# The Costs and Benefits of Interchange Fee Regulation: An Empirical Investigation

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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. If the pre-regulatory interchange fee was optimal, any change in the interchange fee would result in lower aggregate welfare for consumers, merchants, and banks. Merchant acceptance of debit and credit cards increased when interchange fees were reduced via government intervention in Spain during a ten-year period. In addition, usage of credit and debit cards increased. Assuming that payment cards are preferred to cash transactions by cardholders and merchants when they choose to adopt and use them, we find that consumer and merchant welfare improved. Furthermore, we find that bank revenues increased suggesting that interchange fee regulation may also be beneficial to banks. Our welfare results are critically dependent on merchant acceptance being far from complete.

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

JEL Codes: L11, G21, D53

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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. Greater acceptance and usage of payment cards suggests that a growing number of consumers and merchants prefer payment cards to cash and checks. Empirical studies suggest that debit card transactions are substituting for cash transactions. Amromin and Chakravorti (2009) find that transactional demand for cash has declined resulting from greater usage of debit cards in 13 OECD countries.[1]

Payment cards come in three forms—debit, credit, and prepaid. 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. 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. Prepaid cards may be referred to as "pay before" cards because they allow consumers to pay merchants with funds already transferred to a prepaid account. In this article, we will focus on debit and credit cards.

Payment card transactions occur over networks. These 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 fixed

[1] These 13 countries are: Austria, Belgium, Canada, Finland, France, Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom, and the United States.

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.

Some economists have advocated that policymakers should encourage the adoption of electronic payments because paper-based payment instruments such as cash and checks are less efficient to use and process (Humphrey *et al.*, 2001; Carbó *et al.,* 2003). They argue that society as a whole would benefit from cost savings by moving to more efficient electronic alternatives. However, not all participants may benefit from the transfer to electronic payments with regard to the potential cost savings.

Despite their growing market share at the expense of paper-based payments, debit and credit card networks continue to face antitrust scrutiny by public authorities regarding the pricing of payment services (Bradford and Hayashi, 2008). The debate about pricing payment card services has generated a significant amount of attention from academics. The two-sided market literature has been used to analyze the socially optimal structure of fees paid by consumers and merchants to their respective banks. Rochet and Tirole (2004) define a two-sided market when the price structure affects the total volume of transactions when end-users are unable to negotiate prices based on costs to participate on a platform. The price structure or balance is the share that each type of end-user pays

of the total price of a payment service. The socially optimal price structure is the one that maximizes the sum of consumer, merchant and bank surplus.[2]

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 optimal interchange fees.

In an effort to increase card usage and decrease cash usage, the Spanish public authorities took several regulatory actions to lower interchange fees starting in 1997. During the ten-year period from 1997 to 2007, debit card transactions increased from 156 million to 863 million. During the same period, credit card transactions increased from 138 million to 1.037 billion.

Specifically, we study the effects of several regulatory interventions in Spain during 1997 to 2007. We ask whether government intervention can improve social welfare in an already competitive environment where network adoption externalities still exist. If more merchants adopt, consumers do not leave the card networks, and usage increases, we would argue that social 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.

[2] For a more general treatment of two-sided markets, see Armstrong (2006), Caillaud and Jullien (2003), Jullien (2001), and Rochet and Tirole (2006).

A brief summary of our results are as follows. Merchant fees are strongly positively correlated with government-mandated reductions in the interchange fee. In fact, the correlation between merchant discounts and interchange fees is close to 1. Furthermore, we find strong evidence suggesting that merchant acceptance has increased because of a reduction in the merchant fees. However, the increase in acceptance of debit and credit cards differ based on the level of the fee reduction and when it occured.

Cardholder adoption for debit cards may have reached saturation because they also serve as ATM cards. We find that consumers do not reduce their participation in credit card networks when annual fees increase suggesting that the consumer demand for payment card services is fairly inelastic or consumers are willing to pay higher fees in exchange for greater merchant acceptance. Our empirical analysis suggests that in payment card markets where merchant acceptance is low, interchange fee regulation may be beneficial to get more merchants on board and increase payment card usage.

