EUROPEAN CENTRAL BANK
EUROSYSTEM

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INTEGRATION AND INNOVATION

WORKING PAPER SERIES
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In 2009 all ECB publications feature a motif taken from the €200 banknote.

This paper can be downloaded without charge from http://www.ecb.europa.eu or from the Social Science Research Network electronic library at http://ssrn.com/abstract_id=1511809.

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Retail payments: integration and innovation

"Retail payments: integration and innovation" was the title of the joint conference organised by the European Central Bank (ECB) and De Nederlandsche Bank (DNB) in Frankfurt am Main on 25 and 26 May 2009. Around 200 high-level policy-makers, academics, experts and central bankers from more than 30 countries of all five continents attended the conference, reflecting the high level of interest in retail payments.

The aim of the conference was to better understand current developments in retail payment markets and to identify possible future trends, by bringing together policy conduct, research activities and market practice. The conference was organised around two major topics: first, the economic and regulatory implications of a more integrated retail payments market and, second, the strands of innovation and modernisation in the retail payments business. To make innovations successful, expectations and requirements of retail payment users have to be taken seriously. The conference has shown that these expectations and requirements are strongly influenced by the growing demand for alternative banking solutions, the increasing international mobility of individuals and companies, a loss of trust in the banking industry and major social trends such as the ageing population in developed countries. There are signs that customers see a need for more innovative payment solutions. Overall, the conference led to valuable findings which will further stimulate our efforts to foster the economic underpinnings of innovation and integration in retail banking and payments.

We would like to take this opportunity to thank all participants in the conference. In particular, we would like to acknowledge the valuable contributions of all presenters, discussants, session chairs and panellists, whose names can be found in the enclosed conference programme. Their main statements are summarised in the ECB-DNB official conference summary. Twelve papers related to the conference have been accepted for publication in this special series of the ECB Working Papers Series.

Behind the scenes, a number of colleagues from the ECB and DNB contributed to both the organisation of the conference and the preparation of this conference report. In alphabetical order, many thanks to Alexander Al-Haschimi, Wilko Bolt, Hans Brits, Maria Foskolou, Susan Germain de Urday, Philipp Hartmann, Päivi Heikkinen, Monika Hempel, Cornelia Holthausen, Nicole Jonker, Anneke Kosse, Thomas Lammer, Johannes Lindner, Tobias Linzert, Daniela Russo, Wiebe Ruttenberg, Heiko Schmiedel, Francisco Tur Hartmann, Liisa Väisänen, and Pirjo Väkeväinen.

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Abstract
We study the effect of government encouraged or mandated interchange fee ceilings on consumer and merchant adoption and usage of payment cards in an economy where card acceptance is far from complete. We believe that we are the first to use bank-level data to study the impact of interchange fee regulation. We find that consumer and merchant welfare improved because of increased consumer and merchant adoption leading to greater usage of payment cards. We also find that bank revenues increased when interchange fees were reduced although these results are critically dependent on merchant acceptance being far from complete at the beginning and during the implementation of interchange fee ceilings. In addition, there is most likely a threshold interchange fee below which social welfare decreases although our data currently does not allow us to quantify it.

Key words: consumer payment choice, merchant payment adoption, network competition

JEL Codes: L11, G21, D53

1. Introduction

The economics of how platforms set prices for two or more distinct end users is receiving increasing attention by economists and policymakers. This literature, commonly referred to as two-sided markets, blends together the network economic literature with the multiproduct firm literature.[1] Rochet and Tirole (2004) define a two-sided market when the price structure, or the share that each end-user pays the platform, affects the total volume of transactions when end-users are unable to negotiate prices based on costs to participate on a platform. Examples of platforms include media portals, online dating sites, and payment networks. Often platforms will charge asymmetric prices to each side of the market. For example, online news providers may not charge eyeballs that view their sites but earn all of their revenue from advertisers. In this article, we empirically test the impact of government intervention in the pricing of a service that has two distinct end-users.

We focus on the impact of government-encouraged interchange fee reductions in payment card networks on adoption and usage of credit and debit cards. Today, payment cards have become an indispensable part of the retail economy in advanced economies. Recently, a broader set of merchants, such as fast food chains, doctors' offices, and taxis, have started to accept card-based payments. For example, American Airlines along with some other U.S. airlines began accepting only payment cards for inflight purchases on their domestic routes since June 2009. Furthermore, some local governments have mandated that taxis accept payment cards. Greater acceptance and usage of payment

[1] For a broader description of this market, see Armstrong (2006), Caillaud and Jullien (2003), Jullien (2001), Rochet and Tirole (2006), Rysman (2009), and Weyl (2009).

cards suggests that a growing number of consumers and merchants prefer payment cards to cash and checks.

Payment networks are comprised of consumers, their financial institutions (known as issuers), merchants, their financial institutions (known as acquirers) and a network operator. A consumer makes a purchase from a merchant. Generally, the merchant charges the same price regardless of the type of payment instrument used to make the purchase. Consumers often pay annual membership fees to their financial institutions for credit cards and may pay service charges for a bundle of services associated with transactions accounts. Merchants pay fees known as merchant discounts. Acquirers pay an interchange fee to the issuer. The underlying payment fee structure is determined by the interrelated bilateral relationships among the players, their bargaining power, and the ability of the network to maximize profits for its members.

Payment card networks continue to face antitrust scrutiny by public authorities regarding the pricing of payment services (Bradford and Hayashi, 2008). Public authorities are concerned about the collective setting of interchange fees by banks to extract rents from merchants and use these rents to encourage consumers to use more costly payment instruments.[2] Some economists have argued that too much competition at the issuer level may result in distorting incentives to use more costly payment instruments.[3]

In this article, we test whether the fees set by the network are socially optimal. To our knowledge, we are the first to use bank-level data to study multiple government-

[2] The Reserve Bank of Australia (2008) states this motivation for their payment card regulation.
[3] A similar argument is made by Donze and Dubec (2009) about the ATM market where collective setting of interchange fees coupled with downstream competition for ATM withdrawals may result in "too many" ATMs.

induced reductions in interchange fees. We use a simultaneous equation approach to test the impact of lower interchange fees on adoption and usage decisions of consumers and merchants. Furthermore, we also study the impact of lower interchange fees on issuer and acquirer revenues.

Specifically, we study the effects of several regulatory interventions in Spain during 1997 to 2007. Carbó Valverde et al. (2003) report that as a country Spain was more cash intensive than countries of similar size and geography. They report that in 2000, Spain had a currency to GDP ratio of 8.9 percent compared to 6.2 percent for Germany, 4.7 percent for Portugal, and 3.2 percent for France. Similarly, Spain had far fewer non-cash transactions per capita per year at 56 than Germany (177), Portugal (94), and France (196). Comparatively, Spain's acceptance of debit cards by merchants was extremely low resulting in low card usage.

We ask whether reductions in interchange fees can improve social welfare where network adoption externalities still exist. If more merchants adopt, consumers do not leave the card networks, and usage increases, we would argue that welfare for consumers and merchants has improved. We are able to study the impact of greater card adoption and lower interchange fees on bank revenue albeit with a very simplistic approach given data limitations. We are limiting our focus on the merchant adoption externality. Furthermore, how surplus is shared in the absence of externalities is not addressed in our analysis. In addition, we recognize that interchange fees may be reduced without government pressure and, in some markets, they have been lowered as a market response to attract more merchants. Thus, our results should not be viewed as a blanket endorsement for interchange fee regulation.

Our main results are as follows. First, merchant fees are strongly positively correlated with reductions in the interchange fee. Furthermore, we find strong evidence suggesting that merchant acceptance has increased because of a reduction in merchant fees. However, the increase in acceptance of debit and credit cards differ based on the level of the fee reduction and when it occurred. Nevertheless, our empirical analysis suggests that in payment card markets where merchant acceptance is low, reduction in interchange fees may be beneficial to get more merchants on board and increase payment card usage and reduce the merchant adoption externality.

Second, consumer adoption of payment cards did not significantly decrease over the period because of lower interchange fee revenue for issuers. Consumer preference towards payment cards differ based on a card's functionality. Adoption for debit cards by consumers may have reached a saturation point earlier than credit cards because they were adopted for their ATM functionality more than a decade before. In particular, the number of debit cards reached its peak in 2003 (33.1 million) and it has decreased since then to 31.5 million in 2007. However, Spanish consumers increased their holdings of credit cards even when annual fees increased suggesting that the market for credit cards had not reached its saturation point and consumers are willing to pay higher fees in exchange for greater merchant acceptance. The number of credit cards increased monotonically during the period, reaching 43 million in 2007.

