cardholders, the card network should have merchants, but merchants will be willing to join the card network if many cardholders also do. This is the ‘chicken and egg problem’ in the card payment market. The card networks solve it by offering rewards to cardholders through issuers and recover the loss by charging MSC through acquirers. The cardholder has more incentives to use a card rather than the other forms of payment when the benefit from the card usage is greater than the membership fee. By offering rewards to cardholders, issuers affect the participation of cardholders on the market. Therefore, the card network becomes more attractive for the merchant and results in getting both sides on board. In section 4, I will I explain why merchants accept card payments although it is costly for them.

[3] Rochet and Tirole quotations (2003, page 990).

2. Research Background.

2.1. Antitrust Policy on Open Payment Card Networks.

The payment card network originally is the result of an association of banks, which can take different forms, including a Joint Venture among banks as when they are not able to provide payment services on their own and therefore they delegate them to a new card network built jointly by them. The association of banks creates specific payment card services that its members cannot produce it singly (Carlton and Frankel, 1995; Evans and Schmalensee, 1995). Payment card networks have set some rules, such as the IF, in order to control the relationship between their members. Rochet and Tirole (2002) and Sykes (2014) among others argue that setting of the IF as the outcome of an agreement among banks is beneficial as it economises the high transaction costs of individual negotiations between multiple issuers and acquirers. It reduces the per card transaction cost of all bilateral negotiations between banks. On the contrary, Prager et al. (2009) argue that the setting of a common IF for all banks could be interpreted as collective price determination by the member banks. Therefore, it is possible that this approach could be considered as illegal collusion under antitrust principles.

Antitrust authorities on a routine basis assess anticompetitive aspects of the IF. They argue that card networks set an arbitrarily high IF compared to any costs incurred by issuers or acquirers. The high IF limits the acquirer's power to set the lower MSC when negotiating with merchants. In fact, the IF determines a floor under the MSC and restricts competition between acquirers; therefore it is unlikely that an acquirer would be willing to reduce the level of its MSC below the IF. The restriction on competition between acquirers results in inflating the cost of accepting cards. Despite the high MSC, merchants are compelled to accept card payment since refusing the card may result in losing part of their customers. In turn, merchants pass the MSC to cardholders by inflating their retail prices. In such case, cardholders pay twice for the card usage: once through the membership fee and the second time through higher retail prices. On the other hand, higher retail prices may lead to lower sales that harm merchants. So, the high IF results in limited competition between acquirers, which ultimately harms cardholders and merchants. Competition in the card payment market takes place at two interrelated levels: upstream competition, as different card networks such as Visa and MasterCard try that banks join them, and downstream competition, as on the one side, acquirers compete to attract more merchants and on the other side, issuers compete to attract more cardholders to hold and use their cards.

Open payment card networks compete with each other when they try to expand, which they do by attracting more banks to join them. The IF is a key strategic variable in this competition (Pindyck, 2007). They compete by offering higher IF to issuers so that they issue the network's card brands instead of cards of a rival. Therefore, competition between payment card networks increases the IF level that generates more profits for issuers per card transaction. Issuers have the incentive to return some part of the IF to cardholders to encourage them to increase card usage. Due to the existence of the membership externality, this causes card acceptance to be more attractive to merchants.

Downstream competition takes place at the two sides of the market: competition between issuers and competition between acquirers. Issuers compete for cardholders. The higher IF generates a higher profit margin per card transaction for issuers. In the competition for more cardholders, issuers have an incentive to offer zero or low membership fees and more rewards on card usage in order to encourage cardholders to retain and use their cards. Under imperfect competition, issuers may pass less than 100% of the increasing IF to cardholders resulting in supra-competitive profits (Prager et al., 2009). At the other side of the market, acquirers compete for merchants to accept more cards. A high IF (resulting from the upstream competition) leads to a high MSC and accepting cards becomes then more expensive for merchants, which is to their detriment. Merchants will make less profit unless they increase their retail prices. This process of 'merchant internalisation' harms cardholders since they lose some part of the surplus that they obtain from card usage by facing higher retail prices.

With reference to the negative effects of the high IF on cardholders and merchants, some public authorities have intervened in the card payment market. In the following, I explain in more detail the main policy interventions regarding the IF in Spain.

2.1.1. Interchange Fee Regulation in Spain.

Until 2018, there were three national financial associations of banks in the form of card payment networks in Spain, namely *Servired*, *Euro 6000,* and *Sistema 4B*[4]. All banks belonged to each one of them. They were licenced as principal members of Visa and MasterCard and allowed to issue cards, set the operating rules, and the level of the IF. Their behaviour has consistently drawn the attention of regulators in Spain.

The first investigation regarding the card payment market in Spain took place in 1999. The Spanish competition authority (at that time, the Tribunal de Defensa de la Competencia, henceforth TDC) forced the national card networks to cut their IF levels from 3.5% in July 1999 to at a maximum of 2.75% in July 2002, by reducing 0.25 points per year. Before the expiry of this regulation, in April 2002, the TDC asked the Spanish card networks to detail their methods of setting the IF. In April 2003, the TDC argued that their methods were contrary to the principle of competition. The reason was that the methods of setting the IF were not sufficiently justified in terms of costs; they did not distinguish between credit and debit cards, while the cost of a credit transaction was different from the cost of a debit one. Consequently, the TDC ruled that the IF levels were set arbitrarily without any cost justification. Therefore, the TDC requested the Spanish card networks to set the IF based on the issuer's cost method which was proposed by Visa in 2002. The Spanish national card networks appealed against the TDC's decision to the Supreme Court and maintained their position until the agreement of 2005.

There are two important events that significantly affected the setting of IF in Spain. The first one took place in December 2005, when the Ministry of Industry, Tourism, and Trade and the Ministry of Economy reached an agreement with merchant associations and card networks on the reduction of the IF levels, with different schedules for debit and credit cards. The objective of this agreement was to reduce the MSC through lowering the IF and ultimately obtain a reduction in retail prices. At that year the inflation rate was 3.3% in Spain and this agreement was considered to be a way to reduce it. The agreement established that the IF must be set based on the cost of providing services by distinguishing between debit and credit cards. So, the level of the IF was to be as

[4] In 2018, the National Commission of Markets and Competition (CNMC) authorized the merger of the three domestic card payment systems in Spain. The intention was to form a single domestic card payment system in Spain that could compete on equal terms with Visa and MasterCard. The CNMC declared that financial institution members, merchants, and end-users were free to decide whether to use the new domestic card payment system or the old ones. For more information on this topic see https://www.cnmc.es/2018-02-01-la-cnmc-autoriza-con-compromisos-la-fusion-de-los-tres-sistemas-de-pago-con-tarjeta-que.

progressively reduced during a transitional period of three years from 2006 to December 2008, shown by table (1). The table shows that the IF for the credit card is stated in percentage terms while the debit card one is in monetary terms. In the case of merchants with an annual revenue from POS card payment of less than €100 million, the reduction in credit card IF was 21% between 2006 and 2008, 40% for revenue between €100 and €500 million, and 18% for revenue above €500 million. In the case of debit cards, the reduction was 24% for merchants with revenue from POS card payment of less than €100 million, 30% for those with revenue between €100 and €500 million, and 22% for those with revenue above €500 million. Besides, the Ministry of Industry, Tourism, and Trade and the Ministry of Economy provided a guarantee clause for the IF related to debit and credit cards for the following two years, 2009-2010. The aim was to protect merchants, and eventually customers, from the high IF. The aforementioned regulation expired in December 2010. After that, the Spanish card networks were free to set the IF based on the issuer's cost, but any agreement between card networks had to be reported to the National Commission of Markets and Competition (CNMC) in order to prove compatibility with antitrust legislation.

Table 1.Projected evolution of the maximum IF during 2006-2010

	2006		**2007**		**2008**		**2009-2010**	
Merchant's annual POS revenue (€)	**Debit (€)**	**Credit (%)**	**Debit (€)**	**Credit (%)**	**Debit (€)**	**Credit (%)**	**Debit (€)**	**Credit (%)**
0-100 mill	0.53	1.40	0.47	1.30	0.40	1.10	0.35	0.79
100-500 mill	0.36	1.05	0.29	0.84	0.25	0.63	0.21	0.53
>500 mill	0.27	0.66	0.25	0.66	0.21	0.54	0.18	0.45

Source: Ministry of Industry, Tourism and Trade of Spain[5].

The second important event took place in July 2014 and was in line with the EC's proposal regarding capping the IF in 2015[6]. The objective of this regulation was the same as the Agreement in 2005. The Royal Decree-Law (RDL) 8/2014 approved the cap on IF with different schedules for debit and credit cards. In compliance with this regulation, the IF for the debit card must be set as a percentage of the transaction amount. The maximum permissible IF for an operation carried out with debit cards was 0.2% of the transaction amount, with a maximum of 7 euro cents. In an operation carried out with credit cards, the maximum permissible IF was 0.3% of the transaction amount. In addition, the RDL 8/2014 restricted the maximum permissible IF for transactions of less than 20 euros so that the maximum fee for debit cards was 0.1% of the transaction amount and for the credit card was 0.2% of the transaction amount. The RDL 8/2014 anticipated what EC's regulations were about to impose.

2.2. Literature Review

[5]http://www.comercio.gob.es/en/comercio-interior/distribucion-comercial-estadisticas-y-estudios/tarjetas-de pago/ pages/ tarjetas-de-pago.aspx.

[6]In 2015, the European Parliament and the Council imposed a cap on the IF for all domestic and cross-border transactions with debit and credit cards among the EEA. The aim of this regulation was to harmonise the IFs across the EEA and reduce their levels. Based on this regulation the maximum permissible IF for a transaction carried out with credit cards was 0.3% of the transaction amount and 0.2% for debit ones.

