THE ROLE OF INTERCHANGE FEES IN TWO-SIDED MARKETS: AN EMPIRICAL INVESTIGATION ON PAYMENT CARDS

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Abstract—We study the impact of reductions in interchange fees on payment card services. We find that consumer and merchant acceptance and transaction volumes increased when interchange fees were reduced. Our results suggest that a 10% reduction in the rate of decline per quarter in the average interchange fee by an acquirer resulted in a rate of increase in merchant acceptance per quarter of up to 1.4%. In addition, a 10% increase in the rate of interaction of merchant acceptance and the total number of cards increased the rate of quarterly issuer transaction volumes up to 1.7%.

I. Introduction

PAYMENT networks are the backbone of any well-functioning financial market. Specifically, retail payment networks allow buyers of products and services to transfer monetary value to sellers. Increasingly, these monetary transfers are initiated with payment cards. Payment cards are generally characterized as a two-sided market. Rochet and Tirole (2006b) define a two-sided market when the price structure, or the share that each type of end user pays the platform, affects the total volume of transactions.[1] The key aspect of these markets is the presence of indirect network externalities and how fee structures are able to internalize these externalities. Often platforms subsidize the participation of one type of end user by extracting surplus from another type of end user to internalize this externality.

Payment card networks are composed of consumers (one type of end user), their financial institutions (known as issuers), merchants (the other type of end user), their financial institutions (known as acquirers), and a network operator or platform. 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, including debit card services. Merchants pay fees known as merchant discounts. Acquirers pay interchange fees to issuers.

The level of interchange fees continues to receive attention around the world by public authorities. A small but controversial section of the Dodd-Frank Wall Street Reform and Consumer Protection Act passed by the U.S. Congress and signed into law by the president in 2010 gives the Federal Reserve the authority to regulate U.S. debit card interchange fees to promote a more efficient retail payment system. The Reserve Bank of Australia regulated interchange fees in 2002 after concluding that consumers did not face the correct incentives to use the most efficient payment instrument. The European Commission in 2007 ruled that MasterCard's interchange fees violated the EU's antitrust laws. Additionally, the European General Court judgment of May 2012[2] confirmed the commission's finding in its MasterCard Decision of December 2007.[3] Alternatively, the reduction in interchange fees may also occur without regulatory intervention, as occurred in the United States when card networks convinced large department stores and grocery stores to accept payment cards by reducing interchange fees, which resulted in lower merchant fees.

The economic theory regarding interchange fees predicts that by lowering the optimal interchange fees, some merchants not currently accepting card payments may start to accept them. However, lowering interchange fees would increase cardholder fees, and some of them may abandon their payment cards or use them less frequently. However, changes in external factors such as greater awareness of the benefits of payment cards or reductions in processing and credit intermediation costs may result in greater adoption and use by consumers even when consumer fees increase resulting from interchange fees being lowered by the card network or by government mandate.

Using a unique Spanish proprietary bank-level data set, we study the impact of interchange fee reductions from 1997 to 2007 on merchant acceptance, consumer adoption, payment card transaction volumes, and issuer and acquirer revenues. Our main results are as follows. First, we find strong evidence suggesting that merchant acceptance has increased because of a reduction in interchange fees. Second, consumer adoption of debit cards did not significantly decrease over the period because of lower interchange fees, as would be predicted by theoretical models absent changes in external factors. Credit card adoption increased dramatically during the period of interchange fee reductions, suggesting the value proposition for those consumers previously not having credit cards improved

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[1] For a broader description of two-sided markets, see Armstrong (2006), Rochet and Tirole (2006b), Rysman (2009), and Weyl (2010).

[2] Directive 2007/64/EC of the European Parliament and of the Council of 13 November 2007 on payment services in the internal market (the so-called payment services directive, or PSD) is currently being complemented with proposals (under discussion) such as the Proposal for a Regulation of the European Parliament and the Council on Interchange Fees for Card-Based Payment Transactions (SWD(2013)288).

[3] See Evans (2011) and Weiner and Wright (2005) for more details on regulatory interventions in other countries.

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despite higher fees. Third, most important, reductions in interchange fees resulted in a dramatic increase in payment card transactions during this period. Fourth, bank payment revenues from debit and credit card services increased as a result of lower interchange fees. Our results for bank revenues suggest that the increase in the number of transactions appears to offset the decrease in the per transaction bank revenue.

Our paper is organized in the following way. In the next section, we survey the main theoretical and empirical studies on interchange fees. Section III analyzes the industry and the data. We discuss our empirical strategy in section IV. In section V, we present our results. We offer some concluding remarks in section VI.

II. Payment Card Markets and Interchange Fees: Literature Background

The theoretical literature on payment cards, along with the broader two-sided market literature, stresses the balancing of two different types of end users. In the case of payment card services, the two types of end users are consumers and merchants. When markets are competitive, the optimal level of total fees (the sum of consumer and merchant fees) occurs when the sum of benefits of consumers and merchants is equal to the sum of the costs to consumers and merchants. However, the price structure or the proportion of the total fee paid by each type of end user matters. Baxter (1983) concluded that a side payment from one type of end user to the other type of end user might be required to reach the optimal level of payment card use. Thus, while a decrease in interchange fees may result in greater merchant adoption, the increase in price to consumers may result in a decrease in consumer adoption and use. In this paper, we test if consumers decreased their adoption and use of payment cards when the cost of payment services increased even when the number of accepting merchants increased.

The implementation of this side payment between merchants and consumers occurs through the interchange fee. If the interchange fee decreases, the cost to consumers will increase and the cost to merchants will decrease. The impact on adoption and use by consumers and merchants is dependent on demand elasticities of each end user type. Furthermore, a critical component of each type of end user's demand is critically dependent on the level of adoption by the other type of end user. Consumers will not adopt and use payment cards unless a sufficient number of merchants accept cards. Like consumers, merchants will not accept cards unless a sufficient number of consumers on the other side adopt and use payment cards. Hence, there is a level of interchange fees that ensures that the optimal level of payment card adoption and usage occurs. If the interchange fee is lowered from the optimal one, consumers will decrease their use and adoption, and if it is raised, merchants will decrease their acceptance or be reluctant to actually accept them even if they advertise that they will.[4]

Since Baxter's initial study, researchers have extended this analysis in various directions. Schmalensee (2002) considers issuers and acquirers with market power but still finds a similar role for interchange fees. Rochet and Tirole (2002) consider strategic reasons for merchants to accept payment cards, such as business stealing from other merchants, and finds that the socially optimal interchange fee may be lower than the fee set by banks.[5] For the most part, the theoretical literature does not consider changes to the price level. An exception is Chakravorti and Roson (2006), who consider the effects of competition on price level and price structure. In particular, they examine three types of market structures for payment networks: cartel, noncooperative duopoly under product differentiation, and Bertrand duopoly (price competition for homogeneous products). They find that competition unambiguously improves consumer and merchant welfare while reducing the profits of payment networks.

However, the theoretical literature solves a static problem without consideration to potential exogenous environmental changes such as lower technology costs and increased awareness by consumers and merchants of the benefits, along with the benefits of scale and scope economies that may further drive costs lower with increased payment volumes. These environmental changes and scale and scope economies are likely to affect the price level along with the price structure. During the ten-year period that we study, there were likely improvements to technology that may have reduced payment-processing costs and increased awareness of card benefits that may have also increased perceived consumer benefits of card adoption and use.