Third, bank payment revenues from debit and credit card services are positively related to increased transactions resulting from lower interchange fees. Even though per-transaction revenues decreased, this loss in revenue is offset by greater transactional volume. In other words, intense competition between issuers for cardholders coupled

with relatively high interchange fees may have resulted in higher than revenue-maximizing and socially optimal interchange fees. However, there may be a critical interchange fee below which revenue for issuers and acquirers decreases. Furthermore, increased revenue may be associated with higher costs. Unfortunately, our dataset does not include issuer or acquirer costs. Nevertheless, reduction in interchange fees to some threshold level may be Pareto improving. However, in other countries such as the United States, interchange fees for new entrants such as grocery stores in the 1990s were reduced significantly to encourage merchant acceptance of payment cards without government intervention. Such market-based strategies also reduce the impact of the merchant adoption externality on social welfare and may be equally effective.

Our article is organized in the following way. In the next section, we discuss several theoretical economic models. We summarize the impact of interchange fee regulation in two other countries in section 3. In section 4, we discuss the market for payment services in Spain along with the regulatory actions taken by the public authorities. We discuss our empirical strategy in section 5. We describe our dataset in section 6. In section 7, we present our results. We discuss robustness tests in section 8. Finally, we offer some concluding remarks in section 9.

2. Relevant Literature

The theoretical literature on payment cards suggests that the interchange fee is a balancing mechanism that is necessary to bring both sides on board (Baxter, 1983 and Rochet and Tirole, 2002).[4] In other words, one type of end user may be willing to subsidize the other type of end user resulting in both types being better off. If the

[4] For a general survey of the payments economic literature, see Kahn and Roberds (2009).

interchange fee is too high, merchants will not adopt resulting in low usage and consumer adoption. If the interchange fee is too low, consumers may not have sufficient incentives to participate.

Using Rochet and Tirole's framework, a consumer will use a payment card if $b_B > f$ where b_B is the consumer's net benefit of using a payment card and f is the fee for using the card. The consumer fee, f, is assumed to decrease with increases in the interchange fee. The net benefit is defined as the additional benefit from using cards instead of an alternative such as cash. Similarly, merchants will accept cards if $b_S > m$ where b_S is the net benefit of the merchant to accept cards versus another payment alternative and m is the merchant fee to accept the card. The merchant fee is generally assumed to increase when the interchange fee increases.

Society benefits from card usage if:

$$b_B + b_S > c_I + c_A \qquad (1)$$

where c_I and c_A are issuer and acquirer costs, respectively. Note that the joint benefits of end users must be greater than joint costs. This condition does not necessarily imply that costs be split evenly between consumers and merchants. The mechanism to balance the demands across end-users to recover costs is the interchange fee. In reality, there is heterogeneity among consumers and merchants regarding the level of benefits they derive from payment cards. Such heterogeneity may explain why all consumers and merchants do not adopt payment cards.

A key assumption is that consumers and merchants are unable to negotiate prices based on the type of payment instrument.[5] If merchants are able to pass on payment costs, the level of interchange fees will not affect the usage of payment cards assuming

[5] Some jurisdictions have prohibited no-surcharge rules but they existed in Spain during our sample period.

that the proportion of merchants accepting cards is constant.[6] Given that merchants are restricted in setting prices based on payment instrument costs in many jurisdictions and merchants often do not differentiate prices in jurisdictions where they can, the level of the interchange fee affects the adoption and usage of payment cards.

Standard economic theory suggests that competition would increase consumer and merchant surplus. Some theoretical models predict that competition in a two-sided market environment may worsen social welfare. Rochet and Tirole (2004) and Guthrie and Wright (2007) find that network competition may yield a price structure that has a lower social welfare than when there is only one network. If competition is too strong on the consumer side, the network may extract too much from merchants resulting in higher than socially optimal interchange fees. Merchants generally accept cards from multiple networks and consumers choose their preferred issuer and network. Therefore, competition on the consumer side may be more intense especially intra network competition when merchants cannot discriminate card acceptance by issuer (Katz, 2005).

The empirical literature on payment cards has focused on certain aspects of the payment industry. One area that has received a significant amount of attention is the competitiveness of credit card interest rates. Ausubel (1991) suggests that card issuers may be able to extract greater surplus from consumers via higher interest rates. Calem and Mester (1995) maintain that issuers can extract surplus from their customers due to imperfect competition for high-balance customers, which is tied to information-based barriers to switching between issuers. Knittel and Stango (2003) argue that there may be

[6] See Gans and King (2003) for a more general treatment of when interchange fees are neutral. Katz (2005) questions this result based on the level of pass-through between issuers and acquirers to consumers and merchants, respectively. Bolt and Chakravorti (2008a) consider different levels of pass-through in a theoretical model

tacit collusion on credit card interest rates by issuers around an U.S. state interest rate ceiling allowing for issuers to keep credit card interest rates high even when their costs decrease.

3. Effects of Interchange Fee Regulation in Other Countries

There are several jurisdictions where interchange fees were directly regulated or significant pressure was exerted by the public authorities on networks to reduce their interchange fees. In this section, we will discuss the impact of interventions in two countries—Australia and Mexico.

Concluding that surcharges alone would not put sufficient downward pressure on interchange fees, the Australian authorities imposed explicit interchange fee targets for the two large four-party payment networks—MasterCard and Visa—but did not impose any restrictions on three-party networks—American Express and Diners Club.[7] In 2002, the RBA imposed weighted-average credit card interchange fee caps and later imposed per transaction targets for debit cards. As of April 2008, the weighted-average credit card interchange fees in the MasterCard and Visa networks must not exceed 0.50 percent of the value of transactions. The Visa debit weighted-average interchange fee cap must not exceed 12 cents (Australian) per transaction. The EFTPOS (electronic funds transfer at point of sale) interchange fees for transactions that do not include a cash-out component must be between 4 cents (Australian) and 5 cents (Australian) per transaction.

The Reserve Bank of Australia (2008a) reports that the interchange fee regulation, coupled with the removal of the no-surcharge rule, improved the price signals that

[7] In four-party networks, the issuer and the acquirer need not be the same. In three-party networks, the issuer and acquirer are the same resulting in no explicit interchange fee between them.

consumers face when deciding which payment instruments to use. Specifically, annual fees for credit cards increased and the value of the rewards decreased. The Reserve Bank of Australia (2008a) calculates that for an AUS$100 transaction, the cost to consumers increased from –AUS$1.30 to –AUS$1.10 for consumers who pay off their balances in full every month. A negative per transaction cost results when card benefits such as rewards and interest-free loans are greater than payment card fees.[8]

In its recent five-year review of their payment card policies, the Australian Payments System Board suggested that the explicit regulation of interchange fees be removed subject to certain conditions. In other words, the authorities will remove restrictions if the payment card networks do not raise their fees beyond some threshold. However, the actual threshold is not quantified.

Those who oppose the Australian interchange fee regulation argue that consumers have been harmed by reduced rewards and higher fees and have not shared in the cost savings—in terms of lower prices for goods and services. However, measuring price effects over time of interchange fee regulation is difficult.

Another interesting case where government authorities exerted pressure to decrease interchange fees occurred in Mexico.[9] Similar to the RBA in Australia, the Bank of Mexico—the Mexican central bank—has the authority to regulate retail payment systems throughout the country. Unlike the RBA, the Bank of Mexico used moral suasion to reduce interchange fees. The motivation of the Mexican authorities to reduce

[8] For more discussion about the effect of rewards on card use, see Carbó-Valverde and Liñares-Zegarra (2009) and Ching and Hayashi (2006).
[9] Discussions with Bank of Mexico staff, especially José Luis Negrín, were critical to our understanding of the Mexican payment card market.

interchange fees was to reduce merchant fees that were preventing greater adoption and usage of payment cards in Mexico.