Evaluating the effects generated by capping the IF on merchants, cardholders and their banks are the main concern of the existing empirical studies in the card payment market. Carbo-Valverde et al. (2016) is the closest work to this paper. They apply the two-sided markets theory to study the effects of the IF reduction on markets 1, 2, and 3 described in section (1). They use quarterly payment card data from 45 Spanish banks from 1997 to 2007. The data includes bank-level information on payment cards such as transaction volume by issuer and acquirer, the IF and MSC for debit and credit cards, annual credit fee, merchant acceptance, number of cardholders, and number of ATM and POS terminals. In market 1, they find that card usage increases as a result of capping the IF. In market 2, their results show that card acceptance and transaction volumes increase when the IF is decreased. In market 3, they find that issuers benefit from capping the IF since the increase in card transactions can offset the loss of the IF's revenue. However, contrary to the aim of this work, they do not investigate the effect that IF may have on prices paid by customers. Regarding the effects of the EC regulation 2015, Ardizzi and Zangrandi (2018) study the effects of this cap on MSC and merchant acceptance in the card payment market in Italy. They only focus on market 2 and do not study the effects of capping the IF on the cardholder side. They use the half-yearly institution-level data (banks and non-banks in the acquiring market) of 400 financial institutions that reported to the Bank of Italy from 2009 to 2017. Their results show that the MSC is reduced and the merchant acceptance is increased as a consequence of this policy in Italy. Recently, two consultancy groups (Ernst & Young and Copenhagen Economics (2020)), in a report for the EC, show that acquirers pass 50% of the IF reduction to merchants and hold 50% as savings as a consequence of the regulation 2015. In order to find to what extent the merchants pass the lower MSC to customers, they use a meta study approach[7]. They find that, on average, the merchants pass 66% of the reduction in their costs to customers in the form of lower retail prices.

Some of the existing relevant papers analyse policy changes on IF in the United States and Australia. In 2011, the US Federal Reserve Board implemented the Durbin Amendment (also known as Regulation II), which was part of the Dodd-Frank financial reform legislation and enforced a reduction on the debit card IF from 44 cents to 21 cents per transaction plus 0.05% of the transaction amount for debit card issuers with assets above USD 10 bn. This means that smaller debit card issuers were exempt from this regulation. The objective of this regulation was to reduce the IF, which ultimately benefited merchants and customers. Wang (2012) studies the effect of this cap on the revenues of issuers, relying on descriptive comparative statistics. He finds that the revenue of treated issuers (issuers with assets above USD 10 bn) decreased while the revenue of untreated issuers (issuers with assets below USD 10 bn) increased. Merchants benefited from this regulation by paying lower MSC. The impact of this regulation on customers was less clear since, on the one hand, the issuers argued that they would increase membership fees, and on the other hand merchants argued that they would decrease retail prices due to the lower IF. Evans et al. (2011) study the effects of the IF cap on membership fees by focusing on households and small businesses in the short-run. They find that the cap harmed lower-income households and small businesses since issuers immediately offset a reduction in revenue due to the lower IF by increasing membership fees. They argue that these harms are unlikely to be compensated by price reductions in the short-run since retail prices are sticky and merchants do not change quickly the prices in response to the cost reduction.

[7]The meta-study approach is a simulation of the effects taking the values from other papers that have studied pass-through. This method considers that the pass-through rate is consistent with the historical average cost pass-through rate from other empirical studies, such as studies that focus on the effect of cost change on retail prices due to imposing a tax or a change in the foreign exchange rate.

In 2003, the Reserve Bank of Australia (RBA) enforced a cap on the credit card IF, by which the IF was reduced from 0.95% to 0.55% of the transaction amount. The RBA argued that the credit card IF was set too high, resulting in too low charges of credit card usage (even negative) by cardholders from a social perspective. This leads the overuse of the credit card compared to other cheaper payment forms. Chang et al. (2005) use the data provided by Visa card network in Australia between 1992:3 and 2005:1 to study the effects of capping the credit card IF from the cardholder's side and the merchant's side. On the cardholder's side, they study the effect of this cap on the issuer's revenue and the cardholder's fee. On the merchant's side, they study how much of the IF reduction passes to the merchant through the lower MSC and how much of the MSC reduction passes to buyers through lower retail prices. Most of their work relies on descriptive comparative statistics. They find that issuers lost around 42% of their IF's revenues but they were able to offset their losses by charging higher fees to cardholders. Merchants benefited from this regulation with a 0.21% reduction in the MSC. Chang et al. (2005) argue that merchants passed their cost saving to retail prices at a lower rate than the reduction in the MSC. By considering 50% pass-through rate, they state that the reduction in retail prices would be 0.105%.

Evaluating the effects of the IF reduction on retail prices is an important policy question that previous work has not examined by taking into account the two-sided nature of card payment markets. The main contribution of this paper is to fill this gap. In particular, applying the ARDL model allows me to study the short- and long-run impacts of the IF reduction on retail prices. An important reason to study the short- and long-run relationships is that many prices are sticky in the short-run and merchants are reluctant to change prices quickly, as argued by Evans, Litan, and Schmalensee (2011), Carlton (1986), Alvarez et al. (2010), Dhyne et al. (2006), Anderson et al. (2015). As mentioned before, the stickiness of prices is the argument used by Evans et al. (2011) to discuss that the harms of lower IF levels are unlikely to be compensated by price changes in the short run. However, as will be discussed in the following, there will be long run effects worth taking into account.

3. Data Description

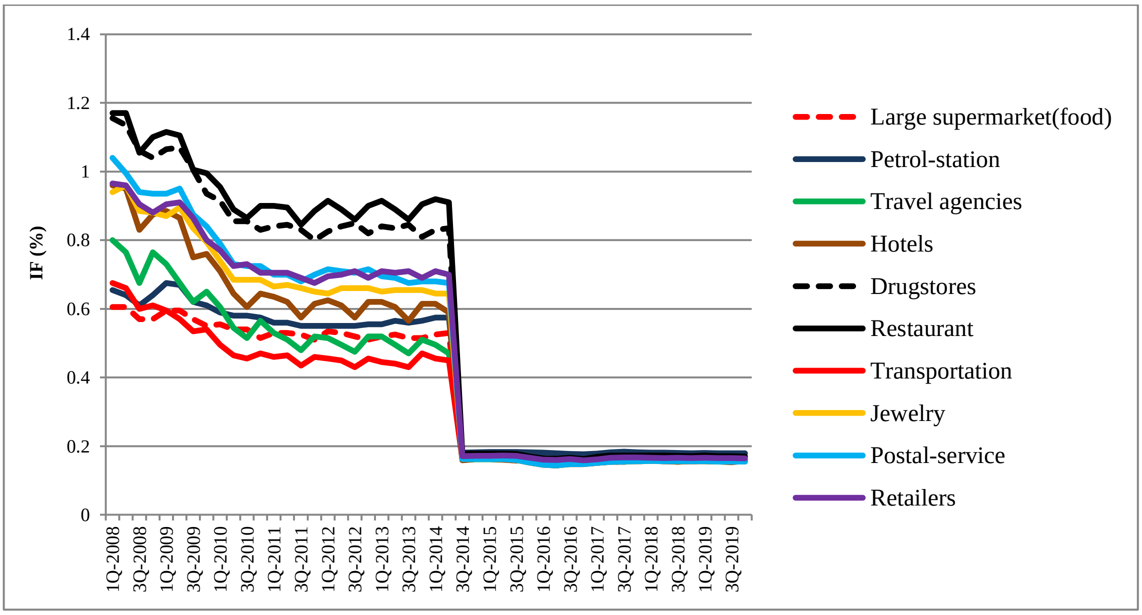
The data used in this study have been obtained from two main sources: the Bank of Spain and the National Statistics Institute of Spain (henceforth INE).

The payment systems department of the Bank of Spain provided quarterly data related to national card payment networks from 2008:1 to 2019:4. The data contains information on the number of devices accepting card payment located in Spain owned by Spanish banks (POS and ATM), volume and value of card transactions at POS and ATM, and volume of cards in circulation. The data also provides rich information on the MSC for domestic payment transactions across 21 different merchant sectors in Spain. The definition of each merchant sector is based on the aggregation of up to 100 different business categories. The data shows that the MSC differs among merchant sectors. Moreover, the data contains the IF levels, on which two time periods can be identified: the first period includes the data from 2008:1 to 2014:2 and the second period includes the data from 2014:3 to 2019:4. In the first period, the data comprises two different measurements of the IF. One measurement is carried out according to the details of the 2005 Agreement, so that the IF is reported in terms of turnover value (table 1). The second measurement in 2008:1 to 2014:2 period reports the IF in terms of intra-and inter-network transactions, and details the figures for the same merchant sectors as the MSC. In the second period, the IF is reported in accordance with the RDL 8/2014 and the Regulation No. 2015/751 on IF, which requires distinguishing between credit card and debit card payments. In this case, data is provided across 9 different merchant sectors (Bank of Spain, 2014).

The above information indicates that there are no uniform data series on the IF. To overcome this problem, I use the following procedure to build a homogeneous series. In the first period, I pick the levels of IF for intra- and inter-network transactions, since this allows me to study the IF across the same merchant sectors as the MSC. This data indicates that the inter-network IF is greater than the intra-network one, as it includes the interconnection cost that is a fixed amount per transaction (Bank of Spain, 2014). Then, to obtain a single value for IF in this period, I compute the average of inter- and intra-network IFs for each merchant sector. In the second period, I compute the average of debit and credit IFs for each merchant sector. Figure 2 illustrates the resulting evolution of IFs in some selected merchant sectors across my sample period. The higher IFs belong to the restaurant and the drugstore sectors and the lower ones belong to the transportation and the large supermarket sectors. The figure shows that the IFs sharply drop in 2014:3 in line with the RDL 8/2014 and then smoothly fluctuate up to 0.2% and become almost identical in all sectors.