Unfortunately, empirical research on the impact of changes in interchange fees on use is limited. Hayes (2007) uses structural break analysis to study the impact of interchange fee regulation in Australia. An important difference between Australia and Spain is that in Australia, the authorities regulated interchange fees to reduce the incentive to use credit cards instead of debit cards. Hayes uses aggregate-level monthly data and looks at the changes in interchange fees on the share of credit card purchases of all payment purchases. Given the maturity of the Australian market, he finds no evidence of structural breaks resulting from an almost 50% mandated decrease in interchange fees. While the change in interchange fees may not have affected the long-run trend of credit card use, the distribution of economic surplus among agents may have shifted.

Chang, Evans, and Swartz (2005) explore the impact of interchange fee reduction in Australia. They use quarterly data from Visa Australia to calculate loss in interchange income per card. Most of their analysis is based on descriptive comparative statistics based on annual aggregate data, and their main econometric analysis focuses on how the decreasing trend in interchange fees accelerated as a consequence of anticipation to the regulatory changes. Their

[4] Rochet and Tirole (2011) call this the tourist test.

[5] For a review of this literature, see Bolt and Chakravorti (2008), Evans (2011), and Evans and Mateus (2011).

descriptive analysis shows that while merchants benefited from interchange fee reductions, merchants did not pass on these benefits to consumers.

Rysman (2007) studies the interaction of consumer use and merchant acceptance in the context where consumers hold more than one credit card. He finds a correlation between consumer use and merchant acceptance at the network level, which suggests a positive feedback loop between consumer use and merchant acceptance consistent with our results.

There are some empirical investigations of other two-sided markets (Argentesi & Filistucchi, 2007; Dubois, Hernandez-Perez, & Ivaldi, 2007; Kaiser & Wright, 2006; Rysman, 2004). Our approach is similar to Rysman (2004), who uses a simultaneous equation estimation technique to study the trade-offs between consumers and advertisers in the market for Yellow Pages. He estimates the consumer demand for Yellow Page use as a function of advertising and the inverse demand for advertising as a function of consumer use. He is able to identify a positive network effect.

III. The industry and the Data

Spain provides a unique natural experiment to study the effects of reductions in interchange fees on consumer and merchant payment card adoption and use. Very few other countries have experienced such a rapid reduction of interchange fees over a short time frame resulting in significant changes in acceptance, adoption, and use. In 2000, Spanish residents relied more on cash to make purchases than their neighboring countries did. Carbó Valverde, Humphrey, and López del Paso (2003) report that Spain had a currency-to-GDP ratio of 8.9% compared to 6.2% for Germany, 4.7% for Portugal, and 3.2% for France.

One strategy to increase merchant acceptance of payment cards is to reduce interchange fees. However, whether greater merchant acceptance increases card adoption by consumers or payment card transactions generally is an empirical question that we address in this paper. Four important events have significantly affected the setting of interchange fees in the Spanish payment card industry since the late 1990s.[6] From an empirical perspective, estimating the impact that such events could have had on the level of interchange fees is difficult because it is not possible to identify a precise date for each intervention; most of them took place over a long time period and did not have an immediate and clearly identifiable effect on fees. In addition, the interventions had short-term and long-term effects that interact with other macroeconomic and microeconomic factors. In our empirical analysis, we control for the effects of such events, although we acknowledge that it is difficult to disentangle the effect of mandatory reductions in fees from industry trends. Therefore, we focus on the effects of the reductions themselves regardless of their origin.

A. The Data

We use proprietary quarterly payment card data from 45 Spanish banks from 1997:1 to 2007:4. These data are adjusted to reflect mergers during our sample 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.[7] The database contains quarterly bank-level (acquirer and issuer) information on payment cards, ATMs, and POS terminals, as well as fees for debit (interchange and merchant fees) and credit card transactions (interchange fees, merchant fees, and annual credit card fees). Our data also include merchant acceptance and transaction volume by acquirer and number of cardholders and transaction volume by issuer. Our data allow us to test, for the first time, some of the fundamental predictions of the two-sided market theoretical payment card models regarding the impact of interchange fee reductions on payment card adoption and use.

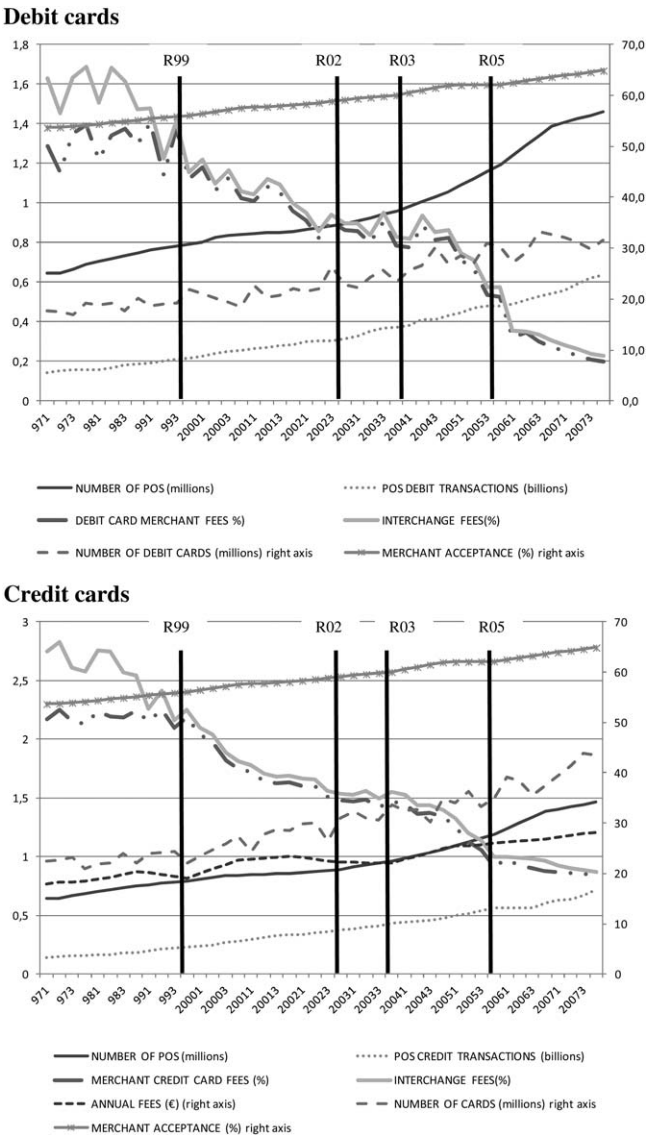
B. Adoption and Use: Main Figures

From 1997 to 2007, debit card transactions increased from 156 million to 863 million and credit card transactions increased from 138 million to 1.037 billion according to the Bank of Spain data (2007). Figure 1 depicts the evolution of some of the main variables from 1997 to 2007 from our proprietary data set. Interchange and merchant fees are highly correlated (simple correlation is .94). Besides, the evolution of these fees seems to be asymmetrically related to the evolution of annual fees. Although credit card annual fees increase over time, merchant acceptance (percentage of merchants accepting cards) grows over the whole period. Overall, the number of POS and cards and related transaction volumes also increase significantly. From 1997 to 2007, the number of debit cards increased by 40.9% while the number of credit cards increased by 207.1%. Furthermore, the average number of POS transactions per card per year increased from 7.1 to 27.8 during the same period.