We also find that 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 may have decreased, this loss in revenue is offset by greater transactional volume. In other words, intense competition between issuers coupled with greater bargaining power than acquirers may have pushed interchange fees too high. Payment card network researchers have suggested that the issuing side has greater negotiating power in a card association than the acquiring side.

Our article is organized in the following way. In the next section, we discuss the theoretical economic models and identify predictions that we would like to test. In section 3, 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 4. We describe our dataset in section 5. In section 6, we present our results. We discuss bank revenue resulting from interchange fee regulation in section 7. Finally, we offer some concluding remarks in section 8.

## 2. Economic Models of Payment Cards

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). 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 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 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. 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.

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.

A key assumption is that consumers and merchants are unable to negotiate prices based on the type of payment instrument. If merchants are able to pass on payment costs, the level of interchange fees will not affect the usage of payment cards assuming that the proportion of merchants accepting cards is constant.[3] 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. However, in two-sided markets this may not be the case given the externalities present. In fact, the price structure may worsen when there is competition at the network level (Guthrie and Wright, 2007, and Rochet and Tirole, 2003). If competition for consumers is more intense than for merchants, the resulting interchange fee may be higher than the socially optimal one.

## 3. Payments in Spain

The banking infrastructure in Spain continues to grow and remain among the highest in terms of density and penetration of bank branches, ATMs and POS terminals.

[3] See Gans and King (2003) for a more general treatment of when interchange fees are neutral.

Spanish banks have developed an extensive network of tellers and POS terminals (32.5 POS terminals per 1,000 inhabitants at the end of 2007) and have also issued a large number of cards. Traditional banking penetration has also evolved along with card distribution channels.

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

Cash remains a very important way to pay in Spain, with ATM withdrawals per card and per year increasing from 23.9 in 1997 to 32.6 in 2007. The average withdrawal in real terms also increased from 71€/transaction in 1997 to 112€/transaction in 2007. The density of these devices may partially explain the evolution of the use of cards. Spain ranks among the highest in terms of ATMs per capita at 1.3 ATMs per 1.000 inhabitants at the end of 2007. In particular, average ATM density (ATMs/$km^2$) also increased (from 0.07 in 1997 to 0.12 in 2007) suggesting that residents are relying on ATMs more than bank branches to acquire cash.

Table 1 also shows that the average value of debit card transactions (in real terms) have increased significantly from 38.5 to 46 euros/transaction between 1997 and 2007. The increasing average real debit card per transaction value is explained by the generalization of the use of these cards for payments of larger-value purchases at the POS. On the other hand, the average credit card transaction value (in real terms) has

decreased from 58.5 to 54.3 euros. The lower average real credit card per transaction value may result from the diffusion of these cards among customers for payments of lower-value purchases.

*Key regulatory developments*

During 1997-2007, there were four important regulatory events that significantly affected the setting of interchange fees in the Spanish payment card industry. All the regulatory events, which are summarized in Table 2, resulted from explicit 'agreements' or moral suasion, under the threat of intervention by the public authorities.[4]

The first regulatory intervention occurred in May 1999, when the government mandated the three Spanish payment card networks—Servired, Euro6000 and 4B—to gradually reduce maximum interchange fees from 3.5% in 1999 to 2.75% in July 2002. 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.[5] The second regulatory action came in April 2002 when Spain's Antitrust Authority (the Tribunal de Defensa de la Competencia, TDC) requested the Spanish networks to provide information on how they determined their interchange fees.

[4] The four regulatory events usually came in the form of agreements between the different payment system participants (networks, banks, merchants) and these 'agreements' were sponsored by the Ministry of the Economy or the Ministry of Industry, Tourism and Trade.

[5] 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.

A third important regulatory episode 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.[6]

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. In December 2005, the Ministry of Industry, Tourism and Trade decided that the multilateral interchange fees should not exceed the costs to provide card services.

A new regulatory framework stated that from 2009 onwards, each of the card networks would audit their operations and provide a cost-based analysis for debit and credit cards. During the implementation, the fee levels had to be reduced in a stepwise manner. Specifically, from January 2006 until December 2008, the highest interchange fee would be progressively reduced.