Mexico's Bank Association (ABM) set different interchange fees for debit and credit cards in August 2004; prior to this time, the fees were the same for both types of cards. Interchange fees were set based on a merchant's monthly transaction volume. By August 2005, debit card interchange fee for the largest merchants fell from 2.00 percent to 0.75 percent while the credit card interchange fee fell from 2.00 percent to 1.80 percent. The category that applied to the smallest merchant was eliminated; as a consequence the interchange fee of this group fell from 3.50% to 1.95% and 3.50% to 2.70% for debit and credit cards, respectively. The ABM also proposed interchange fees based on a formula where the interchange fee balances out the issuing and acquiring banks' profits (net of interchange), and where profits are normalized by revenue (net of interchange). A reference rate is obtained and specific interchange fee levels are calculated for a number of merchant categories using proxies of the demand elasticity for each category.

In 2008, the ABM further reduced debit and credit card interchange fees. The new interchange fee levels implied a reduction in the weighted average of 12.5% and 9% for credit and debit, respectively.[10] As expected, merchant fees also decreased. In order to follow the evolution of merchant fees, the Bank of Mexico gathered information from a sample of 1000 firms that accepted card payments. Their results are that from 2005 to

[10] The weighted average interchange fee for credit cards decreased from 1.84% to 1.61% and for debit cards decreased from .78% to .71%.

2008, the average merchant discount rate decreased 12.3% and 23.3% for credit and debit, respectively.[11]

The installation of POS terminals was subsidized through a private, nonprofit trust fund called FIMPE that was initially funded by the banks. The banks received a tax credit from the government for their investment in FIMPE. It is important to note that there may be significant fixed and variable costs. The reduction in interchange fees resulted in lower per transaction costs, and the terminal subsidies reduced the fixed costs. As a result of reductions in interchange fees and POS subsidies, the number of POS terminals installed increased to 446,025 by the end of 2008 compared to 129,971 in 2002. POS transactions increased from 52 million in 2002 to 215 million by the end of 2008 of which 46% were credit card transactions.

4. Spanish Regulatory Developments

The Spanish and European antitrust authorities wanted to reduce the extraction of rents by payment networks, specifically issuers, resulting from the collective setting of interchange fees. During 1997-2007, there were four important events that significantly affected the setting of interchange fees in the Spanish payment card industry. During this period, debit card transactions increased from 156 million to 863 million and credit card transactions increased from 138 million to 1.037 billion.

The reduction in interchange fees increased the acceptance and usage of payment cards. As shown in Table 1, from 1997 to 2007, the number of debit cards has increased by 40.9% while the number of credit cards has increased by 207.1%. During the same

[11] From 2005 to 2008, the average merchant fee decreased from 2.85% to 2.50% and the average debit merchant fee declined from 2.53% to 1.94%.

period, the number of transactions increased substantially with debit card transactions being five times larger in 2007 than in 1997 while credit card transactions increased by seven times. Furthermore, the average number of POS transactions per card per year has increased from 7.1 to 27.8 during the same period.

Table 1 also shows that the average value of debit card transactions have increased significantly from 38.5 to 46 euros/transaction (in real terms) between 1997 and 2007. The increasing average real debit card per transaction value can be explained by the greater usage of these cards for payments of larger-value purchases at the POS. On the other hand, the average credit card transaction value decreased from 58.5 to 54.3 euros (in real terms). The lower average real credit card per transaction value may result from the greater usage of these cards among consumers for lower-value purchases. In addition, the lower value could be interpreted as greater penetration among cardholders with lower incomes along with greater acceptance by a more diverse set of merchants.

All government-initiated events are summarized in Table 2. These agreements were sponsored by the Spanish Ministry of the Economy or the Ministry of Industry, Tourism and Trade. In motivating this decision, the TDC stated "interchange fees will be reduced permitting an adequate adoption by merchants and, ultimately, by cardholders" (TDC Decision of 26 April 2000, No. A 264/99). In May 1999, the Spanish government promoted an agreement between the three payment networks and the main merchant associations to reduce maximum multilateral interchange fees to 2.75 per cent in July 2002. This agreement was accepted by the Spain's Antitrust Authority (TDC) in 2000 (TDC Decision of 26 April 2000, No. A 264/99). These maximum fees varied

significantly across merchant categories. For example, in 2002, the average interchange fee was 2.79% in casinos and 0.63% in gas stations.

To some extent the evolution of Spain's interchange fee regulation was affected by a European Commission (EC) decision regarding European Union (EU)-wide cross-border interchange fees in 2002.[12] In 2002, the main government intervention was triggered by the European Commission (EC) Decision 2002/914/EC of 24 July, regarding Case No. COMP/29.373 – Visa International – Multilateral Interchange Fee. Following these investigations of the EC, the TDC followed suit and requested the Spanish payment card networks to provide information on Visa's methodology for determining interchange fee for Visa.

In May 2003, the Spanish Congress requested the TDC to investigate the setting of interchange fees and to follow the basic principles that the European Commission adopted for EU-wide cross-border interchange fees. The TDC issued a report on competition in commercial activities and related payments (*Informe sobre las condiciones de competencia en el sector de la distribución comercial*) and refused several proposals of the networks on their setting of interchange fees. In December 2003, the TDC announced that the 'special authorization' for the setting of interchange fees of the three payment card networks were going to be revoked although this decision was not formally undertaken until 2005.

[12] In July 2002, the EC cleared Visa's European cross-border interchange fees and offered some insights on the position of EU competition authorities with regard to the setting of interchange fees. The EC found that there were upward pressures on the level of interchange fees. More recently, MasterCard and the European Commission have agreed on a substantially lower multilateral interchange fees for cross-border European transactions. In addition, the European Commission has opened new discussions with Visa about these fees as well.

The third important event occurred from 2003 until 2005, when the networks tried to maintain their 'special authorization' for collective determination of interchange fees from the TDC. Several attempts from the industry to maintain their 'special authorization' for the setting of interchange fees were refused during these two years and the networks were requested to set levels of interchange fees that only reflect operating and fraud costs.

The most important regulatory action for the Spanish payment card industry took place in December 2005. The debate started in April 2005, when the TDC definitively refused the proposals of the networks regarding how interchange fees were set and asked them to use a 'cost-based' approach. The network operators were also requested to make a distinction between debit and credit card interchange fees. Some TDC resolutions required the card networks to only include two costs when setting domestic multilateral interchange fees (MIFs): a fixed cost for processing each transaction and a variable ad valorem cost for the risk of fraud (TDC Decisions of 11 April 2005, No. A 314/02, No. A 318/2002and No. A 287/00). As a consequence of this resolution, the Spanish government promoted an agreement between payment networks and merchant associations to establish a timetable to progressively reduce interchange and merchant fees from 2005 to 2009.

During January 2006 to December 2008, the highest interchange fee levels had to be reduced in a stepwise manner. Furthermore, a distinction had to be made between debit and credit interchange fees, with the former being a fixed amount per transaction and the latter being a percentage amount per transaction. For merchants with an annual value of point of sale card payment receipts less than €100 million, the credit card

interchange fee was set to decrease from 1.40% per transaction in 2006 to 0.35% in 2009 while for debit cards the reduction should be from €0.53 per transaction to €0.35 per transaction regardless of the purchase amount. From 2009 onwards, each of the card networks would audit their operations and provide a cost-based analysis for debit and credit cards. Unfortunately, we are not able to test the effects of the new regulatory framework because our sample period ends in 2007.

5. The Empirical Model

In this section, we explore the impact of reductions in debit and credit card interchange fees on consumers, merchants, and banks in an empirical model. Before discussing the empirical model, let us discuss the distinction between debit and credit cards. Debit cards allow consumers to access funds at their financial institutions that are transferred to the merchants' financial institutions and may be referred to as "pay now" cards because funds are debited from the cardholder's transactions account. Debit cards substitute for cash at the point of sale in the sense that the consumer uses the card to access funds at her bank instead of withdrawing cash. Debit card service fees are bundled with other demand deposit services. Credit cards allow consumers to access lines of credit at their financial institutions when making payment and may be referred to as "pay later" cards because the consumer pays the balance at a future date. Unlike debit cards, consumers can use credit cards to make purchases even if they do not have funds at their bank. Credit card services are stand alone products that usually have explicit fees in Spain.