[6] The first regulatory decision on interchange fees took place 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% in July 2002 from maximum interchange fees of 3.5%. From July 2002 to January 2003, the maximum interchange fee in Spain was reduced from 2.75% to 1.85%. In May 2003, the Spanish Congress requested the TDC investigate the setting of interchange fees and follow the basic principles that the European Commission adopted for EU-wide cross-border interchange fees. The TDC refused several proposals from the networks regarding their setting of interchange fees. The maximum interchange fee was progressively reduced from 1.85% in January 2003 to 1.75% in December 2005. The most important regulatory action for the Spanish payment card industry took place in December 2005, when the Spanish government promoted an agreement between payment networks and merchant associations to establish a timetable to progressively reduce interchange fees from 2005 to 2009, with different schedules for debit and credit cards. Average debit card interchange fee declined from 0.39 to 0.31 euros per transaction from 2005 to 2009, while the average credit card interchange fee fell from 1.23% to 0.67%.

[7] Banks in our sample represented 56.7% of total card payment transactions in 1997 and 64.8% in 2007 when compared to the Bank of Spain (2007) aggregate data.

FIGURE 1.—ADOPTION, TRANSACTION VOLUMES, FEES, AND REGULATORY EVENTS



Rxx: regulatory event and year (xx).

Consumer preferences for debit and credit cards differ. Adoption for debit cards by consumers reached a saturation point earlier than credit cards because they were adopted for their ATM functionality more than a decade before. In particular, as also shown in figure 1, the number of debit cards reached its peak in 2006 (33.1 million) and decreased to 31.5 million in 2007. It is important to note that the number of cards increased monotonically during the period, reaching 43 million in 2007, according to the Bank of Spain. Spanish consumers increased their holdings of credit cards even though card annual fees increased. According to our sample data, average credit card annual fees increased from 18.53 euros in December 1997 to 28.16 euros in December 2007. We also observe that interchange fees decreased on average from 3.42% in 1997 to 0.90% in 2007.

C. *Definition of the Variables*

Table 1 provides the main definitions of the posited explanatory variables and their scope (bank level, network level, and dummy variables). Banks in our sample belong to two of the three Spanish networks, Euro6000 and Servired.[8] The distinction between bank-level and network-level variables is important for our empirical purposes. For example, a consumer's decision to adopt an issuer's payment card is dependent on the total number of merchants that accept the payment cards. Similarly, a merchant's acceptance of debit cards is dependent on the total number of cardholders who have debit cards. From the data, we observe that most of the issuers and acquirers operate in different regions. We capture the regional effects in various ways. Merchant acceptance by acquirer has been computed as a branch-weighted average of merchant acceptance in the different regions where the acquirer operates. Similarly, the variable for merchant acceptance at the market 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.

In addition, although the maximum and minimum thresholds of interchange fees for different merchant activities are set at the network level, the average acquirer-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 an acquirer is computed as a transaction weighted average of merchant discount fees charged by the bank in the different merchant sectors using the acquirer's POS machines.

Our data also permit us to consider some nonmonetary costs that may affect decisions regarding adoption and use by consumers and merchants. In particular, there are nonmonetary costs that affect the adoption of a card such as the "shoe leather" costs involved in the distance to reach a cardholder's bank branches to withdraw cash, the main alternative to payment cards. We use population density as a proxy for the availability of payments infrastructure.

When a consumer chooses to use a payment card, the density of ATMs from other issuers affects her decision to use a debit card. To capture the opportunity cost of using a debit card, we compute a rival ATM density variable as a proxy of the relative costs of withdrawing cash at rivals' ATMs.

We also consider other variables, such as region-specific control variables that may influence card transactions. For example, our crime data are region specific and measure robberies and assaults per 1,000 residents in a given region. If the acquirer or issuer operates in more than one region,

[8] Cardholders belong to only one payment network. However, some merchants belong to more than one of these three networks.

TABLE 1.—VARIABLE DEFINITIONS

Variable	Definition	Scope
$MACCD_{it}$: Debit card merchant acceptance by acquirer	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	Bank level
$MACCC_{it}$: Credit card merchant acceptance by acquirer	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	Bank level
$MACCDN_t$: Debit card merchant acceptance in the network	Percentage of merchants accepting debit cards where the network operates	Network level
$MACCCN_t$: Credit card merchant acceptance in the network	Percentage of merchants accepting credit cards where the network operates	Network level
$MFEED_{it}$: Merchant debit card discount fee	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	Bank level
$MFEEC_{it}$: Merchant credit card discount fee	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	Bank level
$DIFEED_{it}$: Merchant debit card interchange fee	Average (transaction-weighted) debit card interchange fee paid by the bank computed as the (transaction-weighted) average interchange fee paid by the bank	Bank level
$CIFEEC_{it}$: Merchant credit card interchange fee	Average (transaction-weighted) interchange fee paid by the bank computed as the (transaction-weighted) average interchange fee paid by the bank	Bank level
$DCARDS_{it}$: Number of debit cards by issuer	Total number of debit cards issued by a bank	Bank level
$CCARDS_{it}$: Number of credit cards by issuer	Total number of credit cards issued by a bank	Bank level
$DCARDSN_t$: Number of debit cards in the network	Total number of debit cards issued by the network	Network level
$CCARDSN_t$: Number of credit cards in the network	Total number of credit cards issued by the network	Network level
$DEBPOSTR_{it}$: Debit card transactions at the POS	Debit card transactions per POS terminal by an acquirer	Bank level
$CREDPOSTR_{it}$: Credit card transactions at the POS	Credit card transactions per POS terminal by an acquirer	Bank level
$DEBISS_{it}$: Debit card transactions (issuer perspective)	Debit card transactions per card by issuer	Bank level
$CREDISS_{it}$: Credit card transactions (issuer perspective)	Credit card transactions (month end/no interest) per card by issuer	Bank level
$POPDS_{it}$: Population density	Number of inhabitants per km^2 in the regions where the bank operates	Bank level
$RATMD_{it}$: Rival ATM density	Number of an issuer's rival bank ATMs per km^2 in the regions where the bank operates	Bank level
$AFEECRED_{it}$: Annual credit card fee	Average (asset-weighted) annual credit card fee changed by the bank	Bank level
$BSIZE_{it}$: Bank size	Log (bank assets)	Bank level
$CRIME_{it}$: Crime rate	The (asset-weighted) ratio of robbery and assaults per 1,000 inhabitants in the regions where the acquirer or issuer operates	Bank level
GDP_t: GDP growth	Computed as (branch-weighted) average quarterly real GDP growth in the regions where the bank operates	Bank level
$BANKDACR_{it}$: Bank (debit card) acquiring revenues	Acquirer income from debit card merchant discount fees	Bank level
$BANKDISR_{it}$: Bank (debit card) issuing revenues	Issuer income from debit card interchange fees	Bank level
$BANKCACR_{it}$: Bank (credit card) acquiring revenues	Acquirer income from credit card merchant discount fees	Bank level
$BANKCISR_{it}$: Bank (credit card) issuing revenues	Issuer income from credit card interchange fees and credit card annual fees	Bank level

All monetary magnitudes are expressed in real terms. All variables (except for regulatory dummies) are in logarithms.
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).

we use a weighted average by the number of bank branches in the region.