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

[6] In May 2003, the Spanish Congress requested the TDC to investigate on the setting of interchange fees and to follow the basic principles that the European Commission adopted for EU-wide cross-border 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.

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 amount. These fees are the maximum allowable. Additionally, price differences between debit and credit cards, merchant sectors, and intra- and inter-system operations should also be progressively reduced.

## 4. The Empirical Model

The government mandated or encouraged interchange fee ceilings in Spain allow us a natural laboratory to test whether consumer and merchant welfare has improved. We explore the following questions:

- Did the lowering of interchange fees increase merchant participation?
- Did the lowering of interchange fees reduce card adoption and usage by consumers?
- Did the lowering of interchange fees reduce or increase bank payment card revenues?

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

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

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

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:

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

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

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 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).

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 include market-specific instruments which control for those otherwise immeasurable aspects of the change in markets over time such as lagged GDP. 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. 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. 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, preclude us from using dynamic specification.[7]

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 number of debit/credit transactions over total transactions in the network where the bank operates) to control for any increases in bank size during the sample period. In order to control the (mainly upward) trend in the data for merchant acceptance, number of cards and number of transactions, all equations also incorporate a linear time trend.[8]

[7] 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. These results are available upon request.

[8] We have also considered a specification with a linear plus a quadratic time trend and the results were qualitatively identical.

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.[9] 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.

As for vector *R*, we also include four regulatory dummies to measure the impact of the different regulations on interchange fees. These regulatory dummies represent the year when the regulatory intervention was introduced. The summary statistics for the variables in the 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.[10] If cardholders decrease their participation in card networks or use their cards less because their benefits decreased, 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.

[9] Some theoretical money models suggest that crime may be a reason to move away from cash (He, Huang, and Wright, 2005).

[10] Some authors have suggested that additional sales should be a criterion for accepting cards (Bolt and Chakravorti, 2008). 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.

*Cardholder Extensive Margin*

The impact of increases in consumer debit card fees on the extensive debit cardholder margin is difficult to measure for debit cards 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 of debit cards may be more complex than for credit cards. 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 prices may be contemporaneously related while transactions, issuance and usage may be determined by observed previous acceptance. Second, debit cards became more attractive to consumers as cash acquisition costs increased. 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, this annual fee has been rising. Our empirical model allows us to study the impact of lower interchange fee 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. For both consumer extensive margin regressions, we also include our control and regulatory variables discussed above.

*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 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 merchant acceptance by an acquirer and the number of total network cards increases. However, while adoption may increase, it is still an empirical question whether usage 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. The key explanatory variable is an interaction term of the merchant acceptance in the network and the number of debit cards issued by the bank. We include the same control and regulatory dummies as in the other regressions.

*Bank revenues*

We employ a similar approach to estimating the impact regulatory intervention on bank revenues. We separate banks into issuers and acquirers of debit and credit cards. Our dependent variables are issuer and acquirer payment card revenue by type of card. For issuers, this would be the interaction of the average interchange fees and the number

of transactions and total annual fees collected (is this true only for credit cards). For acquirers, this would be the merchant discount minus the interchange fee 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 average rivals' ATM density and bank size as control variables. In addition, we have our regulatory dummies.

## 5. Our Dataset

Our data are from banks that participate in a Spanish payment network. 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. While consumer and merchant level data may be preferred, analyzing bank level data provides key insights into consumer and merchant behavior.

We use proprietary quarterly payment card data from 45 Spanish banks participating in a payment card network 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.[11] 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 showing 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 showing 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 relevant maximum and minimum thresholds of interchange fees for the different merchant activities—as well as for debit and credit card transactions in these sectors—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 in every 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.

[11] 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.

## 6. Results

In tables 5-9, we report our regression results. We will first discuss debit card extensive and intensive margins and then discuss our credit card results. Generally, we find that consumers and merchants benefit from government-mandated reduction in interchange fees because increased merchant card acceptance result in greater adoption and usage of payment cards.