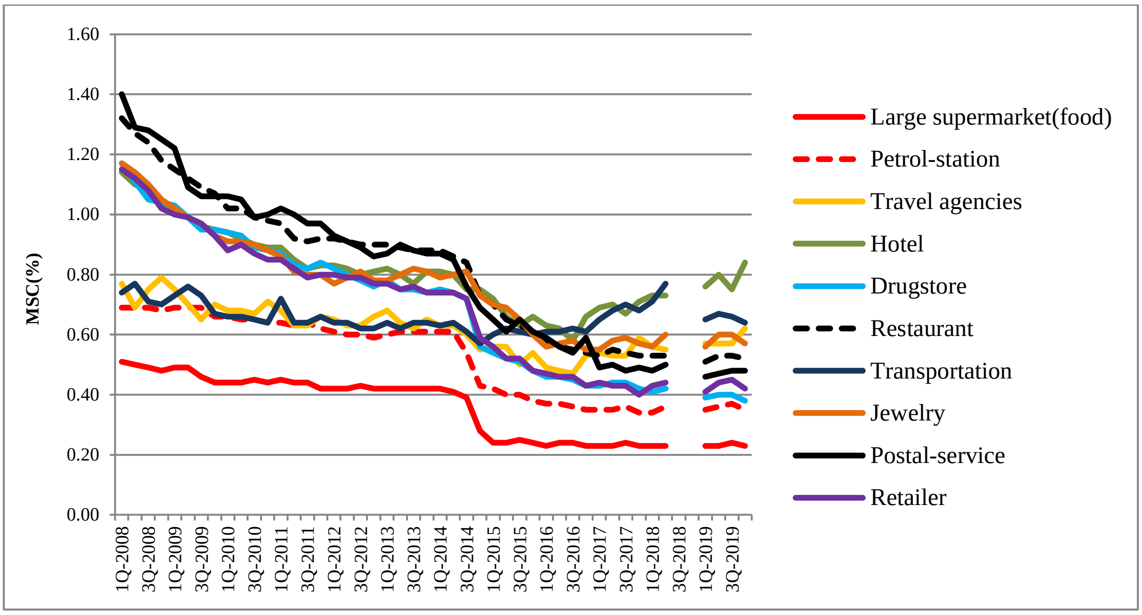
As mentioned earlier, one of the objectives of capping the IF was to decrease the MSC. From the data, it is observed that the IF reduction correlates with lower MSC. Figure 3 shows that, in general, the MSCs have downward trends. The higher MSCs are those of postal services and restaurants and the lower ones those of petrol stations and large supermarkets. The MSCs dropped in 2014:4, after the cap imposed on the IF in 2014:3. This may indicate that the MSC in the current period depends on the IF level in the previous period. While the IF appeared to have stabilised after the third quarter of 2014, the MSCs of some merchant sectors continued to fall during the sample period. However, a visual inspection can barely be used as adequate evidence of policy impact. Therefore, it is essential to analyse empirically whether decreasing the IF causes a reduction in the MSC.

Figure 2. Aggregate average IF paid by an acquirer to issuer per card transaction among some selected merchant sectors.



Source: Bank of Spain and own calculation.

Figure 3. Aggregate average MSC for some selected merchant sectors.



Source: Bank of Spain and own calculation.

The data also shows that after regulation 2014, the number of cards in circulation (comprising debit and credit cards) grew significantly. Table (2) shows the annual average increase in the number of payment cards.

Table 2. Annual average growth rate of number of cards in circulation in Spain (%).

2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
-1.6	-3.01	-5.6	0.02	0.26	-0.94	0.81	5.51	7.12	4.35	5.25

Source: Bank of Spain and own calculation.

Besides, the number of POS terminals significantly grew after regulation 2014. The number of ATM decreased over sample period except in 2016 and 2018 (table 3).

Table 3. Annual average growth rate of number of accepting devices in Spain (%).

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
POS	2.49	-0.96	-0.26	-0.68	-4.50	-5.24	12.64	5.80	6.35	5.16	4.63
ATM	-0.02	-0.27	-0.34	-0.21	-0.47	-0.48	-0.20	0.08	-0.02	0.31	-0.15

Source: Bank of Spain and own calculation.

Tables (4) and (5) show the annual average growth rate of volume and value of card transactions at POS and ATM, respectively. It is observed that the card usage grew at POS. This evidence could show that card payments replace cash payments in Spain during the sample period, in line with the report on the assessment of the effects of the EC's IF cap in 2015 provided by Ernst & Young and Copenhagen Economics (2020).

Table 4. Annual average growth rate of volume of card transaction at POS and ATM Spain (%).

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
POS	2.25	5.84	3.90	0.92	2.38	8.51	7.21	13.43	12.61	13.13	15.76
ATM	-2.95	-0.16	-1.72	-4.22	-2.95	0.44	1.49	0.6	1.01	-0.28	-0.78

Source: Bank of Spain and own calculation.

Table 5. Annual average growth rate of value of card transaction at POS and ATM Spain (%).

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
POS	-3.58	4.57	3.25	-0.79	1.1	7.42	6.09	10.72	8.73	8.49	9.74
ATM	-2.87	0.81	-0.43	-2.61	-1.26	1.97	3.11	2.96	3.54	1.90	1.97

Source: Bank of Spain and own calculation.

The second category of data, including the consumer price index (CPI) and the household total expenditure, is obtained from the INE. The CPI is a measure of prices of a basket of goods and services in an economy. The CPI is calculated based on the base year 2016 in Spain, using approximately 220,000 monthly prices. The INE provides the total household expenditure in the Household Budget Survey (Encuesta de Prespuestos Familiares) that contains detailed breakdown of consumption expenses by approximately 24,000 households. The total household expenditure contains all domestic costs incurred by households to satisfy their everyday needs. The CPI is reported monthly and the household total expenditure is reported annually. Since the data related to the card payment is reported quarterly, in order to have the same frequency among data, the monthly and annual data are converted into quarterly ones. Another issue is that the INE uses ECOICOP classification for products, but the data from the Bank of Spain is descriptive, not classified in the same way. To overcome this heterogeneity between two sources of the data, I take the merchant sectors reported by the Bank of Spain as the baseline and attempt to find the most similar sectors from the INE. In this regard, 10 different merchant sectors are selected that are perfectly suitable for the two sources. Thus, the investigation is restricted to large supermarket-food, petrol stations, travel agencies, hotels, drugstores, restaurants, transportation services, jewelry stores, postal services, and retailers. Table (6) provides the identification of each merchant sector. The number before each sector is ECOICOP digits reported by the INE. I exclude from the analysis the following sectors included in the original data from the Bank of Spain: supermarkets categorised as ‘other’, chemists, toll-highways, car rental, entertainment, casinos, massage-saunas, night clubs, low-value category items, payments to charity and solidarity organisations, and others.

Table 6. Identification of equivalent sectors in card payment fee data (Bank of Spain) and CPI (INE).

Bank of Spain	**INE**
Large supermarket(food)	01 Food and non-alcoholic beverages
Petrol station	0722 Fuels and lubricants for personal transport equipment
Travel agency	0960 Package holidays
Hotel	112 Accommodation services
Drugstore	0630 Hospital services
Restaurant	1111 Restaurants, cafes and the like
Transportation	0735 Combined passenger transport
Jewelry	1231 Jewelry, clocks and watches
Postal service	081 Postal services
Retailer	031 Clothing

Table (7) shows the definition of the variables that I use for the empirical models to be estimated. The CPI level (indexed at 100 in 2016) is used to measure the retail prices variable (P). The data does not contain the data related to the card payment usage at POS. Instead, it contains data related to the transaction volumes at POS and ATM. By using this information, I define the card payment usage at POS (VolPOS) as the portion of transaction volumes at POS to total transaction volumes at POS and ATM. This is a choice variable that indicates whether a cardholder chooses the card payment method or not. I assume that the card payment usage is the same for all the sectors. The corresponding data exist for the rest of the variables.

Table 7.Definition of the variables.

Variable	Unit	Definition
P	Number	Consumer price index (CPI)
MSC	Percent	Merchant service charge
IF	Percent	Interchange fee
Totexp	Billion Euros	Total household expenditure
VolPOS (card payment usage)	Percent	$\frac{\text{Volume of transaction at pos}}{(\text{Volume of transaction at pos} + \text{Volume of transaction at ATM})}$
NC	Number	Number of cards in circulation (Million)
POS	Number	Number of POS device (Million)

Table (8) shows the descriptive statistics of the variables. The table reports overall, between and within variations of the empirical variables. Within shows the variation over time (time variant), between shows the variation across sectors (time-invariant) and overall shows the variation over time and sectors. As can be observed, there is a strong variation in retail prices over time. The total expenditure varies strongly across merchant sectors. It is worth to remind that some variables such as VolPOS, NC, and POS are only time-variant.

Table 8. Descriptive statistics of the variables.

Variable		Mean	Std.Dev.	Min	Max	Observations
P	Overal	98.4878	10.73706	60.711	128.963	N=480
	Between		5.700557	91.73571	110.5829	n=10
	Within		9.272359	67.24094	123.3459	T=48
MSC	Overal	0.678413	0.2262286	0.23	1.4	N=460
	Between		0.1479519	0.3582609	0.8213043	n=10
	Within		0.1773011	0.320587	1.260587	T=46
IF	Overal	0.4547613	0.2987823	0.14415	1.17	N=480
	Between		0.0834745	0.341299	0.5957115	n=10
	Within		0.2880739	0.0220749	1.047726	T=48
Totexp	Overal	4.434095	5.837232	0.02	19.67	N=420
	Between		6.133532	0.0278571	18.85119	n=10
	Within		0.3664421	2.825286	5.734334	T=42
VolPOS	Overal	0.7311549	0.0510493	0.6547304	0.8432481	N=460
NC	Overal	73.31152	5.24214	67.48	85.61	N=460
POS	Overal	1.586978	0.1503086	1.322	1.942	N=460

Table (9) shows the descriptive statistics of the IF and the MSC at the sector level. The highest (lowest) MSC is that of postal services (large supermarket-food) and the highest (lowest) IF is that of restaurants (transportation services, jewelry stores, and postal services). The comparison of the average of the MSC and the IF at different merchant sectors shows that acquirers get lower margins in some sectors such as large-supermarket (food) and petrol stations. The intuition could be that these sectors have large transaction volumes, so their merchants have a better bargaining position vis-à-vis acquirers than merchants in sectors with lower volumes and thus they receive volume discounts and formally pay a lower MSC.

Table 9. Descriptive statistics of the IF and the MSC.