The summary statistics for the variables that we use for our empirical model are shown in table 2. Over the sample period, the average percentage of merchants accepting debit cards of merchant banks in the regions where these banks have branches is 55.36% compared to 57.23% in the case of credit cards. At a network level (including all banks integrating the networks), the average acceptance is a bit higher: 58.02% for debit cards and 59.37% for credit cards. As for prices, in line with the trends shown in figure 1, average merchant discount fees are found to be larger for credit cards (2.03%) than for debit cards (1.36%). Similarly, average credit card interchange fees (1.96%) are larger than debit card interchange fees (1.24%).

Along with the trends in prices and transactions shown in figure 1, table 2 shows some interesting features related to the market size and infrastructure. In particular, each bank has 480,000 debit cards and 550,000 credit cards issued on average over the sample period. The average number of POS transactions is 11.14 million for debit cards and 12.28 million for credit cards. In addition, rivals' ATM density is 0.9 ATMs per square kilometer for a population density of 83.3 inhabitants per square kilometer.

TABLE 2.—SUMMARY STATISTICS

	Mean	SD	Minimum	Maximum
Debit card merchant acceptance by acquirer in regions where it has branches ($MACCD_{it}$) (percent)	55.36	2.16	51.15	59.36
Credit card merchant acceptance by acquirer in regions where it has branches ($MACCC_{it}$) (percent)	57.23	1.97	52.12	61.06
Debit card merchant acceptance in the network ($MACCDN_t$) (percent)	58.02	2.02	53.60	61.94
Credit card merchant acceptance in the network ($MACCCN_t$) (percent)	59.37	1.92	53.51	62.49
Merchant debit card discount fee by acquirer ($MFEED_{it}$) (percent)	1.36	1.18	0.36	3.18
Merchant credit card discount fee by acquirer ($MFEEC_{it}$) (percent)	2.03	1.93	1.06	3.56
Merchant debit card interchange fee by acquirer ($DIFEED_{it}$) (percent)	1.24	1.13	0.31	2.93
Merchant credit card interchange fee by acquirer ($CIFEEC_{it}$) (percent)	1.96	1.85	1.01	3.27
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 ($DEBISS_{it}$) (percent)	1.21	4.16	0.04	10.27
Credit card transactions by issuer ($CREDISS_{it}$) (percent)	1.60	5.21	0.02	12.56
Population density ($BRDS_{it}$) (Population/km^2)	84.3	13.5	61.1	98.7
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 ($BSIZE_{it}$) (log million euros)	8.3	2.19	5.15	12.30
Crime rate ($CRIME_{it}$)	0.37	0.21	0.10	0.68
GDP growth (GDP_{it})	0.51	0.43	0.23	1.28
Bank (debit card) acquiring revenues *(BANKDACR)* (millions of euros)	4.31	2.19	0.08	45.23
Bank (debit card) issuing revenues *(BANKDISR)* (millions of euros)	25.43	13.84	0.32	114.15
Bank (credit card) acquiring revenues *(BANKCACR)* (millions of euros)	6.17	3.12	0.11	54.89
Bank (credit card) issuing revenues *(BANKCISR)* (millions of euros)	28.06	14.16	0.23	131.12

IV. Empirical Strategy

Our empirical analysis focuses on how decreasing interchange fees affected merchant and consumer adoption of payment cards, as well as issuer and acquirer transaction volumes and revenues. We compare the impact of lowering interchange fees on two types of payment cards: debit and credit. In our empirical analysis, an issuer or an acquirer is our unit of study. In other words, we study the impact of lowering interchange fees on an acquirer's changes in merchant acceptance in the region that it operates in and its transaction volume and an issuer's changes in its number of cardholders and its transaction volume.

A. Merchant Acceptance and Consumer Adoption

Lowering interchange fees is likely to increase merchant acceptance of payment cards because some merchants previously not accepting payment cards would choose to accept payment cards at a lower fee. In addition to the level of fees, merchants also consider consumer adoption in their acceptance decisions.

Lowering interchange fees is also likely to increase cardholder annual fees.[9] The level of increase in consumer debit card fees is difficult to measure because of the bundle of services offered with a transaction account or a line of credit. Unlike debit cards, credit cards have explicit annual fees. Facing higher fees, some cardholders may abandon their payment cards. But if the increase in fees is associated with greater merchant acceptance, cardholders may value credit cards more and continue to hold them, or new consumers may adopt them even if fees increase. Alternatively, if the demand for payment cards is sufficiently inelastic, consumers may continue to hold their payment cards Our empirical analysis is unable to distinguish between these two explanations. However, the addition of new cardholders as evidenced by greater card adoption would be due to additional benefits associated with the cards such as increased merchant acceptance.

We estimate equations (1) and (2) that identify merchant acceptance and consumer adoption decisions:

$$\text{Merchant acceptance} = f(X_{ma}, C), \tag{1}$$

$$\text{Consumer adoption} = f(X_{ca}, C), \tag{2}$$

where X_{ma} and X_{ca} are exclusion restrictions that identify merchant acceptance and consumer adoption decisions, respectively, and C is the vector of control variables common to both equations. All control variables are expressed as the difference between the logarithms of current quarter and the quarter before.[10] These differences can be interpreted as quarterly growth rates.

[9] Furthermore, consumers may face higher costs other than annual fees from their financial institutions that we are unable to capture, such as reduction in frequent-use rewards or higher interest rates on credit card debt.

[10] Our assumption is that consumer and merchant adoption decisions are not immediately observed. If we use two or four lags instead of one lag, the results are very similar but quantitatively higher (which would be predicted, as they are capturing the effects for a longer time period). The one-lagged approach is similar to other empirical models dealing with payment price structure and network effects such as Kaiser and Wright (2006) and Rysman (2007).

We study the impact of interchange fees separately for debit and credit cards. Merchants face an explicit per transaction fee, the merchant discount fee, to process a debit or credit card transaction that is strongly correlated with the interchange fee. Merchant debit and credit card acceptance exclusion restrictions include the merchant discount fee and the number of cards in the network by type of payment card. Consumer debit card exclusion restrictions are population density and lagged merchant acceptance. For credit cards, the consumer exclusion restrictions are credit card annual fees and one-period lagged merchant acceptance.

There are some key differences in how issuers charge customers for debit and credit cards. Cardholders do not generally pay a fixed or per transaction fee for their debit cards. The pricing for debit card services is often bundled with other banking services such as access to ATMs. Thus, to isolate a fee for debit card services separately is not possible. Instead, we use an instrument to proxy for debit card benefits. The instrument that we use is population density. When population density is high, consumers are more likely to have a debit card because the availability of merchant acceptance terminals and ATMs is higher. Higher population density would most likely positively affect the adoption of ATM and debit cards.

In addition, there is the indirect network effect: as merchant acceptance increases, the value of having a debit card increases. If the direct marginal cost of holding a debit card is close to zero, we would expect an increase in debit card issuance as the proportion of merchants that accept debit cards increases. Eventually debit cards may reach a saturation point (i.e., when most residents already have adopted ATM/debit cards). Merchant acceptance enters the cardholder adoption decision as a lagged explanatory factor. The logic behind this specification is that merchant acceptance and fees may be contemporaneously related, while transactions, issuance, and use may be determined by observed previous acceptance.