In our empirical specification, we simultaneously estimate the equations that identify the extensive margins for merchants and consumers:

$$Consumer\ extensive\ margin = f(X_{cem}, C, R) \quad (2)$$

$$Merchant\ extensive\ margin = f(X_{mem}, C, R) \quad (3)$$

where X_{cem} and X_{mem} are the exclusion restrictions that identify the consumer extensive margin and the merchant extensive margin equations, respectively. C and R are the vectors of control factors and regulatory dummies that are common to all the equations, respectively. Similarly, we will also simultaneously estimate the equations that identify the intensive margins for consumers and merchants:

$$Consumer\ intensive\ margin = f(X_{cim}, C, R) \quad (4)$$

$$Merchant\ intensive\ margin = f(X_{mim}, C, R) \quad (5)$$

where X_{cim} and X_{mim} are the exclusion restrictions that identify the consumer intensive margin and the merchant intensive margin equations, respectively. The simultaneous estimation is undertaken for debit and credit cards separately.

The sets of simultaneous equations are estimated using a General Method of Moments (GMM) routine with bank (acquirer and issuer specific) fixed effects. All variables (except for the regulatory dummies) are expressed as difference between the logarithms of current period and the period before so that these differences can be interpreted as growth rates. The GMM estimation relies on a set of orthogonality conditions which are the products of equations and instruments. Initial conditions for estimation are obtained using three-stage least squares (3SLS), which is a restricted version of the simultaneous equation GMM model. Unlike the standard 3SLS, the GMM estimator allows for heteroskedasticity in addition to cross-equation correlation where

some variables (as merchant acceptance in our case) may appear both as exogenous and (lagged) endogenous variables in the different equations (Hansen, 1982; Wooldrige, 2002).

Our regression analysis may be subject to some endogeneity and autocorrelation issues. In order to control for endogeneity, lagged values of the explanatory variables in the different equations are employed as instruments. Focusing for a moment on the estimation of the set of equations, this treatment eliminates the most obvious source of endogeneity. The primary concern, however, is that some immeasurable aspect of the environment in which banks operate is associated with the acceptance, issuance or usage of cards. Therefore, we also use a simple time trend to control for those otherwise immeasurable aspects of the change in markets over time.[13] The Sargan or J test of overidentifying restrictions is also computed in order to examine the identification of the model with the selected set of instruments under the null hypothesis of correct identifying restrictions. As for potential autocorrelation problems, we also include AR(1) and AR(2) tests of first- and second-order autocorrelation of residuals, respectively, which are asymptotically distributed as a standard normal N(0,1) under the null of no serial correlation.

We consider bank size and the local crime rate where the bank operates as control variables in vector *C*. Given that payment processing is a scale business, we take bank size (in terms of the number of debit/credit transactions over total transactions in the network where the bank operates) to control for any increase in bank size during the sample period. In order to control the (mainly upward) trend in the data for merchant

[13] We also have used GDP and CPI instead of a linear time trend. The qualitative results remain the same regardless of type of variable we use for accounting for strong trends in the data.

acceptance, number of cards and number of transactions, all equations also incorporate a linear time trend.

To capture the effect of crime on the decisions of merchants to accept payment cards, we use time-series crime data from the region where the bank is located.[14] For our crime data, we use robberies and assaults per 1,000 residents in a given region. If the bank operates in more than one region, we use a weighted average by the number of bank branches in the region. We would expect that as crime increases the adoption of payment cards to increase because payment cards are more secure than cash in the event they are stolen or misplaced.

As for vector *R*, we also include four regulatory dummies to measure the impact of the different regulations and or agreements between the Spanish government and market participants on interchange fees. These regulatory dummies represent the year when the regulatory intervention was introduced or the implementation of agreements between market participants. The summary statistics for the variables that we use for our empirical model are shown in Table 4.

Merchant Extensive Margin

Theoretical models predict that merchants would increase their acceptance of payment cards when their fees fall if the number of consumers with cards does not decrease along with the expected usage of these cards.[15] If cardholders decrease their participation in card networks or use their cards less because their benefits decreased,

[14] Some theoretical money models suggest that crime may be a reason to move away from cash (He, Huang, and Wright, 2005).
[15] Some authors have suggested that additional sales should be a criterion for accepting cards (Bolt and Chakravorti, 2008b). In the case of debit cards, additional sales may occur because consumers are able to access their accounts at financial institutions when they do not have sufficient cash in their wallets. Credit cards allow consumers to make purchases before their incomes arrive.

merchants may decrease their adoption even if their fees decreased. Furthermore, even if merchants increased their participation in card networks, the resulting interchange fee may result in lower than optimal card usage. Therefore, the merchant discount fee and the total number of debit cards in the network are the first exclusion restrictions that identify the merchant extensive margin.

Cardholder Extensive Margin

The impact of increases in consumer debit card fees on the adoption of debit cards is difficult to measure because consumers do not generally pay a fixed or per-transaction fee. In addition, because most debit cards also serve as ATM cards, consumer adoption cannot be solely attributable to debit card functionality. In other words, even if consumers choose not to use their debit card functionality, they would still have a card to withdraw cash from ATMs. Furthermore, the pricing for transactional services is often bundled and it is difficult to isolate a fee for debit card services separately.

We consider two key factors for debit card adoption. First, the increased merchant acceptance would increase the value of debit cards and may spur greater adoption. Merchant acceptance appears as the dependent variable in the merchant extensive margin equation and it enters the cardholder extensive margin as a lagged explanatory factor. The logic behind this specification is that merchant acceptance and fees may be contemporaneously related while transactions, issuance and usage may be determined by observed previous acceptance.

Second, debit cards become more attractive to consumers as cash acquisition costs increase. Note that because of the dual functionality of debit cards, cash acquisition cost may enable us to tease out debit functionality. Our indicator of increased cash

acquisition costs to a given bank's customers is the density of rival ATMs because cardholders do not pay surcharges at their own banks. Surcharges for foreign ATM withdrawals have been increasing for Spain during our sample period.

Unlike debit cards, credit cards are stand-alone products. Reductions in credit card interchange fee revenue may increase the annual fee cardholders pay to offset lost revenue by issuers. In fact, credit card annual fees have been rising. For example, according to the Bank of Spain, average credit card annual fees have increased from 21.35 euros in January 2005 to 28.43 euros in December 2007. Our empirical model allows us to study the impact of lower interchange fees on cardholder adoption. If consumers do not give up their credit cards, we can conclude that either consumers are inelastic to changes in credit card fees or are willing to pay higher fees if they can use their cards at more merchant locations.

Merchant Intensive Margin

In addition to adoption, we test for factors that contribute to greater number of payment card transactions. For the merchant intensive margin, we use an acquirer's quarterly transactions per POS terminal as our dependent variable. The exclusion restriction that identifies the merchant intensive margin is an interaction term of merchant acceptance by acquirer and the total number of cards in that network. The probability of a card transaction increases when the product of merchant acceptance by an acquirer and the number of total network cards increases.

Cardholder intensive margin

In the cardholder intensive margin regression, we analyze what factors affect greater usage of payment cards by consumers. The dependent variable is the number of

transactions per issuer per card. The key explanatory variable is an interaction term of the merchant acceptance in the network and the number of cards issued by the bank. We include the same control and regulatory dummies as in the other regressions.

Bank revenues

We separate banks into issuers and acquirers for debit and credit cards. Our dependent variables are issuer and acquirer payment card revenue by type of card. For issuers, this would be the product of the average interchange fees and the number of transactions and total annual fees collected (only for credit cards). For acquirers, this would be the difference between the merchant discount charged and the interchange fee paid multiplied by the number of transactions. Similar to consumer and merchant intensive margin, our explanatory variable for acquirers is one-quarter lag of the interaction of merchant acceptance of a specific acquirer and the total number of cards in the network. Our explanatory variable for the issuers is the number of cards issued by each issuer the quarter before times the proportion of merchants accepting in the whole network. We also include a linear time trend, the crime rate, the rivals' ATM density and bank size as control variables. In addition, we have our regulatory dummies.

6. Our Dataset

Unlike consumer and merchant survey data, we use bank-level administrative data that is less likely to be associated with measurement error. For consumers, we rely on issuer transactional and card adoption data to analyze changes in explanatory variables. For merchants, we rely on acquirer adoption and transactional data to analyze changes in explanatory variables.

We use proprietary quarterly payment card data from 45 Spanish banks from 1997:1 to 2007:4. These data are adjusted to reflect mergers over the period to create a balanced panel by backward aggregating all premerger data on merging banks prior to their merger. In total, there are 1,980 panel observations.[16] The database contains quarterly bank-level information on payment cards, ATMs, POS terminals and related transactions volumes and values as well as prices for debit (interchange and merchant fees) and credit card transactions (interchange fees, merchant fees and annual credit card fees). It also contains time-series data on merchant acceptance for debit and credit cards.