*Debit Card Adoption and Usage*

Our empirical analysis strongly suggests that government mandated or encouraged reductions in interchange fees result in lower merchant debit card fees and greater merchant debit card acceptance (see table 5). Specifically, a 1 percent reduction in the rate of decline in the average merchant discount fee by an acquirer resulted in a 4.3 percent rate of increase in merchant acceptance. Neither bank size nor crime was statistically significant.

The signs of all the regulatory dummies except for 1999 suggest that the regulatory intervention 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 prices of alternative payment instruments such as cash. Specifically, a 1 percent increase in the rate of merchant adoption resulted in a 3.6 percent increase in adoption 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 1 percent increase in the rate of growth of rival ATM density resulted in a 16.4 percent increase in debit cards.

The number of debit cards does not increase monotonically during our sample period and may cause difficulty in interpreting our results. But more importantly, debit card penetration increased monotonically suggesting that the reduction in debit cards in some parts of our sample period does not represent consumer adoption of a debit card in general. Our data limitations do not allow us to conduct careful analysis of costs and benefits of mulithoming by cardholders.

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 as the dependent variable. The interaction of merchant acceptance at an acquirer and the total number of cards is significant and positive suggesting that card usage has increased because there are more merchant and consumers on board with lower interchange fees. Specifically, a 1 percent increase in the rate of merchant adoption resulted in a debit card transaction growth of 3.3 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 rate of transactional volume increased from 1.6 percent to 20.2 percent for the 1999 and 2005 regulatory dummy, respectively.

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 increases consumer transactions. Specifically, a one percent increase in the rate of the interaction of network merchant acceptance and debit cards issued by an issuer resulted in a 11.6 percent increase in an issuer's debit card transactions, which in turn shows the high impact of network effects in the payment cards industry and, in particular in a country like Spain, where merchant acceptance has not reached maturity. Furthermore, a 1 percent increase in the growth of rival ATM density resulted in a 12.7 percent increase in the rate of issuer

debit card transaction volume. 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 8.2 percent whereas the growth rate for the 2005 dummy is 26.4 percent.

Both the extensive and intensive debit card margins 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 at greater frequencies.

*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. As in the case of debit cards, reductions in the merchant discount fee increased merchant acceptance (see table 7). Specifically, a 1 percent decrease in the growth rate of average merchant discounts by an acquirer increased the growth rate of merchant acceptance by 15.9 percent. However, unlike debit cards, the growth rate of credit card adoption impacted merchant acceptance to a similar extent. A 1 percent growth in credit card adoption resulted in a 16.30 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. The impact of the 2003 regulatory dummy on the growth rate of merchant acceptance is 11.2 percent whereas the impact of the 2005 regulatory dummy is 20.2 percent.

As our priors suggested, the number of cards issued by an issuer is positively impacted by the number of merchants that accept the card. Specifically, a 1 percent increase in the growth rate in merchant acceptance increases the growth of card issuance by 30 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 1 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 32.1 percent increase in the growth of acquirer transactions at the point of sale which, again, demonstrates the relevance of network effects in the industry. 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 also report the consumer intensive margin in table 8. We find that a 1 percent increase in the growth rate of the interaction term of merchant acceptance in the network and credit cards issued by issuer results in a 18.5 percent increase in issuer transaction volume. The crime rate also comes in significant and positive. 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 first two columns, we report debit card acquiring revenues and debit card issuing revenues, respectively. In the third and fourth columns, we report credit card acquiring and credit card issuing revenues, respectively. In all four 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.

However, the impact of regulatory dummies is more significant on the issuing side than the acquiring side. 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, especially later regulatory interventions, is positively and significantly related to bank revenues

suggesting that competition may have been too intense on the issuing side resulting in "too high" a merchant discount and interchange fee. 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. In a theoretical model, Chakravorti and To (2007) demonstrate a tradeoff between higher credit card defaults and greater consumer adoption of credit cards. Bolt and Chakravorti (2008a) develop a model that finds lower bounds for merchant fees based on underlying cost structures. A more complete analysis would consider bank payment card profits instead of revenues. Unfortunately, our data limitations do not allow such analysis. Nevertheless, we demonstrate that bank revenues may actually increase with interchange fee regulation when merchant acceptance is sufficiently far from complete.