Unlike debit cards, credit cards are stand-alone products that usually have explicit fees. Reductions in credit card interchange fee revenue should result in higher annual fees for cardholders to offset lost issuer interchange revenue as predicted by the two-sided market literature. As mentioned before, credit card annual fees indeed increased in Spain during our sample period.

Our control variables for all regressions are acquirer and issuer size, the crime rate, and a time trend. Given that payment processing is a scale business, we take bank size (the log of bank's total assets) to control for any increase in bank size during the sample period. We use crime statistics to capture the effect of crime on the decisions of merchants and consumers to accept payment cards.[11] We would expect that as crime increases, the adoption of payment cards will increase because payment cards are more secure than cash in the event they are stolen or lost. In order to control the (mainly upward) trend in the data for merchant acceptance, number of cards, and number of transactions, we use a GDP growth.

[11] Some theoretical money models suggest that crime may motivate the substitution of cash by more secure payment alternatives (He, Huang, & Wright, 2005).

B. *Acquirer and Issuer Transaction Volume*

Unfortunately, our data do not allow us to study transaction per card or per merchant. Instead, we have transaction volume data by acquirer and issuer. However, changes in acquirer and issuer transaction volume are ideal instruments to study the impact of changes in payment card use resulting from changes in the interchange fee. Our dependent variables for use are average quarterly transactions per POS terminal by acquirers and average quarterly transactions by card by issuers separated into debit and credit card transactions.

Unlike adoption and acceptance decisions, we estimate acquirer and issuer transaction volumes separately. Given that our units of study are acquirers and issuers, estimating the volumes separately is appropriate for transaction volumes. In other words, the number of issuers does not affect the acquirers' volumes and vice versa. Our regressions for debit and credit card issuer and transaction volumes are:

$$\text{Acquirer transaction volume} = f(X_{atv}, C), \tag{3}$$

$$\text{Issuer transaction volume} = f(X_{itv}, C), \tag{4}$$

where X_{atv} and X_{itv} are the exclusion restrictions that identify the acquirer transaction volume and the issuer transaction volume equations, respectively, and vector C is the same as in equations (1) and (2).

For acquirer transaction volume, we use an acquirer's quarterly transactions per POS terminal as our dependent variable. The exclusion restriction that identifies the acquirer transaction volume is an interaction term of its merchant acceptance and the total number of debit or credit cards in that network. The probability of a transaction on an acquirer's terminal increases when the number of merchants served by the acquirer increases or the number of total debit or credit cards increases.

Next, we analyze what factors affect issuer transaction volume. 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, except for own rival ATM density for debit cards instead of population density. The use of density of rival ATMs in the transaction volume equation seems to be particularly useful as a proxy for the benefit of using debit cards as it captures the use costs. Given that ATM owners impose surcharges for cards issued by competitor banks' ATMs, as the likelihood of using one of these ATMs increases, the benefit to having a debit card increases.

C. Identifying Issuer and Acquirer Revenues

Although we are unable to measure acquirer and issuer profits directly, we are able to study the impact of changes in interchange fees on bank revenue. As we discussed in section IIIA, average total issuer and acquirer revenues increased during our sample period despite reductions in interchange fees. The loss in per transaction revenue may be made up by a greater number of transactions. If costs remain constant or grow more slowly than revenues, acquirer or issuer profit may increase with increasing revenue. Given large economies of scale and scope, one might expect that costs would not grow as fast as revenues.

As before, 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, along with total annual fees collected (only for credit cards). For debit cards, we use only interchange fee revenue. 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 our transaction volume regressions, our explanatory variable for acquirers is a one-quarter lag of the interaction of merchant acceptance of a specific acquirer and the total number of cards in the network. Our exclusion restriction for issuers is the number of cards issued by each issuer the quarter before times the proportion of merchants accepting in the whole network. Our exclusion restriction for acquirers is the proportion of merchant acceptance of debit and credit cards, respectively, times the number of debit and credit cards, respectively, in the network.

D. GMM Approach and Endogeneity Issues

The identification of equations (1) and (2) and of issuer and acquirer revenues has potential cross-equation restrictions, as well as endogeneity concerns that need specific treatment.

As for cross-equation restrictions, the error terms for consumer adoption and merchant acceptance are assumed to be correlated across the equations. This correlation implies that even if a separate equation-by-equation estimation would be consistent, it would not be as efficient as the simultaneous equation method. Since our model specification allows acceptance and adoption variables to interact with variables related to the number of transactions, this may create nonlinear cross-equation restrictions on the specified parameters. In order to deal with these restrictions, the simultaneous equations are estimated using a general method of moments (GMM) routine with acquirer and issuer specific fixed effects (Hansen, 1982; Wooldridge, 2002).

As for the endogeneity concerns, although it is not possible to eliminate all sources of potential endogeneity completely, we introduce several instruments to try to reduce these potential effects. The main endogeneity concern refers to the (classical) problem of relating prices to quantities in the demand equations. In particular, the level of interchange fees may be a result of the optimal choice by payment networks, possibly to changes in demand conditions on the two sides of the market. For example cardholders' willingness to pay might increase, and this would enable the platform to charge higher cardholders' fees and lower merchant fees, thereby lowering interchange fees. If this is the case, merchants' fees are potentially endogenous in equation (1).

In order to solve this problem, we instrument the fees and correct a major portion of that potential endogeneity bias. A first assumption is that the costs associated with bank-specific efficiency levels partially drive prices charged to merchants and cardholders, but they are not correlated with the error terms of the demand equations. Therefore, we can use the cost/income ratio (operating costs/net income) as instrument for cardholder fees. Similarly, we consider the regional market share of deposits of the acquirer bank as instrument for merchant fees. The idea is that a bank may build an ongoing relationship with a merchant due, for example, to long-standing relationships or cross-selling of products. These contractual relationships may affect fees charged to these merchants, but they are uncorrelated with the demand equations. Following the same logic, we also specify some instruments for the variables at the network level. The natural logarithm of the growth in loans and deposits managed by that network is included as an instrument for the network level present.[12]

We use both current and lagged values of all the instruments. The appropriateness of the instruments is also checked by using a standard test for the orthogonality of the instruments with the residuals. The null hypothesis of the orthogonality of the instruments cannot be rejected at the 5% level in all cases. The standard test of overidentifying restrictions is also reported in the tables.

We cluster standard errors at the bank level, as Petersen (2009) suggested. We also introduce bank fixed effects and time dummies. In addition, we use dummies to control for the regulatory events that took place over the sample period even if, as discussed above, it is not possible to clearly identify such potential effect. Importantly, our results do not change significantly in the signs of the coefficients or their magnitude when these regulation dummies are present.

V. Main Results

The main results of our analysis are shown in tables 3 to 7. We also discuss some robustness tests on the results in the appendix.

[12] Our instrumental variable approach is similar to the one of Berry, Levinsohn, and Pakes (1995), Kaiser and Wright (2006), and Rysman (2007).