Merchant sector	Mean		Std.Dev.		Min		Max		Observations	
	IF	MSC	IF	MSC	IF	MSC	IF	MSC	IF	MSC
Large supermarket(food)	0.3684	0.3582	0.1935	0.1054	0.1528	0.23	0.605	0.51	48	46
Petrol station	0.4008	0.5263	0.2062	0.1377	0.1763	0.34	0.675	0.69	48	46
Travel agency	0.3828	0.6189	0.222	0.0781	0.1489	0.47	0.8	0.79	48	46
Hotel	0.4458	0.8136	0.2842	0.1336	0.1482	0.58	0.96	1.14	48	46
Drugstore	0.5620	0.7004	0.3868	0.2335	0.1442	0.38	1.155	1.17	48	46
Restaurant	0.5957	0.8213	0.4008	0.2395	0.1630	0.51	1.17	1.32	48	46
Transportation	0.3412	0.6582	0.1813	0.0480	0.1441	0.57	0.675	0.77	48	46
Jewelry	0.4675	0.7697	0.3009	0.1730	0.1441	0.55	0.96	1.17	48	46
Postal service	0.4919	0.8178	0.3245	0.2663	0.1441	0.46	1.04	1.4	48	46
Retailer	0.4910	0.6993	0.3100	0.2248	0.1585	0.4	0.965	1.15	48	46

Source: Bank of Spain and own calculation.

The partial correlations between variables are shown in table (10). All variables are expressed in natural logarithm terms. The table shows that the IF and the MSC are positively correlated. The card payment usage is highly correlated with the IF and the MSC. The correlation between card payment usage and the number of cards is also positive.

Table 10. Partial correlations between variables.

	Log (P)	Log (MSC)	Log (IF)	Log (Totexp)	Log (VolPOS)	Log (NC)	Log (POS)
Log(P)	1.00						
Log(MSC)	-0.39	1.00					
Log(IF)	-0.38	0.79	1.00				
Log(Totexp)	0.21	-0.36	-0.06	1.00			
Log(VolPOS)	0.46	-0.61	-0.81	-0.03	1.00		
Log(NC)	0.13	-0.22	-0.33	0.005	0.48	1.00	
Log(POS)	0.45	-0.58	-0.82	-0.01	0.96	0.64	1.00

4. Fee Structure in Open Payment Card Network.

As mentioned in section (1), the issuer sets a membership fee to the cardholder (f), the acquirer sets a MSC to the merchant, and the card network sets the licence fee (Lf) to the issuer and the acquirer. A number of works (see, e.g. Rochet and Tirole, 2002, 2006; Rysman, 2009; Evans et al., 2015; Adachi and Tremblay, 2020) explain that, in the open payment card network, the fees (or rewards) that the cardholders and the merchants pay to (or receive from) their banks depend on the IF, which is paid by the acquirer to the issuer per card transaction. I follow the simple model of Rochet and Tirole (2002) to explain this relationship. Assume that there is a single payment card network in which acquirers compete with each other while issuers have a certain degree of market power. The card network sets the same IF to all acquirers. After the IF has been set, the issuer sets a membership fee (f) to its cardholders as follows.

$$f = F(c_I - \text{IF}) \quad (1)$$

where f is defined as a function of issuer's cost (c_I) and the IF for one card transaction. Rochet and Tirole (2002) therefore assume that the membership fee decreases with the IF. The inverse relationship between the membership fee and the IF indicates that the higher IF lowers the membership fee. If the benefit from using the card (b_B) is greater than the membership fee, then the cardholder has more incentives to use it rather than other forms of payments. Rochet and Tirole (2002) define the demand for cards as follows.

$$D(f(c_I - \text{IF})) = 1 - H(f(c_I - \text{IF})) \quad (2)$$

where $H(f)$ is the cumulative distribution function that captures the fraction of customers with $b_B < f$ that do not have incentive to hold and use the card: card demand is a decreasing function of the membership fee.

On the other side of the market, the acquirer sets the MSC in a way that it covers its cost (c_A) and the IF.

$$MSC = c_A + IF \quad (3)$$

The IF adds to the acquirer's cost of providing payment card services to merchants. The acquirer generally passes the IF to the merchant and it comprises the main fraction of the MSC[8]. Rochet and Tirole (2002) assume that acquirers are competitive and fully pass the IF to merchants. Economic theory specifies that the full pass-through is only possible if there is perfect competition with constant returns to scale. If these conditions are not met, then pass-through relies on the market structure, extent of product differentiation, and competitive interactions between firms as well as curvature of demand. In such case, it is expected that the pass-through rate will be less than 100% (Weyl and Fabinger, 2013; Williams et al., 2014).

The asymmetric fee allocation between the cardholder and the merchant depends on the elasticity of their demands for card payments. Borestam and Schmiedel (2011) argue that the merchant's demand for accepting cards is less elastic than the cardholder's demand for using cards. This implies that the merchant's willingness to accept cards is affected relatively little by changing the MSC but the cardholder's decision to use or hold the card is affected aggressively by changing the membership fee and/or the reward. Their explanation is based on the evidence that card payment has become a necessity payment instrument in many businesses such as restaurants, hotels, gas stations, online selling, and so on. Also, widespread acceptance of cards within the merchant sectors, as well as the cardholder's expectations with respect to using his card rather than cash or check, lead to merchants having a more rigid demand for card payments. The other reason for asymmetric fee allocation may relate to the participation of parties in several card networks. In practice, merchants have to a great extent join several platforms (in other words, they are multi-homing) since they accept cards of various networks. Consequently, cardholders may have less incentive to hold several cards of

[8] For instance, in the United States, the IF comprises 75% of the MSC (Hayashi, 2006).

the same type. Armstrong (2006) explains that this feature leads to a card network having monopoly power over providing access to its cardholders for merchants. It means that if a cardholder joins one card network, then the merchant can access the cardholder only by joining the same network. This feature causes the merchant to pay a larger share of the fee level than the cardholder. In the following, I explain why merchants accept card payments although it is costly for them.

Merchant acceptance

Rochet and Tirole (2002) and later Wright (2004) and Bedre-Defoli and Calvano (2013) explain that the competitive merchants have a strategic reason to accept the card, which is to steal rival's customers and to retain their current customers. So, if they do not accept the card, they will lose part of their sales. Monopoly merchants also have the incentive to accept card payment since it shifts customer's demand upward and consequently accrues additional revenue.

One of the purposes of this paper is to test the degree of the 'Merchant internalisation, which is the concept to which Rochet and Tirole (2002) attribute card acceptance. As the cardholder benefits from paying by the card, the merchant by accepting the card exerts externality on the cardholder. By increasing card acceptance, merchants offer additional surplus to cardholders and can extract part of the consumer's surplus by setting higher retail prices. Given 'Merchant internalisation', merchants are also less resistant to the level of the MSC, as they can pass it through to retail prices. The MSC as a variable cost of accepting card payment has an impact on retail prices charged by merchants to cardholders. Rochet and Tirole (2002) analyse the impact of the IF on retail prices of goods and services. They assume that there are two merchants that sell the same products and accept card payment. They normalise the number of card transactions to 1 and use the Hotelling model where customers are uniformly distributed on the segment [0, 1] and the two merchants are located at either extreme. Each merchant maximises its profits in terms of retail prices as follows:

$$max_{\,p_i}\{[p_i - \left(\tau + D\big(f(c_I - IF)\big).MSC(IF)\right)]x_i\} \quad (4)$$

where the term $(\tau + D\big(f(c_I - \mathrm{IF})\big).MSC(IF))$ is the merchant's marginal cost in which τ captures the transaction cost associated with other form of payments, D is the card demand that is given by equation (2), and the MSC is the merchant service charge that is given by equation (3). The term x_i is the market share of merchant i with $i \in \{1, 2\}$. Given retail prices of both merchants (p_i, p_j) with $i \neq j \in \{1, 2\}$, merchant i's market share is given by $x_i = \frac{1}{2} + \frac{p_j - p_i}{2\sigma}$ where σ reflects the level of transportation costs. Solving equation (4) yields

$$P = [\tau + D\big(f(c_I - \mathrm{IF})\big).MSC(IF)] + \sigma \quad (5)$$

Equation (5) indicates that the IF affects retail prices through two sides: from the cardholder side by affecting card demand and from the merchant side by affecting the MSC. The main analysis of the present paper relies on equation (5) since this is a way to test if 'Merchant internalisation' has an effect on prices.

The model of Rochet and Tirole (2002) is built based on an important assumption that merchants do not make price discrimination against customers who pay by a card or cash. This assumption is in line with the 'no- surcharge' rule that is imposed by open payment card networks. This rule does not allow merchants to charge an extra fee on a cardholder rather than on customers who pay with cash or check. Thus, there is only one retail price in terms of payment method and the choice of payment instrument does not impact on the retail prices. The no-surcharge rule leads to

‘Merchant internalisation’ in the form of higher prices for all customers. Moreover, this rule promotes card payment that is more efficient than cash payment, but it allows the open card network to set the high IF that ultimately passes to all customers. Under this rule, customers who pay with cash grant subsidy to cardholders since both cardholders and cash customers are charged the same price but cardholders receive rewards from the issuer (Carlton and Frankel, 1995). In contrast, if merchants are allowed to charge an extra fee on the cardholder rather than on a customer who pays with cash or to offer some discounts for cash payments (known as the surcharge), then there are different retail prices for cash and card payments. In this case, the merchant is enabled to steer customers towards the payment method that is cheaper by using price signals, but that method may be inefficient as cardholders may switch to paying by cash, leadings to a decrease in card usage and, in turn, to a decrease in merchant’s card acceptance. In this case, the IF has a neutral effect on the market and open card networks cannot operate at their optimal level (Gans and King, 2003). Since the main aim of this paper is to test ‘merchant internalisation’, I make my analysis under the ‘no-surcharge’ rule assumption.

4.1.Model Specification.