Since most of the banks in the sample operate in different regions, the variable for merchant acceptance by acquirer has been computed as an (branch weighted) average of merchant acceptance in the different regions where the (acquirer) bank operates. Similarly, the variable for merchant acceptance at the network level has been computed as a branch-weighted average of the percentage of merchants accepting cards for purchase transactions in the regions where the bank or any other banks belonging to the same network operate over the total number of merchants in those regions.

Additionally, although the maximum and minimum thresholds of interchange fees for different merchant activities is set at the network level, the average bank-level merchant fee varies depending on the actual fee charged and the proportion of the bank's POS debit and credit transactions by merchant sector. Therefore, the merchant discount fee charged by a bank is computed as a transaction weighted-average of merchant discount fees charged by the bank in the different merchant sectors accepting the bank's POS machines.

[16] Our sample banks represented 56.7% of total card payment transactions in 1997 and 64.8% in 2007 when compared to the aggregate date provided by the Bank of Spain.

We are also able to incorporate the availability of cash infrastructure such as ATMs into our analysis. The database also contains information on ATM density that allows computing a rival ATM density variable as a proxy of the relative costs of withdrawing cash at rivals' ATMs. Some other variables are considered in the database as region-specific control variables that may have an influence on card transactions such as the crime rate. We also control for the four main regulatory changes shown in Table 2 including dummies for those regulatory changes. Table 3 provides the main definitions of the posited explanatory variables.

7. Results

In tables 5-9, we report our regression results. Generally, we find that consumers and merchants benefit from lower in interchange fees during our sample period because an increase in merchant card acceptance results in greater adoption and usage of payment cards. Furthermore, we find that issuer and acquirer revenues increased because lower interchange fees resulted in more transactions. The revenue from increased transactions offsets the decrease in per-transaction revenue for issuers during our sample period. For acquirers, the percentage difference between the merchant discount and the interchange fee remained steady for a significant part of our sample. We will first discuss debit card extensive and intensive margins and then discuss our credit card results.

Debit Card Adoption and Usage

Our empirical analysis strongly suggests that government mandated or encouraged reductions in interchange fees resulted in lower merchant debit card fees and greater merchant debit card acceptance (see table 5). Specifically, a 10 percent reduction

in the rate of decline in the average merchant discount fee by an acquirer resulted in a .43 percent rate of increase in merchant acceptance. Neither bank size nor crime is statistically significant.

The signs of all the regulatory dummies except for 1999 suggest that lower interchange fees strongly impacted the rate of merchant acceptance. However, the impact of each intervention was different suggesting that not all interventions were equal in convincing merchants to adopt debit cards. Furthermore, the consistent positive sign on the last three regulatory dummies suggests that merchant acceptance increased with further reductions in interchange fees. Note that in 2005, there was a change in the way debit card interchange fee was imposed from a transaction percentage to a fixed per-transaction fee.

While we are unable to isolate a price effect for consumer adoption debit card services, we find strong evidence to support our hypothesis that consumers value greater merchant acceptance and react to increases in the price of the main alternative payment instrument—cash. Specifically, a 10 percent increase in the rate of merchant adoption resulted in a .36 percent increase in adoption rate of debit cards by consumers. As the rival ATM density increases, consumer adoption of debit cards increases suggesting that increases in cash acquisition costs impacts positively on debit card adoption. Specifically, a 10 percent increase in the rate of growth of rival ATM density resulted in a 1.64 percent increase in the growth rate of debit card adoption.

Now, we turn to the intensive margin for debit cards (see table 6). First, let's consider the impact of interchange fee regulation on merchant transactional volume from looking at acquirer transactional volume per POS terminal as the dependent variable

(table 6, column2). The interaction of merchant acceptance at an acquirer and the total number of cards is significant and positive suggesting that the rate of growth of debit card transactions has increased because there are more merchants and consumers on board because of lower interchange fees. Specifically, a 10 percent increase in the growth rate of merchant adoption resulted in a debit card transaction growth of .36 percent.

All the regulatory dummies are positive and significant suggesting that regulatory intervention increased overall usage at merchant locations. The rate of transaction growth is highest for the period after 2005 suggesting that the later regulatory interventions had more impact on transactional volume at acquirers.

The increase in issuer transactions proxies for the increase in consumer usage albeit imperfectly. The key explanatory variable is the interaction of merchant acceptance and cards issued by a bank. The interaction term is significant and positive suggesting that an increase in consumer and merchant adoption growth rates increases the rate of growth for consumer transactions (table 6, column 3). Specifically, a 10 percent increase in the rate of the interaction of network merchant acceptance and debit cards issued by an issuer resulted in a .46 percent increase in an issuer's debit card transactions per card. Furthermore, a 10 percent increase in the growth of rival ATM density resulted in a .63 percent increase in the rate of issuer debit card transactions per card. In other words, in a cash-intensive country such as Spain, an increase in cash acquisition costs strongly encourages adoption of debit cards.

All the regulatory dummies are positive and significant suggesting that decreases in debit card interchange fees increased debit card transactions for issuers. As before, the later regulatory actions impact issuer transaction volume growth more. Specifically, the

issuer transactional growth rate for 1999 dummy is .096 percent whereas the growth rate for the 2005 dummy is .233 percent.

Both the extensive and intensive debit card margin regressions suggest that consumer and merchant welfare improved when interchange fees were reduced. Not only are transactions occurring at more merchant locations, but each cardholder is using her card more frequently.

Credit Card Adoption and Usage

The underlying dynamics of credit card adoption is significantly different from debit card adoption where consumers had them in their wallets before they started to use them because debit cards also functioned as ATM cards. Reductions in credit card merchant discount fees increased merchant acceptance of credit cards (see table 7). Specifically, a 10 percent increase in the rate of decline of the average merchant discount of an acquirer increased the growth rate of merchant acceptance by 1.59 percent. A 10 percent growth in credit card adoption resulted in a 1.63 percent growth in the acceptance of credit cards by merchants. Note that only the last two regulatory dummies are significant suggesting that the initial regulatory interventions were not as effective in increasing merchant acceptance as the last two.

As our priors suggested, the number of cards issued by an issuer is positively impacted by the number of merchants that accept credit cards (table 7, column 3). Specifically, a 10 percent increase in the growth rate in merchant acceptance increases the growth of credit card issuance by 3.0 percent.

A key result in terms of price effects is that growth in the number of cards issued is not affected by the annual fee. We are unable to disentangle two potential reasons for

this insignificance. First, consumers may be fairly inelastic to increases to credit card annual fees. Second, they are willing to pay higher fees if more merchants accept credit cards. Regardless of why consumers do not respond to prices, there may be benefits to increasing merchants that accept credit cards by imposing higher costs on consumers. These benefits stem from the network externality of merchant acceptance.

We report credit card merchant and consumer intensive margins in table 8. A 10 percent increase in the growth of the interaction term of acceptance by merchants using the same acquirer and total credit cards in the network results in a 2.44 percent increase in the growth of acquirer transactions at the point of sale (table 8, column2). Interestingly, the crime rate is also positive and statistically significant. One cautious interpretation would be that credit cards unlike debit cards are used for large purchases and merchants are more willing to accept them because carrying large amounts of cash is undesirable in high crime areas. The regulatory dummies when significant have positive signs.

We report the consumer intensive margin in table 8, column 3. We find that a 10 percent increase in the growth rate of the interaction term of merchant acceptance in the network and credit cards issued by an issuer results in a 1.93 percent increase in issuer transaction volume. The crime rate also comes in significant and positive suggesting that higher crime rates induce shift from cash to credit cards, which are generally used for higher-value purchases. Similarly, all the regulatory dummies are significant and positive.

Mandatory reductions in credit card interchange fees have improved consumer and merchant welfare as evidenced by greater adoption and usage. We analyze the impact of interchange fee regulation on bank revenues in the next section.

Bank revenues

In table 9, we report our results for bank revenues. In the second and third columns, we report debit card acquiring revenue and debit card issuing revenue regression results, respectively. In the fourth and fifth columns, we report credit card acquiring and credit card issuing revenue regression results, respectively. In both sets of regressions, the increase in the number of transactions is positively correlated with bank revenues suggesting that while per-transaction revenue may have decreased, overall revenues increased because the revenue from increased transactions volume offset the decrease in per-transaction revenue for the time period of our sample.