TABLE 3.—CONSUMERS AND MERCHANTS ADOPTION: DEBIT CARDS
SIMULTANEOUS EQUATION ESTIMATION (GMM WITH FIXED EFFECTS)

	Merchant Adoption of Debit Cards		Consumer Adoption of Debit Cards
	Merchant Acceptance by Acquirer ($MACCD_{it}$)		Number of Debit Cards by Issuer ($DCARDS_{it}$)
Constant	0.21E−11		0.17E−12
	(0.001)		(0.001)
Merchant acceptance in the network ($MACCDN_{t-1}$)	—		0.4418***
			(0.052)
Debit card interchange fee ($DIFEED_{it}$)	−0.0436***		—
	(0.022)		
Number of debit cards in the network ($DCARDSN_t$)	0.0021***		—
	(0.003)		
Population density ($POPDS_{it}$)	—		0.0139***
			(0.007)
Bank size ($BSIZE_{it}$)	0.0087		0.0065***
	(0.011)		(0.012)
Crime rate ($CRIME_{it}$)	−0.0216		−0.0120
	(0.194)		(0.162)
GDP growth (GDP_{it})	0.0249**		0.0253***
	(0.007)		(0.005)
Adjusted R^2	0.89		0.78
Number of observations	1,354		1,354
Bank fixed effects	Yes		Yes
Regulation dummies	Yes		Yes
Time dummies	Yes		Yes
Sargan test of overidentifying restrictions		76.88	
(p-value in parentheses)		(0.005)	
AR(1) (p-value in parentheses)		−0.1263	
		(0.831)	
AR(2) (p-value in parentheses)		−1.270	
		(0.379)	

Clustered standard errors by bank in parentheses. Statistically significant at **5%, ***1%.

TABLE 4.—CONSUMERS AND MERCHANTS ADOPTION: CREDIT CARDS
SIMULTANEOUS EQUATION ESTIMATION (GMM WITH FIXED EFFECTS)

	Merchant Adoption of Credit Cards		Consumer Adoption of Credit Cards
	Merchant Acceptance by Acquirer ($MACCC_{it}$)		Number of Credit Cards by Issuer ($CCARDS_{it}$)
Constant	−0.22E−06		0.24E−06
	(0.001)		(0.001)
Merchant acceptance in the network ($MACCCN_{t-1}$)	—		0.2805***
			(0.063)
Credit card interchange fee ($CIFEED_{it}$)	−0.1395***		
	(0.061)		
Number of credit cards in the network ($CCARDSN_t$)	0.1684***		—
	(0.042)		
Annual credit card fee ($AFEECRED_{it}$)	—		−0.6016
			(0.376)
Bank size ($BSIZE_{it}$)	0.0048**		−0.0018
	(0.004)		(0.003)
Crime rate ($CRIME_{it}$)	0.0622**		0.0712***
	(0.059)		(0.055)
GDP growth (GDP_{it})	0.0291***		0.0149***
	(0.002)		(0.003)
Adjusted R^2	0.89		0.92
Number of observations	1,354		1,354
Bank fixed effects	Yes		Yes
Regulation dummies	Yes		Yes
Time dummies	Yes		Yes
Sargan test of overidentifying restrictions		151.26	
(p-value in parentheses)		(0.001)	
AR(1) (p-value in parentheses)		−1.230	
		(0.306)	
AR(2) (p-value in parentheses)		−1.697	
		(0.115)	

Clustered standard errors by bank in parentheses. Statistically significant at **5%, ***1%.

TABLE 5.—DEBIT CARD TRANSACTION VOLUME FOR CONSUMERS AND MERCHANTS

	Acquirer Transaction Volume: Debit Cards	Issuer Transaction Volume: Debit Cards
	Debit Card Transactions per POS Terminal ($DEBPOSTR_{it}$)	Debit Card Transactions per Card (Issuer Perspective) ($DEBISS_{it}$)
Constant	0.05E−13	−0.07E−10
	(0.001)	(0.001)
Merchant acceptance by acquirer ($MACCD_{it-1}$) × Number of debit cards in the network ($DCARDSN_t$)	0.0273***	—
	(0.010)	
Merchant acceptance in the network ($MACCDN_{t-1}$) × Number of debit cards by issuer ($DCARDS_{it}$)	—	0.0494***
		(0.016)
Rival ATM density ($RATMD_{it}$)	0.0255**	0.0601**
	(0,014)	(0.023)
Bank size ($BSIZE_{it}$)	0.0321**	0.0243**
	(0.016)	(0.014)
Crime rate ($CRIME_{it}$)	0.1349	0.1190
	(0.144)	(0.113)
GDP growth (GDP_{it})	0.0263***	0.0239***
	(0.004)	(0.006)
Adjusted R^2	0.94	0.85
Number of observations	1,354	1,354
Bank fixed effects	Yes	Yes
Regulation dummies	Yes	Yes
Time dummies	Yes	Yes
Sargan test of overidentifying restrictions	140.43	163.26
(p-value in parentheses)	(0.001)	(0.001)
AR(1) (p-value in parentheses)	−1.628	−1.508
	(0.147)	(0.164)
AR(2) (p-value in parentheses)	−1.446	−1.432
	(0.161)	(0.193)

Each equation estimated by 3SLS with fixed effects. Clustered standard errors by bank are in parentheses. Statistically significant at **5%, ***1%.

TABLE 6.—CREDIT CARD TRANSACTION VOLUME FOR CONSUMERS AND MERCHANTS

	Acquirer Transaction Volume: Credit Cards	Issuer Transaction Volume: Credit Cards
	Credit Card Transactions per POS Terminal ($CREDPOSTR_{it}$)	Credit Card Transactions per Card: Issuer Perspective ($CREDISS_{it}$)
Constant	0.13E−07	−0.14E−06
	(0.001)	(0.001)
Merchant acceptance by acquirer ($MACCC_{it-1}$) × Number of credit cards in the network ($CCARDSTN_t$)	0.2063***	—
	(0.066)	
Merchant acceptance in the network ($MACCCN_{t-1}$) × Number of credit cards by issuer ($CCARDS_{it}$)	—	0.1699***
		(0.064)
Bank size ($BSIZE_{it}$)	−0.0746	0.0642**
	(0.188)	(0.021)
Crime rate ($CRIME_{it}$)	0.0916**	0.0508**
	(0.039)	(0.030)
GDP growth (GDP_{it})	0.0315***	0.0277***
	(0.014)	(0.013)
Adjusted R^2	0.84	0.89
Number of observations	1,354	1,354
Bank fixed effects	Yes	Yes
Regulation dummies	Yes	Yes
Time dummies	Yes	Yes
Sargan test of overidentifying restrictions	187.3	107.19
(p-value in parentheses)	(0.01)	(0.01)
AR(1) (p-value in parentheses)	−0.6418	−0.8412
	(0.461)	(0.329)
AR(2) (p-value in parentheses)	−1.153	−0.931
	(0.184)	(0.152)

Each equation is estimated by 3SLS with fixed effects. Clustered standard errors by the bank are in parentheses. Statistically significant at **5%, ***1%.

A. *Debit and Credit Card Adoption*

Table 3 shows the results corresponding to consumers and merchant adoption of debit cards. We find that a 10% reduction in the rate of decline per quarter in the average interchange fee by an acquirer resulted in a .44% rate of increase in merchant acceptance per quarter. Importantly, we observe that by instrumenting the merchant discount fee with the set of instruments described in the previous section, we correct the (typically downward) bias in the fee coefficient since the coefficient estimate when the merchant discount variable is not instrumented is −0.031.