## 8. Conclusion

Our results suggest that interchange fee regulation has had a positive effect on consumer and merchant adoption and usage. They are consistent with the hypothesis that bank competition on the issuing side may have been too intense and bargaining power of issuers was and continues to be greater than of acquirers. These factors along with being far from complete acceptance of payment cards resulted in interchange fees that were greater than the socially optimal one. While we are unable to study the impact of interchange fee regulation on bank profits, we find that bank revenues increased because

the increased in the number of transactions offset the decrease in the per-transaction revenue.

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. Specifically, we are able to demonstrate that when card adoption is low, interchange fee regulation 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. In other words, interchange fee regulation would not necessarily improve social welfare. 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.

**References**


Amromin, Gene and Sujit Chakravorti (2009), "Whither Loose Change? The Diminishing Demand for Small Denomination Currency," *Journal of Money, Credit, and Banking*, 41 (2-3), 315-335.

Armstrong, Mark (2006), "Competition in Two-Sided Markets," *Rand Journal of Economics* 37 (3), 668-691.

Baxter, William F. (1983), "Bank Interchange of Transactional Paper: Legal and Economic Perspectives," *Journal of Law & Economics,* 26, 541-588.

Bradford, Teri and Fumiko Hayashi (2008), "Developments in Interchange Fees in the United States and Abroad, *Payments System Research Briefing*, Federal Reserve Bank of Kansas City, April.

Bolt, Wilko and Sujit Chakravorti (2008a), "Consumer Choice and Merchant Acceptance of Payment Media," Federal Reserve Bank of Chicago Working Paper, 2008-11.

Bolt, Wilko and Sujit Chakravorti (2008b), "Economics of Payment Cards: A Status Report," *Economic Perspectives*, Federal Reserve Bank of Chicago, 4th Quarter, 15-27.

Carbó Valverde, Santiago, David Humphrey, and Rafael López del Paso (2003), "The Falling Share of Cash Payments in Spain," *Moneda y Crédito*, 217, 167-190.

Chakravorti, Sujit and Ted To, "A Theory of Credit Cards," *International Journal of Industrial Organization*, 25 (3), 583-595.

Gans, Joshua S. and Stephen P. King (2003), "The Neutrality of the Interchange Fees in Payment Systems," *Topics in Economic Analysis and Politics*, 3(1).

Guthrie, Graeme, and Julian Wright (2007), "Competing Payment Schemes," *Journal of Industrial Economics*, 55 (1), 37-67.

Hansen, Lars Peter, (1982), "Large Sample Properties of Generalized Method of Moments Estimation"," *Econometrica*, 50, 1029-1054.

He, Ping, Lixin Huang, and Randall Wright (2005), "Money and Banking in Search Equilibrium," *International Economic Review*, 46, 637-670.

Humphrey, David B., Kim, Moshe and Bent Vale (2001), "Realizing the Gains from Electronic Payments: Costs, Pricing and Payment Choice," *Journal of Money, Credit, and Banking*, 33, 216-234.

Humphrey, David B., Lawrence B. Pulley, and Jukka M Vesala (1996), "Cash, Paper, and Electronic Payments: A Cross-Country Analysis," *Journal of Money, Credit, and Banking*, 28 (4), 914-939.

IMA Market Development AB (2000), *Study Regarding the Effects of the Abolition of the Non-Discrimination Rule in Sweden,* IMA Market Development AB: Frodingsvagen.

Rochet, Jean-Charles (2003), "The Theory of Interchange Fees: A Synthesis of Recent Contributions," *Review of Network Economics*, 2 (2), 97-124.

Rochet, Jean-Charles and Jean Tirole (2002), "Cooperation Among Competitors: Some Economics of Payment Card Associations," *Rand Journal of Economics*, 33 (4), 549-570.