In order to examine the impact of the IF on retail prices, I take into account the two-sidedness nature of the card payment market. This means that the impact is examined from the merchant’s and the cardholder’s sides. In this respect, this subsection recalls the three markets involved in a card transaction with an open payment card network, as explained in section (1): Market 1 between issuers and cardholders, Market 2 between acquirers and merchants, and Market 4 between merchants and cardholders. Market 3 between acquirers and issuers is not studied since it is beyond the main purpose of this paper.

In order to evaluate the effect of changes in the IF from the merchant side, Market 2 is considered. In this market, I focus on the sign and magnitude of the relationship between the MSC and the IF to find how changing the IF affects the merchant ($\frac{\partial MSC}{\partial IF}$). I specify the empirical version of equation (3) as follows.

$$\text{Log}\, MSC_{it} = \mu_i + \delta_{1i} \log IF_{it} + \delta_{2i} \log POS_{it} + \delta_{3i} \log NC_{it} + \gamma t + \epsilon_{it} \qquad (6)$$

The dependent variable is the logarithm of MSC that is paid by merchant i (for $i = 1, \dots, 10$) at time t (for $t = 2008{:}1, \dots, 2019{:}3$). The most important explanatory variable is the logarithm of IF that is paid by an acquirer in merchant sector i at time t. To capture the effect of number of transactions on the MSC, I add the POS variable. As explained, there is the membership externality in the card payment market, i.e. more cardholders affect merchants’ card acceptance and vice versa. To control this effect, I add the variable number of cards. The trend variable is shown by t and takes the value 1 at the starting point and grows by 1 each quarter. It can capture impacts such as the progress of digitalisation over time and may have an influence on MSC_{it}.

To study the impact of IF changes on the cardholder side, Market 1 is considered. As previously explained, issuers encourage cardholders to increase card usage by decreasing the membership fee (or offering rewards). In this regard, the empirical version of equation (2) is specified as follows.

$$\text{Log}\, VolPOS_{it} = \mu_i' + \beta_{1i} \log f_{it} + \delta_{3i}' \log POS_{it} + \delta_{4i}' \log TotExp_{it} + \gamma' t + \epsilon_{it}' \qquad (7)$$

The dependent variable is the logarithm of card payment usage at POS. As I explained in section (3), it is defined as the portion of the transaction volume at POS to total transaction volume at POS and ATM. The variable POS is added to capture the attractiveness of using a card by cardholders that depends on the number of merchants that accept the payment card (membership externality). Moreover, the decision to use a card as a payment method instead of alternative payment instruments can be controlled by the total expenditure of the household. As in equation (6), t is the trend variable.

Equation (1) in section (3) has shown that an issuer sets the membership fee according to the difference between the marginal cost it bears from every transaction and the interchange fee. We can assume that such issuer's costs are constant, so that

$$Log\ (f_{it}) = c_I - Log\ (IF_{it}) \quad (8)$$

However, we can assume that the issuer experiences some kind of economies or diseconomies of scale, whereby the marginal cost of each transaction varies with the number of cards issued. So, equation (8) can be written as

$$Log\ (f_{it}) = c_I + Log\ (NC_{it}) - Log\ (IF_{it}) \quad (9)$$

where the number of cards (NC) is a proxy variable that captures the effect of economies or diseconomies of scale in the membership fee. In order to study how changing the IF affects card payment usage by cardholders ($\frac{\partial VolPOS}{\partial IF}$), I insert equation (9) in (7). Therefore, the econometric specification is defined as follows.

$$\text{Log}\, VolPOS_{it} = \omega_i' + \delta_{1i}' \log IF_{it} + \delta_{2i}' \log NC_{it} + \delta_{3i}' \log POS_{it} + \delta_{4i}' \log TotExp_{it} + \gamma' t + \epsilon_{it}' \quad (10)$$

with $\omega_i' = \mu_i' + c_I$.

In Market 4, the price equation (5) showed the effect of a change in the MSC and card payment usage on retail prices. This makes it possible to identify two effects: i) the relationship between retail prices and the MSC to find how much of a reduction in the cost of accepting card passes into cardholders ($\frac{\partial P}{\partial MSC}$), and ii) the relationship between retail prices and the card payment usage to find how a change in the card payment usage affects retail prices ($\frac{\partial P}{\partial VolPOS}$). The econometric specification of such equation follows the structure outlined below:

$$\text{Log}\, P_{it} = \mu_i'' + \delta_{1i}'' \log VolPOS_{it} + \delta_{2i}'' \log MSC_{it} + \delta_{3i}'' \log Totexp_{it} + \gamma'' t + \epsilon_{it}'' \quad (11)$$

The dependent variable is the logarithm of retail prices in the merchant sector i at time t. The key explanatory variables are the logarithm of the card payment usage and the MSC. It is essential to distinguish between a change in prices due to the changing demand of products and what is associated with a decline in the MSC. I do this by including the household total expenditure in each sector as a control variable. Moreover, this variable can also capture the effect of the economic cycle on consumption.

In order to examine the effect of the IF on retail prices from the merchant side, I make use of the following expression.

$$\frac{\partial P}{\partial IF} = \frac{\partial P}{\partial MSC} \frac{\partial MSC}{\partial IF} \quad (12)$$

Equation (12) shows how the IF reduction affects the MSC and how a change in the MSC affects retail prices. From the cardholder's side, the expression would be

$$\frac{\partial P}{\partial IF} = \frac{\partial P}{\partial VolPOS}\frac{\partial VolPOS}{\partial IF} \qquad (13)$$

Equation (13) shows how the IF reduction affects the card payment usage and how a change in card payment usage affects retail prices. Combining both expressions, I will assess the total effect of a change in IF on retail prices, taking into account the relative magnitude of the effects of the two sides in the card payment market.

In order to estimate equations (6), (10) and (11) I follow the econometric method proposed by Pesaran et al. (1999) and study the short- and long-run relationships between variables. The reason is that in the available data, the time period (T=48) is relatively large. In this case, applying the traditional dynamic panel data estimators[9] such as GMM estimators can be problematic since the large time period requires a large number of instruments. The result of the Sargan test on the exogeneity of instruments is not valid. Therefore, the results obtained using GMM are likely inconsistent and unreliable (Pesaran and Smith, 1995). A further issue is that the traditional dynamic panel data estimators are typically limited to short time periods when the stationarity of the variables is ignored. Therefore, when the time period is large, it is necessary to examine whether variables are stationary and then study the relationship between them by applying the appropriate method.

Pesaran and Smith (1995) and Pesaran et al. (1999) argue that when the variables of interest are characterised by I (1) or I (0) and the time period is large, the short- and long-run relationships between variables should be examined by the autoregressive distributed lag (ARDL) approach. The typical process in this case is to first determine the order of integration, and then having determined that the variables have the same order use the ARDL approach. Therefore, the lag length must first be specified. In order to do this, I apply the Schwarz Bayesian Criterion (SBC) for each variable in each sector. Then I compare the orders offered by this test for each variable between 10 merchant sectors to determine the order of the ARDL model. The results of the SBC tests are shown in the appendix. Based on these results, in more than half of the merchant sectors the lag length is as follows: ARDL (1, 1) for equation (6), ARDL (1, 1, 1) for equation (10), and ARDL (1, 1, 1, 1) for equation (11). Given the lag lengths, I am able to apply the ARDL methods to estimate the parameters of equations (6), (10), and (11).

4.2. ARDL Model.

Pesaran et al. (1999) define an ARDL model with lag length 1 for a panel with relatively large time period as follows:

$$y_{it} = \lambda_i y_{i,t-1} + \sum_{j=0}^{1} \delta'_{ij}\, x_{i,t-j} + \mu_i + \epsilon_{it} \qquad (14)$$

where $i = 1, \ldots, N$ and $t = 1, \ldots, T$ represent the number of groups (or sectors) and the time period, respectively. The dependent variable is y_{it} and the vector of explanatory variables is x_{it}. The parameter μ_i shows the constant term. Pesaran et al. (1999) show that the model (14) can be

[9]The traditional dynamic panel data estimators are GMM estimators (the GMM-difference estimator proposed by Arellano and Bond (1991) and the GMM-system estimator by Arellano and Bover (1995) and Blundell and Bond (1998)).

re-parameterized and rewritten as an error correction model as follows:

$$\Delta y_{it} = \varphi_i(y_{i,t-1} - \theta_{0i} - \theta_i x_{i,t-1}) + \delta_i^* \Delta x_{it} + \varepsilon_{it} \tag{15}$$

where $\Delta y_{it} = y_{it} - y_{it-1}$, and $\Delta x_{it} = x_{it} - x_{it-1}$.The parameter $\varphi_i = -(1 - \lambda_i)$ is the error correction parameter, and $(y_{i,t-1} - \theta_{0i} - \theta_i x_{i,t-1})$ is the error correction component. The Error correction term has to lie between 0 and -1, otherwise, the short-run relationships would not converge towards their long-run equilibrium at rate φ_i. The parameter φ_i shows the speed of adjustment to the long-run equilibrium. The parameters θ_{0i} and θ_i are the long-run relationships and they are equal to$\theta_{0i} = \frac{\mu_i}{1-\lambda_i}, \theta_i = \frac{\sum_{j=0}^{1} \delta_{ij}^{'}}{1-\lambda_i}$. The parameter δ_i^* indicates the short-run relationship. If the panel is co-integrated, then the long-run relationship exists. In this case, the parameter φ_i significantly differs from zero.

There are three different estimators for estimating equation (15): the mean group (MG) estimator proposed by Pesaran and Smith (1995), the pooled mean group (PMG) estimator proposed by Pesaran et al. (1999), and the dynamic fixed effect estimator (DFE). For each sector, the MG estimates separate regressions and then calculates a simple arithmetic average of their coefficients. This estimator does not set any limits and allows all coefficients to differ across merchant sectors (Pesaran and Smith, 1995). The results of this estimator are consistent. The DFE allows only intercepts to differ across merchant sectors. This estimator imposes the restriction on the speed of adjustment, slope coefficients, and error variances to be equal across all merchant sectors in the short- and long-run. The PMG estimator is an intermediate estimator between MG and DFE, i.e. a combination of pooling and averaging of coefficients. The key feature of the PMG estimator is that it lets the intercepts, short-run coefficients, the speed of adjustment to the long-run equilibrium, and error variances to be heterogeneous across merchant sectors, but the long-run coefficients are constrained to be identical across merchant sectors. In other words, the parameters θ_{0i} and θ_i are the same across sectors. In fact, the PMG estimator allows examining the long-run homogeneity without imposing homogeneity in the short run. The long-run coefficients are consistent and efficient when the variables of interest are characterised by I (1) or I (0) (Pesaran et al., 1999). All three estimators use maximum likelihood (ML) methods to estimate the short- and long-run relationships.