TABLE 7.—IMPACT ON BANK ISSUING AND ACQUIRING REVENUES

	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	0.10E−07**	0.09E−10**	0.08E−08**	0.08E−09
	(0.001)	(0.001)	(0.001)	(0.001)
Merchant acceptance by acquirer $(MACCD_{it-1})$ × Number of debit cards in the network $(DCARDSN_t)$	0.0460**	—	—	—
	(0.012)			
Number of debit cards by issuer $(DCARDS_{it})$ × Merchant acceptance in the network $(MACCDN_{t-1})$	—	0.1405***	—	—
		(0.016)		
Merchant acceptance by acquirer $(MACCC_{it-1})$ × Number of credit cards in the network $(CCARDSN_t)$	—	—	0.0683***	—
			(0.007)	
Number of credit cards by issuer $(CCARDS_{it})$ × Merchant acceptance in the network $(MACCDN_{t-1})$	—	—	—	0.1706**
				(0.013)
Rival ATM density $(RATMD_{it})$	0.0029	0.0053	—	—
	(0.006)	(0.031)		
Bank size $(BSIZE_{it})$	0.0646**	0.1207**	0.1806**	0.0753**
	(0.047)	(0.059)	(0.014)	(0.016)
Crime rate $(CRIME_{it})$	0.0319	0.0222	0.0197	0.0312
	(0.073)	(0.064)	(0.035)	(0.025)
GDP growth (GDP_{it})	0.0223**	0.0209**	0.0193**	0.0214**
	(0.006)	(0.004)	(0.005)	(0.004)
Adjusted R^2	0.67	0.89	0.71	0.94
Number of observations	1,354	1,354	1,354	1,354
Bank fixed effects	Yes	Yes	Yes	Yes
Regulation dummies	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes
Sargan test of overidentifying restrictions	218.12	231.15	165.23	191.01
(*p*-value in parentheses)	(0.001)	(0.001)	(0.001)	(0.001)
AR(1) (*p*-value in parentheses)	−0.6102	−0.8102	−0.8004	−0.7025
	(0.544)	(0.419)	(0.331)	(0.535)
AR(2) (*p*-value in parentheses)	−0.7035	−0.7530	−0.8243	−0.8413
	(0.503)	(0.426)	(0.326)	(0.323)

Each equation is estimated by 3SLS with fixed effects. Clustered standard errors by the bank are in parentheses. Statistically significant at **5%, ***1%.

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% increase in the rate of merchant adoption per quarter resulted in a 4.4% increase in the quarterly adoption rate of debit cards by consumers. As population density increases, consumer adoption of debit cards increases. Specifically, a 10% increase in population density resulted in a .139% increase in the quarterly growth rate of debit card adoption.

As mentioned before, the underlying dynamics of credit card adoption are significantly different from debit card adoption because credit cards are stand-alone products. Reductions in credit card interchange fees increased merchant acceptance of credit cards (see table 4). Specifically, a 10% percent increase in the rate of decline of the average interchange fee increased the growth rate of merchant acceptance of credit cards by 1.4%. As for the number of credit cards in the network, a 10% quarterly growth rate in this variable resulted in a 1.7% quarterly growth in the acceptance of credit cards by merchants.

As our priors suggested, the number of cards issued is positively affected by the number of merchants that accept credit cards (table 4, column 3). Specifically, a 10% increase in the quarterly growth rate in merchant acceptance increases the quarterly growth of credit card issuance by 2.8%.

A key result is that growth in the number of cards issued is not affected by increases in the annual fee. We are unable to disentangle two potential reasons for this insignificance. First, existing consumers may be fairly inelastic to increases to credit card annual fees and not give up their credit cards. Second, they are willing to pay higher fees if more merchants accept credit cards. Regardless of why consumers do not respond to increases in annual fees, there may be benefits to more credit card–accepting merchants, resulting in greater consumer adoption. These benefits stem from the network externality of merchant acceptance. In any case, that consumers who previously did not have credit cards have adopted them suggests that the benefits of having a credit card has increased despite the increase in the annual fee.

The fact that consumers do not react to prices may appear a bit surprising. Following the hypothesis that consumers may be willing to pay higher prices as merchant acceptance increases, we run separate yearly OLS regressions of this equation from 1997 to 2007. We find that the yearly estimated coefficient of prices decreased over time, suggesting that price sensitivity (in absolute terms) decreases as merchant acceptance increases. The coefficient of credit card annual fees changed from 1997 to 2007 as follows: −0.83,

−0.82, −0.73, −0.72, −0.64, −0.59, −0.58, −0.55, −0.53, −0.54, −0.51. None of the coefficients were statistically significant.[13]

The impact of lower interchange fees on merchant acceptance is positive for both debit and credit cards. Merchants increase acceptance when their fees fall. The impact of lower interchange fees on debit card consumer adoption is less clear for two reasons. First, debit cards also serve as ATM cards, and isolating their debit functionality is difficult. Second, debit card services are bundled with other transaction services because identification of direct debit card fees is difficult.

B. Debit and Credit Card Transaction Volumes

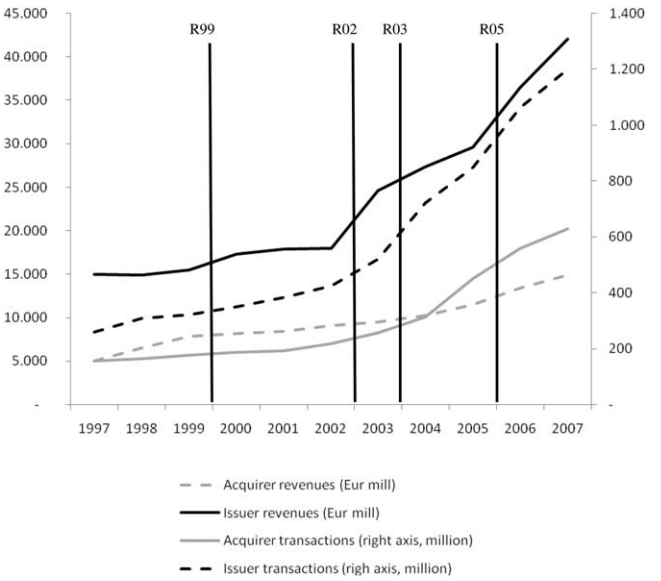
We now turn to payment card transaction volume. First, we consider the impact of interchange fee regulation on merchant debit card transactional volume from looking at acquirer transactional volume per POS terminal as the dependent variable (table 5, column 2). The interaction of merchant acceptance at an acquirer and the total number of cards—showing network effects—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. Specifically, a 10% quarterly growth rate in this interaction resulted in a debit card transaction quarterly growth rate of .27%. In addition, a 10% increase in the quarterly growth rate of rival ATM density, which proxies for the cost of cash withdrawal, resulted in a .26% increase in the quarterly growth rate of debit card transactions at POS terminals.

The increase in issuer transactions proxies for the increase in consumer use. The key explanatory variable is the interaction of merchant acceptance and cards issued by the issuer. The interaction term is significant and positive, suggesting that increases in consumer and merchant adoption growth rates lead to a higher rate of growth for consumer transactions (table 5, column 3). Specifically, a 10% increase in the quarterly rate of growth of the interaction of network merchant acceptance and debit cards issued by an issuer resulted in a .49% quarterly growth rate in an issuer's debit card transactions per card. Furthermore, a 10% increase in the quarterly growth of rival ATM density resulted in a .60% increase in the quarterly growth rate of issuer debit card transactions per card. In other words, an increase in cash acquisition costs strongly encourages use of debit cards.