However, the impact of regulatory dummies is more significant on the issuing side than the acquiring side as also evidenced by the goodness of fit. This result is consistent with the fact that the acquiring side of the business may be more competitive and any reductions in interchange fees would result in an equal magnitude decrease in the merchant discount. We reported earlier that the correlation between the movements in merchant discounts and the interchange fees are close to one. On the issuing side, the reduction in interchange fees is positively and significantly related to bank revenues suggesting that competition may have been too intense on the issuing side resulting in "too high" merchant discount and interchange fees. In turn, fewer card transactions took place at this socially inferior interchange fee.

We present our bank revenue results somewhat cautiously because we are unable to consider additional costs that may have been incurred putting downward pressure on profits. Bolt and Chakravorti (2008a) develop a model that finds lower bounds for merchant fees and implicitly interchange fees based on underlying cost structures. A more complete analysis would consider bank payment card profits instead of revenues. Unfortunately, our dataset does not allow such analysis.

8. Robustness tests

We conduct a series of robustness checks for the empirical results. First of all, we have tried other specifications for the simultaneous equations estimations. In particular, we estimated the system using two-stage-least squares, three-stage least squares and seemingly-unrelated regressions. Although the results were overall qualitatively similar, the goodness of fit of these estimations was far poorer than our GMM estimations.

In the GMM baseline results, autocorrelation tests are included to examine the possibility that lagged values of the dependent variables might affect, at least partially, the current values of these variables. In this case, a "dynamic" specification with lagged dependent variables as regressors could address these feedback effects. However, the values of these tests in all our regressions suggest that the null hypothesis of no serial correlation cannot be rejected and, therefore, do not warrant using dynamic specification. In any event, regressions using dynamic panel techniques were also undertaken and the coefficients of the lagged dependent variables were not found to be significant in any of the equations.

As for our stepwise dummies showing the effects of changes in interchange fee regulation, various alternatives were considered. The dummies were introduced one by

one in the equations and the results were very similar to those obtained when they are included altogether. As for the inclusion of time trends, we have also considered a specification with a linear plus a quadratic time trend and the results were qualitatively identical. Additionally, to identify the regulatory changes, a potential disadvantage of the dummies is that they are a stepwise and discontinuous approximation of the regulatory effect across time. Linear splines give a more precise approximation of the effect of interchange fee regulations as a set of continuous linear functions. Therefore, as a robustness check, we reran our regressions with splines instead of dummies. We approximate the splines as the difference in the number of quarters between four subintervals (the regulatory events). The end points of the linearly approximated subintervals are known as "knots" and the specification of the spline is $f(x) = \alpha_i[(x_{i+1} - x)/(x_{i+1} - x_i)] + \alpha_{i+1}[(x - x_i)/(x_{i+1} - x_i)]$ when $x \in (x_i, x_{i+1}]$ and 0 otherwise, where x is the quarter considered, and x_i are the "knots." The use of splines did not change our results with all the coefficients for the regulatory events maintaining their signs and no statistically significant differences with the estimated values of the coefficients of the dummies in our baseline results.

9. Conclusion

We find evidence that reducing interchange fees have a positive effect on consumer and merchant adoption and usage when merchant adoption is far from complete. While we are unable to study the impact of interchange fee regulation on bank profits, we find that bank revenues increased because the increase in the number of transactions offset the decrease in the per-transaction revenue. Furthermore, there is most

likely a critical interchange fee below which revenues no longer increase. Unfortunately, given our data limitations, we are unable to quantify the critical interchange fee. Interestingly, other market-based solutions may result in maximizing social welfare such as price discrimination based on the benefits received by each merchant and each consumer.

In addition, a richer analysis would include merchant and consumer usage rewards. However, such data is difficult to gather. Given these data limitations, we are still able to shed light on the interchange fee debate when a strong adoption externality exists. Specifically, we are able to demonstrate that when card adoption is low, reducing interchange fees may improve consumer and merchant welfare, and may even increase bank welfare.

However, once merchant and consumer adoption is complete, interchange fee regulation may only result in redistribution of surplus among participants, most notably between banks and merchants. In other words, interchange fee regulation would not necessarily improve social welfare. In this case, we are agnostic about the distribution of surplus among payment card market participants.

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Table 1: Recent Trends in Card Payments in Spain (1997-2007)

All the monetary magnitudes are expressed in real terms

	1997	2007
Total Number of Debit Cards (millions)	22	31
Total Number of Credit Cards (millions)	14	43
Total Number of Debit Card Transactions (millions)	156	863
Total Number of Credit Card Transactions (millions)	138	1037
Average number of POS transactions (per card and year)	7.1	27.8
Average number of ATM withdrawals (per card and year)	23.9	32.6
Average Value of Debt Card Transaction (€)	38.5	46.0
Average Value of Credit Card Transaction (€)	58.5	54.3
Average POS density (POS/km^2)	1.28	2.89
Average ATM density (ATMs/km^2)	0.07	0.12
Average Interchange Fee (*) (%)	1.71(a)	0.90
Average Debit Card Interchange Fee(**) (€/transaction)	-	0.40
Average Credit Card Interchange Fee(**) (%)	-	0.93

(a) Data for 2002, the earliest public data available for the average interchange fees for the entire Spanish market.
(*) Average percentage value of total debit and credit, on-us and intersystem interchange fees.
(**) As a consequence of the intervention of the Spanish Ministry of Industry, Tourism and Trade in 2005, a distinction is made between the applicable debit card interchange fees and credit card interchange fees, with debit card transactions becoming a fixed amount per transaction and credit card transactions continuing to be a percentage amount per transaction.

Source: Bank of Spain and authors' own calculations

Table 2: Regulatory Actions Affecting the Setting of Interchange Fees

Year	Regulatory action	Regulatory body	Main implications for interchange fees
1999	REDUCTION OF INTERCHANGE FEES	THE SPANISH MINISTRY OF THE ECONOMY	Interchange fees were gradually reduced from around 3.5% in 1999 to 2.75% in July 2002.
2002	INVESTIGATION ON THE SETTING OF INTERCHANGE FEES (MORAL SUASION)	SPAIN'S ANTITRUST AUTHORITY	Following the investigations of the European Commission on cross-border interchange fees, the Spain's Antitrust Authority (the TDC) requested the Spanish payment card networks to provide information on their method of determining interchange fee.
2003	PROPOSALS FROM THE NETWORKS ON THE SETTING OF INTERCHANGE FEES ARE REFUSED (MORAL SUASION)	SPAIN'S ANTITRUST AUTHORITY	The TDC refused several proposals of the networks on their setting of interchange fees.
2005	A REDUCTION OF INTERCHANGE FEES AND A FINAL DATE FOR THE ADOPTION OF A COST-BASED MODEL	THE SPANISH MINISTRY OF INDUSTRY, TOURISM AND TRADE	From January 2006 until December 2008, the maximum level for an interchange fee would be progressively reduced. From 2009 onwards each of the card networks would audit their operations and provide a cost-based analysis for debit and credit cards.

Source: Summary of regulatory developments mainly based on the following resolutions: Spanish Antitrust Authority (Tribunal de Defensa de la Competencia, TDC) resolution on the reduction of interchange fees (24 September 1999), Resolution of the European Commission (DG Competition COMP/29373) on the setting of cross-border interchange fees by Visa International (July 24, 2002), TDC inquiries on the setting of interchange fees by the card networks SISTEMA 4B (inquiry A 314/2002) and SERVIRED (inquiry 318/2002). TDC resolution denying the special authorizations on the setting of interchange fees to all Spanish card networks and requiring them to reduce these fees and to adopt a cost-based model (April 11, 2005).