To choose among the MG, PMG, and DFE estimators, the Hausman (1978)-type test can be used. The null hypothesis is that there are no systematic differences between PMG and MG or PMG and DFE. If the null hypothesis is not rejected, then the PMG estimator is suggested because it is consistent and efficient. Under the PMG, the coefficients are homogeneous in the long-run. In other words, the Hausman test tests the existence of the long-run homogeneity of coefficients. If the null hypothesis is rejected, then the coefficients are not the same across the merchant sectors in the long-run and the PMG estimator is inconsistent. In such case, it is recommended to use the MG or DFE estimators (Blackburne III and Frank, 2007).

4.2.1. Implementing the ARDL Model in the Card Payment Market.

Herein, I follow Pesaran et al. (1999) and implement the ARDL model and error correction model for equations (6), (10), and (11). The ARDL model of equation (6) can be specified as follows:

$$\text{Log}\, MSC_{it} = \mu_i + \lambda_i \log MSC_{i,t-1} + \sum_{j=0}^{1} \delta_{1ij} \log IF_{i,t-j} + \sum_{j=0}^{1} \delta_{2ij} \log POS_{i,t-j} + \sum_{j=0}^{1} \delta_{3ij} \log NC_{i,t-j} + \gamma T + \epsilon_{it} \quad (16)$$

where $i = 1, \dots, 10$ represents the merchant sectors, t represents the time periods from 2008:1 to 2019:4, T is the trend variable, and μ_i represents the constant term. The error correction of equation (16) is given by:

$$\Delta\, \text{Log}\, MSC_{it} = \varphi_i(\log MSC_{i,t-1} - \theta_{0i} - \theta_{1i} \log IF_{it} - \theta_{2i} \log POS_{it} - \theta_i \log NC_{it}) - \delta_{1i}\, \Delta\log IF_{it} - \delta_{2i}\, \Delta\log POS_{it} - \delta_{3i}\, \Delta\log NC_{it} + \varepsilon_{it} \quad (17)$$

where $\theta_{0i} = \frac{\mu_i}{1-\lambda_i}$,$\theta_{1i} = \frac{\delta_{10i}+\delta_{11i}}{1-\lambda_i}$, $\theta_{2i} = \frac{\delta_{20i}+\delta_{21i}}{1-\lambda_i}$, $\theta_{3i} = \frac{\delta_{30i}+\delta_{31i}}{1-\lambda_i}$, and $\varphi_i = -(1-\lambda_i)$. The parameter θ are the long-run relationship between dependent and independent variables, and δ are the short-run relationship between them. The ARDL model of equation (10) can be defined as follows:

$$\text{Log}\, VolPOS_{it} = \omega_i' + \lambda_i' \log VolPOS_{i,t-1} + \sum_{j=0}^{1} \delta_{1ij}^{'} \log IF_{i,t-j} + \sum_{j=0}^{1} \delta_{2ij}^{'} \log NC_{i,t-j} + \sum_{j=0}^{1} \delta_{2ij}^{'} \log POS_{i,t-j} + \sum_{j=0}^{1} \delta_{2ij}^{'} \log TotExp_{i,t-j} + \gamma^{'} T + \epsilon_{it}^{'} \quad (18)$$

The error correction of equation (18) is given by:

$$\Delta\, \text{Log}\, VolPOS_{it} = \varphi_i' (\log VolPOS_{i,t-1} - \theta_{0i}' - \theta_{1i}' \log IF_{it} - \theta_{2i}' \log NC_{it} - \theta_{3i}' \log POS_{it} - \theta_{4i}' \log TotExp_{it}) - \delta_{11i}^{'}\, \Delta\log IF_{it} - \delta_{21i}^{'}\, \Delta\log NC_{it} - \delta_{21i}^{'}\, \Delta\log POS_{it} - \delta_{21i}^{'}\, \Delta\log TotExp_{it} + \varepsilon_{it}' \quad (19)$$

where $\theta_{0i}' = \frac{\omega_i'}{1-\lambda_i'}$, $\theta_{1i}' = \frac{\delta_{10i}^{'}+\delta_{11i}^{'}}{1-\lambda_i'}$, $\theta_{2i}' = \frac{\delta_{20i}^{'}+\delta_{21i}^{'}}{1-\lambda_i'}$, $\theta_{3i}' = \frac{\delta_{30i}^{'}+\delta_{31i}^{'}}{1-\lambda_i'}$, $\theta_{4i}' = \frac{\delta_{40i}^{'}+\delta_{41i}^{'}}{1-\lambda_i'}$, and $\varphi_i^{'} = -(1-\lambda_i^{'})$. The parameters θ' are the long-run coefficients and δ' are the short-run coefficients. The ARDL model of equation (11) follows the structure laid out below:

$$\text{Log}\, P_{it} = \mu_i'' + \lambda_i'' \log P_{i,t-1} + \sum_{j=0}^{1} \delta_{1ij}^{''} \log VolPOS_{i,t-j} + \sum_{j=0}^{1} \delta_{2ij}^{''} \log MSC_{i,t-j} + \sum_{j=0}^{1} \delta_{3ij}^{''} \log Totexp_{i,t-j} + \gamma^{''} T + \epsilon_{it}^{''} \quad (20)$$

The error correction of equation (20) is given by:

$$\Delta\, \text{Log}\, P_{it} = \varphi_i''(\log P_{i,t-1} - \theta_{0i}'' - \theta_{1i}'' \log VolPOS_{it} - \theta_{2i}'' \log MSC_{it} - \theta_{3i}'' \log Totexp_{it}) - \delta_{11i}^{''}\, \Delta\log VolPOS_{it} - \delta_{21i}^{''}\, \Delta\log MSC_{it} - \delta_{31i}^{''}\, \Delta\log TotExp_{it} + \varepsilon_{it}'' \quad (21)$$

where $\theta_{0i}'' = \frac{\mu_i''}{1-\lambda_i''}$, $\theta_{1i}'' = \frac{\delta_{10i}^{''}+\delta_{11i}^{''}}{1-\lambda_i''}$, $\theta_{2i}'' = \frac{\delta_{20i}^{''}+\delta_{21i}^{''}}{1-\lambda_i''}$, $\theta_{3i}'' = \frac{\delta_{30i}^{''}+\delta_{31i}^{''}}{1-\lambda_i''}$, and $\varphi_i'' = -(1-\lambda_i'')$. The parameter θ'' are the long-run coefficients, while δ'' are the short-run coefficients.

5. Estimation.

In this section, I first investigate the stationary level of variables to establish whether they are I (0) or I (1). Then, I check whether the panel data are co-integrated in order to ensure that the long-run relationship between variables exists. Finally, I present the estimation results of the error correction models.

5.1.Unit Root Tests.

To investigate the stationary level of variables, I apply Maddala and Wu (1999) (henceforth MW test) and Im-Pesaran-Shin (2003) (henceforth IPS test) tests. The null hypothesis is that all panels contain unit roots. The alternative hypothesis is based on the heterogeneity specification that some panels (or at least one panel) are stationary. These tests differ from unit root tests in the time series since the MW and the IPS tests take into account the heterogeneity between different merchant sectors. Table (11) reports the results of the MW and the IPS tests. The table shows that Log (P) and Log (Totexp) are stationary, while Log (MSC), Log (IF), Log (NC), Log (VolPOS), and Log (POS) are integrated of order one. Nevertheless, all variables are stationary after taking first differences.

Table 11. Panel unit root test.

	Levels				**First differences**			
	IPS With trend		**MW With trend**		**IPS With trend**		**MW With trend**	
Variables	Test value (w-t-bar)	P-value	Test value (Chi2)	P-value	Test value (w-t-bar)	P-value	Test value (Chi2)	P-value
Log(P)	-3.987	0.00	108.12	0.00	-13.39	0.00	235.098	0.00
Log(MSC)	1.81	0.965	8.4	9.88	-6.09	0.00	150.88	0.00
Log(IF)	0.668	0.748	10.35	0.961	-6.75	0.00	219.28	0.00
Log(NC)	6.98	1.00	0.248	1.00	-5.32	0.00	114.2	0.00
Log(Totexp)	-1.83	0.03	31.24	0.052	-3.54	0.08	30.24	0.00
Log(VolPOS)	2.912	0.998	3.181	1.00	-18.91	0.00	370.64	0.00
Log(POS)	5.414	1.00	0.664	1.00	-22.47	0.00	468.45	0.00

5.2. Co-integration Test.

The relationship of co-integration is examined by Westerlund's ECM test (Westerlund (2007)). The null hypothesis is that co-integration does not exist. The logic is to test the null hypothesis by establishing whether an error correction exists for at least one sector or for the panel as a whole. This test contains four panel cointegration tests. Pa and Pt tests are designed to test the hypothesis that the panel is co-integrated as a whole, while Ga and Gt tests are designed to test that at least one merchant sector is co-integrated. The results of the four tests reveal that series are co-integrated (table 12).

Table 12. Panel co-integration test.

Statistic	Westerlund ECM panel co-integration tests		
	Value	z-value	p-value
Gt	-6.7	-13.26	0.00
Ga	-25.66	-4.47	0.00
Pt	-42.088	-29.63	0.00
Pa	-55.11	-16.29	0.00

Note: Results are obtained by applying 'xtwest' command in Stata.

5.3. The MG, PMG, and DFE Results.

The results of the unit root tests and co-integration test ensure that the available data are stationary after taking first differences and characterised by a co-integration process. Therefore, Pesaran et al. (1999) approach is appropriate to examine the effect of IF changes on MSC, card payment usage and the retail prices. Here, I show the results of the PMG, the MG, and the DFE estimators for error correction models (17), (19), and (21).