Rochet, Jean-Charles and Jean Tirole (2003), "Platform Competition in Two-Sided Markets," *Journal of European Economic Association*, 1 (4), 990-1029.

Rochet, Jean-Charles and Jean Tirole (2006), "Two-Sided Markets: A Progress Report," *Rand Journal of Economics* 37 (3), 645-667.

Scholnick, Barry, Nadia Massoud, Anthony Saunders, Santiago Carbó-Valverde, and Francisco Rodriguez-Fernandez (2008), "The Economics of Credit Cards, Debit Cards and ATMs: A Survey and Some New Evidence," *Journal of Banking and Finance*, 32, 1468-1483.

Wooldridge, Jeffrey (2002)," Econometric Analysis of Cross Section and Panel Data," MIT Press.

**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 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 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 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-base 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 at the point of sale by an acquirer. |
| Credit card transactions at the POS ($CREDPOSTR_{it}$) | Credit card transactions at the point of sale by an acquirer. |
| Debit card transactions (issuer perspective) ($DEBISS_{it}$) | Debit card transactions as a percentage of total transactions with all cards at merchant outlets by an issuer. |
| Credit card transactions (issuer perspective) ($CREDISS_{it}$) | Credit card transactions (month-end/no interest) as a percentage of total transactions with all cards at merchant outlets by an 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) | 16.28 | 12.36 | 0.21 | 78.12 |
| Bank (debit card) issuing revenues *(BANKDISR)* (€ millions) | 25.43 | 13.84 | 0.32 | 114.15 |
| Bank (credit card) acquiring revenues *(BANKCACR)* (€ millions) | 18.24 | 11.31 | 0.18 | 96.25 |
| 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<br>(0.001) | 0.21E-12<br>(0.001) |
| *Merchant acceptance in the network ($MACCDN_{t-1}$)* | - | 0.0363**<br>(0.012) |
| *Merchant debit card discount fee ($MFEED_{it}$)* | -0.0429**<br>(0.005) | - |
| *Number of debit cards in the network ($DCARDSN_t$)* | 0.0015**<br>(0.002) | - |
| *Rival ATM density ($RATMD_{it}$)* | - | .1637**<br>(0.014) |
| *Bank size (in the card network) ($BSIZE_{it}$)* | 0.0122<br>(0.021) | 0.0443**<br>(0.018) |
| *Crime rate ($CRIME_{it}$)* | -0.0268<br>(0.161) | -0.0123<br>(0.852) |
| *Linear time trend* | 0.0193**<br>(0.005) | 0.1951**<br>(0.018) |
| *Regulation dummy 1999 (REG99)* | -0.0234*<br>(0.013) | 0.0926**<br>(0.011) |
| *Regulation dummy 2002 (REG02)* | 0.0116**<br>(0.008) | -0.1425*<br>(0.016) |
| *Regulation dummy 2003 (REG03)* | 0.0155**<br>(0.007) | -0.1007<br>(0.023) |
| *Regulation dummy 2005 (REG05)* | 0.0126**<br>(0.005) | -0.1852**<br>(0.035) |
| Adjusted $R^2$ | 0.82 | 0.71 |
| Sargan test of overidentifying restrictions<br>(p-value in parentheses) | 68.58<br>(0.005) | |
| AR(1) (p-value in parentheses) | -0.1009<br>(0.920) | |
| AR(2) (p-value in parentheses) | −1.237<br>(0.216) | |