Table 3: Variable Definitions

Debit card merchant acceptance by acquirer ($MACCD_{it}$)	Computed as (branch-weighted) average of the percentage of merchants accepting debit cards for purchase transactions in the regions where the bank operates over the total number of merchants in those regions.
Credit card merchant acceptance by acquirer ($MACCC_{it}$)	Computed as (branch-weighted) average of the percentage of merchants accepting credit cards for purchase transactions in the regions where the bank operates over the total number of merchants in those regions.
Debit card merchant acceptance in the network ($MACCDN_t$)	The percentage of merchants accepting debit cards where the network operates.
Credit card merchant acceptance in the network ($MACCCN_t$)	The percentage of merchants accepting credit cards where the network operates.
Merchant debit card discount fee ($MFEED_{it}$)	Average (transaction-weighted) debit card merchant discount fee charged by the bank computed as the (transaction-weighted) average discount fee charged to the merchants accepting the bank POS device.
Merchant credit card discount fee ($MFEEC_{it}$)	Average (transaction-weighted) credit card merchant discount fee charged by the bank computed as the (transaction-weighted) average discount fee charged to the merchants accepting the bank POS device.
Number of debit cards by issuer ($DCARDS_{it}$)	Total number of debit cards issued by a bank.
Number of credit cards by issuer ($CCARDS_{it}$)	Total number of credit cards issued by a bank.
Number of debit cards in the network ($DCARDSN_t$)	Total number of debit cards issued by the network.
Number of credit cards in the network ($CCARDSN_t$)	Total number of credit cards issued by the network.
Debit card transactions at the POS ($DEBPOSTR_{it}$)	Debit card transactions per POS terminal by an acquirer.
Credit card transactions at the POS ($CREDPOSTR_{it}$)	Credit card transactions per POS terminal by an acquirer.
Debit card transactions (issuer perspective) ($DEBISS_{it}$)	Debit card transactions per card by issuer.
Credit card transactions (issuer perspective) ($CREDISS_{it}$)	Credit card transactions (month-end/no interest) per card by issuer.
Rival ATM density ($RATMD_{it}$)	Number of an issuer's rival bank ATMs per km^2 in the regions where the bank operates.
Annual credit card fee ($AFEECRED_{it}$)	Average (asset-weighted) annual credit card fee changed by the bank.
Bank size (in the card network) ($BSIZE_{it}$)	Number of bank card transactions over the total number of card transactions in the network in which the bank operates.
Crime rate ($CRIME_{it}$)	The (asset-weighted) ratio of robbery & assaults per 1000 inhabitants in the regions where the acquirer or issuer operates.
Bank (debit card) acquiring revenues (BANKDACR)	Acquirer income from debit card merchant discount fees
Bank (debit card) issuing revenues (BANKDISR)	Issuer income from debit card interchange fees
Bank (credit card) acquiring revenues (BANKCACR)	Acquirer income from credit card merchant discount fees
Bank (credit card) issuing revenues (BANKCISR)	Issuer income from credit card interchange fees and credit card annual fees
Regulation dummy 1999 (*REG99*)	This variable takes the value 1 during the time that the level of interchange fees were reduced by regulation from 1999 to 2002 and zero otherwise.
Regulation dummy 2002 (*REG02*)	This variable takes the value 1 from 2002 to 2003 and zero otherwise and controls for changes related to the moral suasion pressures following the investigation by the Spanish antitrust authority on the collective setting of interchange fees.
Regulation dummy 2003 (*REG03*)	This variable takes the value 1 from 2003 to 2005 and zero otherwise and controls for the increasing pressures and moral suasion on the setting or interchange and the refusal of the proposals for special authorization of collective determination of these fees by the card networks.
Regulation dummy 2005 (*REG05*)	This variable takes the value 1 from 2005 onwards and zero otherwise and controls for changes related to a regulatory initiative on the reduction of interchange fees and the requirement of adoption of a cost-based model for interchange fee setting.
SOURCES: All variables related to card payments have been provided by a payment network of 45 Spanish banks. The crime rate variables have been obtained from the Spain's Statistical Office (INE). EXPLANATORY NOTES: - All monetary magnitudes are expressed in real terms. - All variables (except for regulatory dummies are in logarithms)	

Table 4: Summary Statistics

	Mean	Std. dev.	Min	Max
Debit card merchant acceptance by acquirer in regions where it has branches ($MACCD_{it}$) (%)	55.36	2.16	51.15	59.36
Credit card merchant acceptance by acquirer in regions where it has branches ($MACCC_{it}$) (%)	57.23	1.97	52.12	61.06
Debit card merchant acceptance in the network ($MACCDN_t$) (%)	58.02	2.02	53.60	61.94
Credit card merchant acceptance in the network ($MACCCN_t$) (%)	59.37	1.92	53.51	62.49
Merchant debit card discount fee by acquirer ($MFEED_{it}$) (%)	1.36	1.18	0.36	3.18
Merchant credit card discount fee by acquirer ($MFEEC_{it}$) (%)	2.03	1.93	1.06	3.56
Number of debit cards by issuer ($DCARDS_{it}$) (millions)	0.48	0.72	0.02	4.2
Number of credit cards by issuer ($CCARDS_{it}$) (millions)	0.55	0.94	0.01	4.9
Number of debit cards in the network ($DCARDSN_t$) (millions)	16	5.8	12	21
Number of credit cards in the network ($CCARDSN_t$) (millions)	20	6.3	10	32
Debit card transactions at the POS by acquirer ($DEBPOSTR_{it}$) (millions)	11.14	34.18	0.11	88.1
Credit card transactions at the POS by acquirer ($CREDPOSTR_{it}$) (millions)	12.28	56.26	0.09	94.7
Debit card transactions by issuer ($DEBISS_{it}$) (%)	1.21	4.16	0.04	10.27
Credit card transactions by issuer ($CREDISS_{it}$) (%)	1.60	5.21	0.02	12.56
Rival ATM density by issuer ($RATMD_{it}$) (ATMs/km^2)	0.9	0.4	0.3	1.5
Annual credit card fee by issuer ($AFEECRED_{it}$) (euros)	15	10	3	35
Bank size (in the card network) ($BSIZE_{it}$) (%)	1.16	4.02	0.01	11.28
Crime rate ($CRIME_{it}$)	0.37	0.21	0.10	0.68
Bank (debit card) acquiring revenues *(BANKDACR)* (€ millions)	4.31	2.19	0.08	45.23
Bank (debit card) issuing revenues *(BANKDISR)* (€ millions)	25.43	13.84	0.32	114.15
Bank (credit card) acquiring revenues *(BANKCACR)* (€ millions)	6.17	3.12	0.11	54.89
Bank (credit card) issuing revenues *(BANKCISR)* (€ millions)	28.06	14.16	0.23	131.12

Table 5: Debit Card Extensive Margins for Consumers and Merchants
Simultaneous Equation estimation (GMM with fixed effects)
(Clustered standard errors by bank in parentheses)

	Merchant extensive margin (debit cards)	***Consumer extensive margin (debit cards)***
	Merchant acceptance by acquirer($MACCD_{it}$)	*Number of debit cards by issuer ($DCARDS_{it}$)*
Constant	0.24E-11 (0.001)	0.21E-12 (0.001)
Merchant acceptance in the network ($MACCDN_{t-1}$)	-	0.0363** (0.012)
Merchant debit card discount fee ($MFEED_{it}$)	-0.0429** (0.005)	-
Number of debit cards in the network ($DCARDSN_t$)	0.0015** (0.002)	-
Rival ATM density ($RATMD_{it}$)	-	.1637** (0.014)
Bank size (in the card network) ($BSIZE_{it}$)	0.0122 (0.021)	0.0443** (0.018)
Crime rate ($CRIME_{it}$)	-0.0268 (0.161)	-0.0123 (0.852)
Linear time trend	0.0193** (0.005)	0.1951** (0.018)
Regulation dummy 1999 (REG99)	-0.0234* (0.013)	0.0926** (0.011)
Regulation dummy 2002 (REG02)	0.0116** (0.008)	-0.1425* (0.016)
Regulation dummy 2003 (REG03)	0.0155** (0.007)	-0.1007 (0.023)
Regulation dummy 2005 (REG05)	0.0126** (0.005)	-0.1852** (0.035)
Adjusted R^2	0.82	0.71
Sargan test of overidentifying restrictions (p-value in parentheses)	68.58 (0.005)	
AR(1) (p-value in parentheses)	-0.1009 (0.920)	
AR(2) (p-value in parentheses)	−1.237 (0.216)	
** Statistically significant at 5% level* *** Statistically significant at 1% level*		

Table 6: Debit Card Intensive Margins for Consumers and Merchants
Simultaneous Equation Estimation (GMM with fixed effects)
(Clustered standard errors by bank in parentheses)