The results of the estimation of equation (17) are reported in table (13). The table contains the results of the three estimators along with the Hausman test to compare the efficiency and consistency among the estimates. The results of the Hausman tests show that the PMG is preferred to the MG and DFE. Therefore, the analyses of parameters rely only on the results obtained with this estimator. The error correction coefficient is significantly negative, proving the reliability, consistency and efficiency of the long-run relationship between the variables. The results indicate that all variables' coefficients are significant in the long-run, while they are not significant in the short-run. The IF has a positive impact on the MSC in the long-run. In the results of the PMG estimator, the long-run coefficients are the same across merchant sectors and show that a 1% change in the IF will result in a change in the MSC of 0.41% in the long-run in all merchant sectors. The IF reduction is passed into the merchant through the lower MSC. This result is consistent with Ardizzi and Zangrandi (2018). In contrast, in the short run, the IF has no significant effect on the MSC which can be explained by the existence of agreements between acquirers and merchants on the MSC level that are unlikely to be re-negotiated immediately (Ardizzi and Zangrandi, 2018; Evans et al., 2011). The number of POS has a negative impact on the MSC in the long-run, since increasing the transaction volumes results in lowering costs per transaction. The number of cards has a positive effect on the MSC, since an increase in the number of cards leads to merchants having more incentives to accept cards and that causes an increase in the MSC in the long-run. However, its effect is not significant in the short-run.

Table 13. The merchant service charge model (PMG, MG, and DFE estimates and Hausman tests).

Estimator		**Pooled Mean-Group estimator (PMG)**		**Mean-Group estimator (MG)**		**Dynamic Fixed Effect (DFE)**	
Variable		Coef.	Std.Error	Coef.	Std.Error	Coef.	Std.Error
Long-run effect							
	Log(IF)	0.41*	0.015	0.24*	0.043	0.52*	0.08
	Log(POS)	-0.25**	0.044	-0.308*	0.079	0.58**	0.27
	LOG(NC)	0.42*	0.087	0.76*	0.115	0.75***	0.42
Short-run effect							
	Error correction	-0.205*	0.075	-0.46*	0.055	-0.102*	0.017
	Δ(Log(IF))	-0.038	0.031	-0.077*	0.026	-0.01	0.011
	Δ(Log(POS))	0.027	0.048	-0.072	0.047	-0.073	0.051
	Δ(Log(NC))	0.011	0.159	-0.48*	0.132	0.201*	0.19
	Constant	0.24*	0.081	0.115	0.533	-1.12	0.21
Number of observations		440					
Log Likelihood		888.7466					
Hausman test[1] (PMG or MG)		7.61 (p-value: 0.054)					
Hausman test[2] (PMG or DFE)		0.84 (p-value: 0.839)					

Note:*, **, and *** indicate significance at 1%, 5%, and 10%, respectively. Estimations are obtained by applying the 'xtpmg' command in Stata. For the DFE approach, intra-sector correlation in the computing standard errors is performed with the cluster (id) option.1PMG is efficient than MG under the null hypothesis at the conventional levels of significance.2PMG is efficient than DFE under the null hypothesis at the conventional levels of significance.

Table (14) reports the estimation results of the effect of IF changes on card payment usage in the short- and long-run. The Hausman test confirms that the PMG is a more efficient estimator than the MG and the DFE. Therefore, the focus is on interpreting the results of the PMG estimator. The error correction coefficient is significantly negative, proving the efficiency of the long-run relationship between the variables. As shown in the table, the IF has a positive significant effect on card payment usage in the long-run. This result implies that an IF reduction leads to losing revenue for the issuer who, in turn, may compensate this loss by increasing the membership fees paid by cardholders and/or decreasing their card rewards. Facing higher membership fees or lower rewards, some cardholders will stop using cards, which would lead to a decrease in the card payment usage. Based on the PMG estimates, the long-run equilibrium relationships between the IF and card payment usage are the same across merchant sectors. The intuition is that the common reduction of the IF influences all sectors in a similar way. It can be concluded that in the long-run, irrespectively of the merchant sector, a lower IF results in decreasing card payment usage by cardholders. The NC has a negative significant effect on card usage, showing that there are dis-economies of scale in the issuing market: marginal costs increase as the number of processed cards rises. Therefore, it results in increasing the membership fee and decreasing card usage. The variable POS has a positive effect on card usage in the long-run. Through the membership externality effect, more card acceptance results in more card payment usage by the cardholder which leads to expanding card transactions. This result is in line with the one obtained by Carbo-Valverde et al. (2016). They found that the impact of a 1% increase in merchant's acceptance on debit card usage is 0.44% and on credit card usage is 0.28%. My result, for both types of cards, lies exactly in the middle of the two values estimated by Carbo-Valverde et al. (2016). Finally, the negative impact of total expenditure on card usage could be explained by cardholders choosing alternative methods of payment when their costs increase. In the short-run, the IF and the NC have significant effect on card usage, while the POS has no significant effect.

Table 14. The Card payment usage model (PMG, MG, and DFE estimates and Hausman tests).

Estimator		**Pooled mean-group estimator (PMG)**		**Mean-group estimator (MG)**		**Dynamic Fixed Effect (DFE)**	
Variable		Coef.	Std.Error	Coef.	Std.Error	Coef.	Std.Error
Long-run effect							
	Log(IF)	0.008*	0.001	0.007**	0.003	0.006*	0.001
	Log(NC)	-0.21*	0.011	-0.12*	0.034	-0.22*	0.012
	Log(POS)	0.36*	0.007	0.33*	0.017	0.35*	0.007
	Log(Totexp)	-0.02*	0.004	-0.09*	0.019	-0.012*	0.004
Short-run effect							
	Error correction	-0.43*	0.003	-0.48*	0.018	-0.42*	0.021
	Δ(Log(IF))	-0.006*	0.0004	-0.006*	0.001	-0.005	0.001
	Δ(Log(NC))	0.068*	0.012	0.046*	0.016	0.07*	0.024
	Δ(Log(POS))	-0.16	0.0013	-0.16*	0.003	-0.16*	0.006
	Δ(Log(Totexp))	0.0003	0.041	0.015	0.057	0.01	0.007
	Constant	-1.76*	0.012	-1.65*	0.103	-1.7*	0.084
Number of observations		410					
Log Likelihood		1641.034					
Hausman test[1] (PMG or MG)		0.07 (p-value: 0.999)					
Hausman test[2] (PMG or DFE)		0.00 (p-value: 1.00)					

Note:*, and ** indicate significance at 1%, 5%, respectively. Estimations are obtained by applying the 'xtpmg' command in Stata. For the DFE approach, intra-sector correlation in the computing standard errors is performed with the cluster (id) option. [1]PMG is efficient than MG under the null hypothesis at the conventional levels of significance.[2]PMG is efficient than DFE under the null hypothesis at the conventional levels of significance.

I now turn to the analysis of the effect of the IF on retail prices, taking into account the impacts that arise from the two sides of the market. The results of the estimation of equation (21) are reported in table (15). The Hausman test favours the PMG over MG and DFE. Therefore, once again, the focus is on the results of this estimator. The table shows that the PMG estimates of all variables are significant in the long-run, but they are not so in the short-run. The error-correction term proves the existence of the long-run relationship across merchant sectors. Total expenditure has a positive impact on retail prices both in the short- and long-run, as it captures changes in retail prices due to the changing demand of products and services. Also, it shows the effect of the economic cycle on retail prices.

Impact of IF changes from the merchant side

In the long-run, there is a direct relationship between the MSC and retail prices. The results show that a 1% decrease in the MSC results in a 0.065% reduction in retail prices in the long-run. Taking into consideration the results provided in table (13) in the long-run, it can be computed that a 1% reduction in IF will induce a 0.027% reduction in retail prices in the long-run since $\frac{\partial P}{\partial IF} = \frac{\partial P}{\partial MSC}\frac{\partial MSC}{\partial IF} = 0.065 * 0.41 = 0.0266$. It should be noted that merchants benefit from the IF reduction with a 41% reduction in the MSC. In contrast, in the short run, the PMG estimator produces the inverse relationship between the MSC and retail prices but this relationship is not significant. Recalling the results provided in table (13), I can conclude that the IF reduction has no significant effect on retail prices in the short-run.

Impact of IF changes from the cardholder side

Table (15) shows that card payment usage has a positive impact on retail prices in the long-run. Recalling the results provided in table (14), where it was found that a lower IF leads to a reduction in card usage in the long-run, and taking into account the effect of a change in card payment usage on the retail prices, I can observe that reducing the IF leads to a decrease in retail prices from the cardholder side in the log-run. A 1% reduction in IF will decrease retail prices by around 0.004% in the long-run since $\frac{\partial P}{\partial IF} = \frac{\partial P}{\partial VolPOS}\frac{\partial VolPOS}{\partial IF} = 0.55 * \ 0.008 = 0.004$. As regards the short-run relationship, card payment usage has no significant effect on retail prices. Considering the results reported in table (14) in the short-run, I can conclude that the IF reduction has no significant effect on retail prices.

The total effect of IF changes on retail prices

The total effect of the IF on retail prices depends on the magnitude of these two effects. In the long-run, I find that a 1% reduction in IF leads to a 0.0266% reduction on retail prices from the merchant side and additional 0.004% from the cardholder side, which gives the total effect around 0.03%. The data obtained from the Bank of Spain has shown that there is a sharp decline in the IF from 0.63 to 0.16 (74% drop) on average among all merchant sectors after the regulation 2014 in Spain. Therefore, based on the results of this paper, a 74% reduction in the IF leads to a decrease in retail prices by 2.256% in the long-run. The annual inflation rate and annual cumulative inflation rate among 10 different merchant sectors are reported in table (16). By comparison of these results with the annual cumulative inflation rate, I find that the overall impact of a 74% reduction in IF was almost the same as the annual cumulative inflation rate over the period 2008-2019.

In short, the IF changes affect retail prices. According to the availability of data, this paper provides strong evidence that the RDL 8/2014, which led to IF reductions, has significant effect on reduction of the MSC and retail prices in the long-run.