| ** Statistically significant at 5% level*<br>*** 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 at the POS ($DEBPOSTR_{it}$)* | *Debit card transactions (issuer perspective) ($DEBISS_{it}$)* |
| *Constant* | 0.05E-13<br>(0.001) | -0.05E-13<br>(0.001) |
| *Merchant acceptance by acquirer ($MACCD_{it-1}$)X Number of debit cards in the network ($DCARDSN_{t-1}$)* | 0.0326**<br>(0.010) | - |
| *Merchant acceptance in the network ($MACCDN_{t-1}$)X Number of debit cards by issuer ($DCARDS_{it-1}$)* | - | 0.1160**<br>(0.016) |
| *Rival ATM density ($RATMD_{it}$)* | - | 0.1271**<br>(0.013) |
| *Bank size (in the card network) ($BSIZE_{it}$)* | 0.0231*<br>(0.004) | 0.0091<br>(0.011) |
| *Crime rate ($CRIME_{it}$)* | 0.2736<br>(0.628) | 0.1029<br>(0.257) |
| *Linear time trend* | 0.1858**<br>(0.002) | 0.1696**<br>(0.004) |
| *Regulation dummy 1999 (REG99)* | 0.0163**<br>(0.004) | 0.0824*<br>(0.009) |
| *Regulation dummy 2002 (REG02)* | 0.1025**<br>(0.008) | 0.0899**<br>(0.012) |
| *Regulation dummy 2003 (REG03)* | 0.1021**<br>(0.004) | 0.1269*<br>(0.021) |
| *Regulation dummy 2005 (REG05)* | 0.2026**<br>(0.012) | 0.2635**<br>(0.015) |
| Adjusted $R^2$ | 0.92 | 0.64 |
| Sargan test of overidentifying restrictions<br>(p-value in parentheses) | 144.64<br>(0.001) | |
| AR(1) (p-value in parentheses) | −1.517<br>(0.129) | |
| AR(2) (p-value in parentheses) | −1.452<br>(0.147) | |
| ** Statistically significant at 5% level*<br>*** 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<br>(0.001) | 0.53E-06<br>(0.001) |
| *Merchant acceptance in the network ($MACCCN_{t-1}$)* | - | 0.2985**<br>(0.007) |
| *Merchant credit card discount fee ($MFEEC_{it}$)* | -0.1585**<br>(0.023) | - |
| *Number of credit cards in the network ($CCARDSN_t$)* | 0.1630**<br>(0.018) | - |
| *Annual credit card fee ($AFEECRED_{it}$)* | - | 0.6023<br>(0.730) |
| *Bank size (in the card network) ($BSIZE_{it}$)* | 0.0045*<br>(0.001) | -0.0013<br>(0.019) |
| *Crime rate ($CRIME_{it}$)* | 0.0696*<br>(0.012) | 0.0651**<br>(0.018) |
| *Linear time trend* | 0.1694**<br>(0.001) | 0.1388**<br>(0.042) |
| *Regulation dummy 1999 (REG99)* | -0.0950<br>(0.011) | 0.0372**<br>(0.004) |
| *Regulation dummy 2002 (REG02)* | 0.0633<br>(0.071) | -0.0231<br>(0.032) |
| *Regulation dummy 2003 (REG03)* | 0.1124**<br>(0.055) | 0.2651**<br>(0.018) |
| *Regulation dummy 2005 (REG05)* | 0.2023**<br>(0.018) | 0.2955**<br>(0.009) |
| Adjusted $R^2$ | 0.87 | 0.93 |
| Sargan test of overidentifying restrictions<br>(p-value in parentheses) | 152.28<br>(0.001) | |
| AR(1) (p-value in parentheses) | -1.198<br>(0.231) | |
| AR(2) (p-value in parentheses) | −1.677<br>(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 at the POS ($CREDPOSTR_{it}$)* | *Credit card transactions (issuer perspective) ($CREDISS_{it}$)* |
| *Constant* | 0.25E-06<br>(0.001) | -0.19E-06*<br>(0.001) |
| *Merchant acceptance by acquirer($MACCC_{it-1}$)X Number of credit cards in the network ($CCARDSTN_{t-1}$)* | 0.3216**<br>(0.004) | - |