	Merchant intensive margin (debit cards)	***Consumer intensive margin (debit cards)***
	Debit card transactions per POS terminal ($DEBPOSTR_{it}$)	*Debit card transactions per card (issuer perspective) ($DEBISS_{it}$)*
Constant	0.04E-13 (0.001)	-0.03E-10 (0.001)
Merchant acceptance by acquirer ($MACCD_{it-1}$)X Number of debit cards in the network ($DCARDSN_{t-1}$)	0.0359** (0.004)	-
Merchant acceptance in the network ($MACCDN_{t-1}$)X Number of debit cards by issuer ($DCARDS_{it-1}$)	-	0.0458** (0.009)
Rival ATM density ($RATMD_{it}$)	-	0.0630* (0.018)
Bank size (in the card network) ($BSIZE_{it}$)	0.0441* (0.004)	0.0112 (0.013)
Crime rate ($CRIME_{it}$)	0.1503 (0.323)	0.1130 (0.692)
Linear time trend	0.1853** (0.001)	0.1138** (0.002)
Regulation dummy 1999 (REG99)	0.0226* (0.004)	0.0963** (0.004)
Regulation dummy 2002 (REG02)	0.1308** (0.008)	0.0635* (0.008)
Regulation dummy 2003 (REG03)	0.0921* (0.005)	0.1002* (0.019)
Regulation dummy 2005 (REG05)	0.2528** (0.011)	0.2331** (0.011)
Adjusted R^2	0.89	0.71
Sargan test of overidentifying restrictions (p-value in parentheses)	154.29 (0.001)	
AR(1) (p-value in parentheses)	−1.528 (0.129)	
AR(2) (p-value in parentheses)	−1.416 (0.136)	
** Statistically significant at 5% level* *** Statistically significant at 1% level*		

Table 7: Credit Card Extensive Margins for Consumers and Merchants
Simultaneous Equation Estimation (GMM with fixed effects)
(Clustered standard errors by bank in parentheses)

	Merchant extensive margin (credit cards)	*Consumer extensive margin (credit cards)*
	Merchant acceptance by acquirer ($MACCC_{it}$)	*Number of credit cards by issuer ($CCARDS_{it}$)*
Constant	-0.30E-06 (0.001)	0.53E-06 (0.001)
Merchant acceptance in the network ($MACCCN_{t-1}$)	-	0.2985** (0.007)
Merchant credit card discount fee ($MFEEC_{it}$)	-0.1585** (0.023)	-
Number of credit cards in the network ($CCARDSN_t$)	0.1630** (0.018)	-
Annual credit card fee ($AFEECRED_{it}$)	-	0.6023 (0.730)
Bank size (in the card network) ($BSIZE_{it}$)	0.0045* (0.001)	-0.0013 (0.019)
Crime rate ($CRIME_{it}$)	0.0696* (0.012)	0.0651** (0.018)
Linear time trend	0.1694** (0.001)	0.1388** (0.042)
Regulation dummy 1999 (REG99)	-0.0950 (0.011)	0.0372** (0.004)
Regulation dummy 2002 (REG02)	0.0633 (0.071)	-0.0231 (0.032)
Regulation dummy 2003 (REG03)	0.1124** (0.055)	0.2651** (0.018)
Regulation dummy 2005 (REG05)	0.2023** (0.018)	0.2955** (0.009)
Adjusted R^2	0.87	0.93
Sargan test of overidentifying restrictions (p-value in parentheses)	152.28 (0.001)	
AR(1) (p-value in parentheses)	-1.198 (0.231)	
AR(2) (p-value in parentheses)	−1.677 (0.094)	
** Statistically significant at 5% level* *** Statistically significant at 1% level*		

Table 8: Credit Card Intensive Margins for Consumers and Merchants
Simultaneous Equation Estimation (GMM with fixed effects)
(Clustered standard errors by bank in parentheses)

	Merchant intensive margin (credit cards)	*Consumer intensive margin (credit cards)*
	Credit card transactions per POS terminal ($CREDPOSTR_{it}$)	*Credit card transactions per card (issuer perspective) ($CREDISS_{it}$)*
Constant	0.10E-07 (0.001)	-0.13E-05 (0.001)
Merchant acceptance by acquirer($MACCC_{it-1}$)X Number of credit cards in the network ($CCARDSTN_{t-1}$)	0.2243* (0.005)	-
Merchant acceptance in the network ($MACCCN_{t-1}$)X Number of credit cards by issuer ($CCARDS_{it-1}$)	-	0.1931** (0.002)
Bank size (in the card network) ($BSIZE_{it}$)	-0.1814 (0.226)	0.0108** (0.003)
Crime rate ($CRIME_{it}$)	0.0995* (0.008)	0.0550* (0.016)
Linear time trend	0.2201** (0.006)	0.1864** (0.002)
Regulation dummy 1999 (REG99)	0.0428 (0.063)	0.0792* (0.008)
Regulation dummy 2002 (REG02)	0.2633** (0.004)	0.2131** (0.002)
Regulation dummy 2003 (REG03)	0.1491* (0.003)	0.1016* (0.004)
Regulation dummy 2005 (REG05)	0.2950** (0.009)	0.3056** (0.004)
Adjusted R^2	0.68	0.95
Sargan test of overidentifying restrictions (p-value in parentheses)	66.34 (0.02)	
AR(1) (p-value in parentheses)	−0.6453 (0.421)	
AR(2) (p-value in parentheses)	−1.176 (0.192)	
** Statistically significant at 5% level* *** Statistically significant at 1% level*		

Table 9: Impact on Bank Issuing and Acquiring Revenues
Simultaneous Equations Estimation (GMM with fixed effects)
(Clustered standard errors by bank in parentheses)

	Bank (debit card) acquiring revenues (BANKDACR)	*Bank (debit card) issuing revenues (BANKDISR)*	*Bank (credit card) acquiring revenues (BANKCACR)*	*Bank (credit card) issuing revenues (BANKCISR)*
Constant	0.11E-07* (0.001)	0.09E-10* (0.001)	0.04E-09* (0.001)	0.09E-10 (0.001)
Merchant acceptance by acquirer ($MACCD_{it-1}$) X Number of debit cards in the network ($DCARDSN_{t-1}$)	0.0362* (0.014)	-	-	-
Number of debit cards by issuer ($DCARDS_{it-1}$) X Merchant acceptance in the network ($MACCDN_{t-1}$)	-	0.1432** (0.008)	-	-
Merchant acceptance by acquirer ($MACCC_{it-1}$) X Number of credit cards in the network ($DCARDSN_{t-1}$)	-	-	0.0838** (0.008)	-
Number of credit cards by issuer ($DCARDS_{it-1}$) X Merchant acceptance in the network ($MACCDN_{t-1}$)	-	-	-	0.1743** (0.005)
Rival ATM density ($RATMD_{it}$)	0.0020 (0.004)	0.00672 (0.005)	-	
Bank size (in the card network) ($BSIZE_{it}$)	0.0837** (0.009)	0.1284** (0.0010)	0.1924** (0.005)	0.0754** (0.004)
Crime rate ($CRIME_{it}$)	0.0346 (0.047)	0.0182 (0.019)	0.0305 (0.034)	0.0310 (0.040)
Liner time trend	0.6684** (0.003)	0.6577** (0.004)	0.5938** (0.006)	0.8036** (0.006)
Regulation dummy 1999 (REG99)	0.0110 (0.011)	0.0439 (0.082)	0.01432 (0.033)	0.0320 (0.077)
Regulation dummy 2002 (REG02)	0.0189 (0.019)	0.0916** (0.003)	0.0316 (0.031)	0.0671** (0.005)
Regulation dummy 2003 (REG03)	0.04461* (0.009)	0.1432** (0.004)	0.0925* (0.010)	0.1946** (0.006)
Regulation dummy 2005 (REG05)	0.031 (0.027)	0.1673** (0.001)	0.1063 (0.012)	0.2838** (0.003)
Adjusted R^2	0.42	0.88	0.44	0.89
Sargan test of overidentifying restrictions (p-value in parentheses)	215.36 (0.001)		184.12 (0.001)	
AR(1) (p-value in parentheses)	−0.6533 (0.510)		−0.7142 (0.493)	
AR(2) (p-value in parentheses)	−0.7760 (0.516)		−0.8471 (0.398)	
** Statistically significant at 5% level* *** Statistically significant at 1% level*				

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