Table 15. The retail price model (PMG, MG, and DFE estimates and Hausman tests).

Estimator		**Pooled mean-group estimator (PMG)**		**Mean-group estimator (MG)**		**Dynamic Fixed Effect (DFE)**	
Variable		Coef.	Std.Error	Coef.	Std.Error	Coef.	Std.Error
Long-run effect							
	Log(VolPOS)	0.55*	0.102	-0.70	1.08	1.44*	0.316
	Log(MSC)	0.065*	0.018	-0.37	0.29	0.153**	0.074
	Log(Totexp)	0.13*	0.017	0.34**	0.162	-0.042	0.066
Short-run effect							
	Error correction	-0.35***	0.198	-0.58*	0.193	-0.36*	0.039
	Δ(Log(VolPOS))	-0.18	0.221	-0.201	0.24	-1.69*	0.38
	ΔLog(MSC)	-0.16	0.11	-0.107	0.09	-0.28*	0.070
	ΔLog(Totexp)	0.18	0.149	0.026	0.112	0.067	0.091
	Constant	1.29***	0.72	1.84***	0.99	1.96*	0.309
Number of observations		410					
Log Likelihood		1127.962					
Hausman test[1] (MG or PMG)		5.07 (p-value: 0.166)					
Hausman test[2] (PMG or DFE)		0.09 (p-value: 0.992)					

Note:*, **, and *** indicate significance at 1%, 5%, and 10%, respectively. Estimations are obtained by applying the ‘xtpmg’ command in Stata. For the DFE approach, intra-sector correlation in the computing standard errors is performed with the cluster (id) option. 1PMG is efficient than MG under the null hypothesis at the conventional levels of significance.2PMG is efficient than DFE under the null hypothesis at the conventional levels of significance.

Table 16. Inflation and annual cumulative inflation rate among 10 merchant sectors in Spain.

Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Annual cumulative inflation rate**
Inflation	5.7	0.1	3.4	4.6	4	1.5	-0.6	0.6	-0.3	2.8	2.4	1.5	2.12%

Source: INE and own calculation.

6. Conclusion.

The present paper has evaluated the effects of the IF reduction on retail prices in Spain in a context of policy changes regulating its level for credit and debit card payments. The objective of these regulations was to achieve a decrease in the MSC and, ultimately, a decrease in retail prices. This paper has studied the extent to which the IF reduction passes into cardholders through retail prices. Taking into account the two sidedness of the card payment market, the paper has analysed the effect of the IF reduction on the MSC and card payment usage, and finally the joint impact of changes in the MSC and card payment usage on retail prices. The specification of the econometric model has relied on the error correction based autoregressive distributed lag (ARDL) model. The results show that the main channel by which changes in IF affect retail prices is through the merchant side. However, the impact of IF reduction on card usage has also contributed to reducing prices.

According to my knowledge, this is the first attempt to assess the effect of the IF reduction on retail prices in Spain by focusing on the two-sided market theory in the short- and long-run. The results obtained from the ARDL model provided robust evidence of decreasing the MSC as a result of the IF reduction in the long-run. Merchants have passed some part of their cost reduction to cardholders by deflating retail prices. Furthermore, the results show that the IF reduction leads to decreasing card payment usage, which also results in lower retail prices. The total effect of a 1% reduction in the IF is a 0.03% deflation of retail prices. In the long-run, this finding indicates that the capping IF has been successful in reducing retail prices in Spain. Although there are some limitations which can be due to its reliance on aggregate data this paper sheds new light on examining the comprehensive effects of capping the IF.

Appendix.

The following tables show the Schwarz Bayesian Criterion (SBC) test for all variables in each sector.

LnP	Large supermarket (food)		Petrol station		Travel agency		Hotel		Drugstore	
Lag	AIC	SBIC	AIC	SBIC	AIC	SBIC	AIC	SBIC	AIC	SBIC
0	-3.45	-3.45	-1.38	-1.34	-1.93	-1.89	-1.78	-1.74	-3.76	-3.72
1	-7.41*	-7.41*	-2.76*	-2.68*	-2.38*	-2.22*	-1.86	-1.78	-7.93	-7.85
2	-7.38	-7.38	-2.74	-2.61	-2.28	-2.16	-1.94	-1.82	-7.99*	-7.87*
3	-7.40	-7.40	-2.71	-2.55	-2.29	-2.21	-2.55*	-2.39*	-7.97	-7.81
Lag	Restaurant		Transport		Jewellery		Postal-service		Retailers	
	AIC	SBIC	AIC	SBIC	AIC	SBIC	AIC	SBIC	AIC	SBIC
0	-3.93	-3.89	-2.01	-1.97	-1.06	-1.02	-1.27	-1.23	-2.24	-2.2
1	-9.94	-9.86	-5.50*	-5.42*	-5.50	-5.42	-4.81*	-4.73*	-4.7*	-4.53*
2	-10.4*	-10.28*	-5.47	-5.35	-5.99	-5.87*	-4.79	-4.66	-4.62	-4.5
3	-10.37	-10.21	-5.43	-5.27	-6.01*	-5.85	-4.77	-4.61	-4.40	-4.31

Lnmsc	Large supermarket (food)		Petrol station		Travel agency		Hotel		Drugstore	
Lag	AIC	SBIC	AIC	SBIC	AIC	SBIC	AIC	SBIC	AIC	SBIC
0	0.46	0.51	0.23	0.27	-1.27	-1.23	-0.96	-0.91	0.54	0.58
1	-2.64	-2.56	-3.29	-3.20	-2.96*	-2.88*	-3.64*	-3.56*	-3.36*	-3.27*
2	-2.73*	-2.61*	-3.34*	-3.22*	-2.92	-2.79	-3.59	-3.46	-3.31	-3.18
3	-2.72	-2.55	-3.29	-3.12	-2.94	-2.77	-3.55	-3.38	-3.26	-3.09
Lag	Restaurant		Transport		Jewellery		Postal-service		Retailers	
	AIC	SBIC	AIC	SBIC	AIC	SBIC	AIC	SBIC	AIC	SBIC
0	0.21	0.25	-2.49	-2.44	-0.4	-0.36	0.42	0.46	2.30	2.34
1	-4.23	-4.14*	-3.37*	-3.28*	-3.85*	-3.72*	-3.105*	-3.01*	-0.21*	-0.12*
2	-4.25	-4.12	-3.32	-3.19	-3.80	-3.68	-3.102	-2.97	-0.16	-0.04
3	-4.29*	-4.12	-3.33	-3.16	-3.81*	-3.686	-3.055	-2.88	-0.12	0.04

lnIF	Large supermarket (food)		Petrol station		Travel agency		Hotel		Drugstore	
Lag	AIC	SBIC	AIC	SBIC	AIC	SBIC	AIC	SBIC	AIC	SBIC
0	1.81	1.90	1.80	1.84	1.95	1.99	2.23	2.27	2.59	2.63
1	-0.60*	-0.52*	-0.6*	-0.51*	-0.65*	-0.56*	-0.32*	-0.24*	0.08*	0.17*
2	-0.56	-0.43	0.55	-0.43	-0.60	-0.48	-0.27	-0.15	0.13	0.25
3	-0.51	-0.35	-0.51	-0.34	-0.55	-0.39	-0.23	-0.07	0.17	0.34
Lag	Restaurant		Transport		Jewellery		Postal-service		Retailers	
	AIC	SBIC	AIC	SBIC	AIC	SBIC	AIC	SBIC	AIC	SBIC
0	2.54	2.58	1.74	1.78	2.33	2.37	2.4	2.44	-2.25	-2.21
1	0.08*	0.16*	-0.83*	-0.75*	-0.25*	-0.17*	-0.19*	-0.10*	-6.25	-6.16
2	0.13	0.25	-0.78	-0.66	-0.21	-0.08	-0.14	-0.02	-7.58*	-7.45*
3	0.17	0.34	-0.74	-0.58	-0.16	-0.002	-0.1	0.062	-7.53	-7.36

Lntotexp	Large supermarket (food)		Petrol station		Travel agency		Hotel		Drugstore	
Lag	AIC	SBIC	AIC	SBIC	AIC	SBIC	AIC	SBIC	AIC	SBIC
0	-5.50	-5.46	-2.52	-2.48	-1.41	-1.37	-0.96	-0.92	-0.08	-0.05
1	-7.73	-7.64	-4.80	-4.71	-4.86*	-4.73*	-5.99*	-4.97*	-2.23*	-2.17*
2	-8.92*	-8.79*	-5.85*	-5.72*	-4.85	-4.70	-5.94	-5.86	-2.17	-2.096
3	-8.88	-8.71	-5.80	-5.63	-4.81	-4.64	-5.88	-5.77	-2.12	-2.015
Lag	Restaurant		Transport		Jewellery		Postal-service		Retailers	
	AIC	SBIC	AIC	SBIC	AIC	SBIC	AIC	SBIC	AIC	SBIC
0	-2.17	-2.13	-1.78	-1.73	-0.27	-0.22	-0.57	-0.53	-2.25	-2.21
1	-5.37	-5.29	-4.68*	-4.60*	-3.65	-3.56	-1.51*	-1.42*	-6.25	-6.16
2	-6.9*	-6.77*	-4.62	-4.50	-4.20*	-4.07*	-1.47	-1.34	-7.58*	-7.45*
3	-6.85	-6.68	-4.58	-4.41	-4.18	-4.01	-1.42	-1.25	-7.53	-7.36

Lag	Lnnc	
	AIC	SBIC
0	-2.7193	-2.67708
1	-5.81677*	-5.69011*
2	-5.78198	-5.613
3	-5.75145	-5.51701

Lag	LnPOS	
	AIC	SBIC
0	-0.202537	-0.160315
1	-3.37919*	-3.2103*
2	-3.14228	-3.06125
3	-3.18808	-3.06141

Lag	LnVolPOS	
	AIC	SBIC
0	-2.7839	-2.74168
1	-6.98998*	-6.82109*
2	-6.91385	-6.78718
3	-6.83027	-6.74583

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