| *Merchant acceptance in the network ($MACCCN_{t-1}$)X Number of credit cards by issuer ($CCARDS_{it-1}$)* | - | 0.1854**<br>(0.002) |
| *Bank size (in the card network) ($BSIZE_{it}$)* | -0.1618<br>(0.025) | 0.0123*<br>(0.002) |
| *Crime rate ($CRIME_{it}$)* | 0.0851*<br>(0.039) | 0.0742*<br>(0.023) |
| *Linear time trend* | 0.2214**<br>(0.003) | 0.1996**<br>(0.001) |
| *Regulation dummy 1999 (REG99)* | 0.0681<br>(0.072) | 0.0725**<br>(0.004) |
| *Regulation dummy 2002 (REG02)* | 0.2335**<br>(0.004) | 0.1935**<br>(0.002) |
| *Regulation dummy 2003 (REG03)* | 0.1073**<br>(0.003) | 0.1180**<br>(0.002) |
| *Regulation dummy 2005 (REG05)* | 0.3104**<br>(0.009) | 0.2932**<br>(0.006) |
| Adjusted $R^2$ | 0.68 | 0.94 |
| Sargan test of overidentifying restrictions<br>(p-value in parentheses) | 59.52<br>(0.02) | |
| AR(1) (p-value in parentheses) | −0.7830<br>(0.434) | |
| AR(2) (p-value in parentheses) | −1.290<br>(0.197) | |
| ** Statistically significant at 5% level*<br>*** 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* | 0.24E-09*<br>(0.001) | 0.12E-10*<br>(0.001) | 0.20E-08*<br>(0.001) | 0.08E-12<br>(0.001) |
| *Merchant acceptance by acquirer ($MACCD_{it-1}$) X Number of debit cards in the network ($DCARDSN_{t-1}$)* | 0.1236**<br>(0.010) | - | - | - |
| *Number of debit cards by issuer ($DCARDS_{it-1}$) X Merchant acceptance in the network ($MACCDN_{t-1}$)* | - | 0.1183**<br>(0.009) | - | - |
| *Merchant acceptance by acquirer ($MACCC_{it-1}$) X Number of credit cards in the network ($DCARDSN_{t-1}$)* | - | - | 0.1327**<br>(0.011) | - |
| *Number of credit cards by issuer ($DCARDS_{it-1}$) X Merchant acceptance in the network ($MACCDN_{t-1}$)* | - | - | - | 0.1615**<br>(0.009) |
| *Rival ATM density ($RATMD_{it}$)* | 0.0037<br>(0.005) | 0.0062<br>(0.007) | - | |
| *Bank size (in the card network) ($BSIZE_{it}$)* | 0.1199**<br>(0.008) | 0.1291**<br>(0.009) | 0.1633**<br>(0.007) | 0.0952**<br>(0.005) |
| *Crime rate ($CRIME_{it}$)* | 0.0208<br>(0.032) | 0.0194<br>(0.022) | 0.0385<br>(0.040) | 0.0323<br>(0.044) |
| *Liner time trend* | 0.5228**<br>(0.004) | 0.6128**<br>(0.005) | 0.7013**<br>(0.008) | 0.7518**<br>(0.007) |
| *Regulation dummy 1999 (REG99)* | 0.0125<br>(0.017) | 0.0453<br>(0.088) | 0.01623<br>(0.020) | 0.0445<br>(0.062) |
| *Regulation dummy 2002 (REG02)* | 0.0152<br>(0.015) | 0.0922**<br>(0.002) | 0.0322<br>(0.037) | 0.0528**<br>(0.004) |
| *Regulation dummy 2003 (REG03)* | 0.0288*<br>(0.003) | 0.1251**<br>(0.007) | 0.0914*<br>(0.016) | 0.1753**<br>(0.008) |
| *Regulation dummy 2005 (REG05)* | 0.026<br>(0.010) | 0.1726**<br>(0.001) | 0.1051*<br>(0.008) | 0.2251**<br>(0.004) |
| Adjusted $R^2$ | 0.41 | 0.86 | 0.48 | 0.86 |
| Sargan test of overidentifying restrictions (p-value in parentheses) | 194.15<br>(0.001) | | 175.18<br>(0.001) | |
| AR(1) (p-value in parentheses) | −0.7930<br>(0.427) | | −0.7812<br>(0.445) | |
| AR(2) (p-value in parentheses) | −0.8151<br>(0.415) | | −0.8346<br>(0.402) | |

** Statistically significant at 5% level*
*** Statistically significant at 1% level*