We report credit card acquirer and issuer transaction volume regressions in table 6. A 10% increase in the quarterly growth of the interaction term of acceptance by merchants using the same acquirer and total credit cards in circulation results in a 2.06% increase in the growth of acquirer transactions at the point of sale (table 6, column 2). 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.

We report the issuer transaction volume in table 6, column 3. We find that a 10% increase in the quarterly growth rate of the interaction term of merchant acceptance in the network and credit cards issued by an issuer results in a 1.70% increase in issuer transaction volume. The coefficient on the crime rate is also significant and positive, suggesting that higher crime rates induce shift from cash to credit cards, which are generally used for higher-value purchases.

FIGURE 2.—ACQUIRER AND ISSUER REVENUES AND TRANSACTIONS, 1997–2007



Rxx: regulatory event and year (xx).

C. Issuer and Acquirer Revenues

In table 7, we report our results for issuer and acquirer 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 quarterly growth of number of transactions is positively correlated with the quarterly growth of 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. This evidence also seems to be supported by descriptive data, as shown in figure 2, where transaction volume increased in parallel to revenues.

[13] Even considering these empirical tests, the fact that consumers do not react to prices is a puzzling one. Although it is not the main purpose of our analysis, it is an interesting avenue of future research.

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 is close to 1. On the issuing side, the quarterly rate of decrease in interchange fees is positively and significantly related to the quarterly rate of bank revenues.

VI. Conclusion

The structure of fees in two-sided markets has been addressed in the theoretical literature, but there has been little empirical analysis regarding the impact of changes to fee structures. Theory predicts that platforms in two-sided markets may subsidize the participation of one type of end user by extracting surplus from another type of end user to internalize indirect network externalities. We find evidence that reducing interchange fees may have a positive effect on consumer and merchant adoption and use when merchant adoption is far from complete.

We also find that bank revenues increased following interchange fee reductions because the increase in the number of transactions appears to offset the decrease in the per transaction revenue. However, 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.

We acknowledge that payment card networks may lower interchange fees to increase merchant acceptance. For example, in the United States, interchange fees for new entrants such as grocery stores in the 1990s were reduced significantly by payment card networks to encourage merchant acceptance of payment cards. Such market-based strategies also internalize the merchant adoption externality. 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 this case, we are agnostic about the distribution of surplus among payment card market participants.

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APPENDIX

Robustness Tests

We conduct several robustness tests to consider alternate explanations for increased adoption and use of payment cards.

Other Empirical Specifications

We have tried other specifications for the simultaneous equations estimations. In particular, we estimated the system using two-stage least

TABLE A1.—CONSUMERS' AND MERCHANTS' ADOPTION OF DEBIT AND CREDIT CARDS OVER FOUR TIME PERIODS
SIMULTANEOUS EQUATION ESTIMATION (GMM WITH FIXED EFFECTS)

	Merchant Adoption: Debit Cards	Consumer Adoption: Debit Cards		Merchant Adoption: Credit Cards	Consumer Adoption: Credit Cards
1997–1998	Merchant Acceptance by Acquirer ($MACCD_{it}$)	Number of debit cards by Issuer ($DCARDS_{it}$)		Merchant Acceptance by Acquirer ($MACCC_{it}$)	Number of credit cards by Issuer ($CCARDS_{it}$)
Merchant acceptance in the network ($MACCDN_{t-1}$)	—	0.7213*** (0.043)	Merchant acceptance in the network ($MACCCN_{t-1}$)	—	0.1953** (0.072)
Debit card interchange fee ($DIFEED_{it}$)	−0.0217** (0.018)	—	Credit card interchange fee ($CIFEED_{it}$)	−0.0633*** (0.043)	
1999–2001	Merchant Acceptance by Acquirer ($MACCD_{it}$)	Number of Debit Cards by Issuer ($DCARDS_{it}$)		Merchant Acceptance by Acquirer ($MACCC_{it}$)	Number of Credit Cards by Issuer ($CCARDS_{it}$)
Merchant acceptance in the network ($MACCDN_{t-1}$)	—	0.2736** (0.039)	Merchant acceptance in the network ($MACCCN_{t-1}$)	—	0.3107*** (0.066)
Debit card interchange fee ($DIFEED_{it}$)	−0.0614** (0.020)	—	Credit card interchange fee ($CIFEED_{it}$)	−0.1788** (0.064)	
2002–2004	Merchant Acceptance by Acquirer ($MACCD_{it}$)	Number of Debit Cards by Issuer ($DCARDS_{it}$)		Merchant Acceptance by Acquirer ($MACCC_{it}$)	Number of Credit Cards by Issuer ($CCARDS_{it}$)
Merchant acceptance in the network ($MACCDN_{t-1}$)	—	0.2007*** (0.055)	Merchant acceptance in the network ($MACCCN_{t-1}$)	—	0.2046** (0.053)
Debit card interchange fee ($DIFEED_{it}$)	−0.0179*** (0.017)	—	Credit card interchange fee ($CIFEED_{it}$)	−0.0913** (0.038)	
2005–2007	Merchant Acceptance by Acquirer ($MACCD_{it}$)	Number of Debit Cards by Issuer ($DCARDS_{it}$)		Merchant Acceptance by Acquirer ($MACCC_{it}$)	Number of Credit Cards by Issuer ($CCARDS_{it}$)
Merchant acceptance in the network ($MACCDN_{t-1}$)	—	0.5603*** (0.050)	Merchant acceptance in the network ($MACCCN_{t-1}$)	—	0.3219*** (0.068)
Debit card interchange fee ($DIFEED_{it}$)	−0.0681*** (0.024)	—	Credit card interchange fee ($CIFEED_{it}$)	−0.1892** (0.066)	

Only the main coefficients are shown for simplicity. Clustered standard errors are by bank are in parentheses. Statisfically significant at **5 %, ***1%.

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.

In addition, our results suggest that consumers and merchants benefit from reductions in interchange fees during our sample period because an increase in merchant card acceptance results in greater adoption and use of payment cards. This result is dependent on relatively low adoption of payment cards as a starting point. Rochet and Tirole (2006a) suggest a couple of reasons that merchants may choose to accept cards even if they are made worse off by doing so. They argue that merchants may accept cards as a strategic tool to steal customers from their competitors. Second, their acceptance decision is based on the average consumer benefit and not the marginal benefit. While we are unable to test whether cards are being used too much, we do find that lowering fees increases use in a market where card use is relatively low compared to other countries in the region, as noted above. In any event, we run year-by-year OLS regressions on the impact of merchant acceptance on consumer adoption and find the coefficient (.44 in table 4, column 3) remains relatively stable over the period (between .42 and .48). It would be interesting to analyze these relationships in more mature markets where adoption is close to complete and consumer choice at the point of sale determines use.

Estimations for Different Subperiods

A simpler (although less informative) approach to likely changes in merchants' and consumers' adoption and use of debit and credit cards is to estimate our main equations for four time periods: 1997–1998, 1999–2001, 2002–2004, and 2005–2007. The effects of changes in interchange fees on merchant adoption and of merchant acceptance in the network on the number of debit cards are from one to three times higher in the 1999–2001 and 2005–2007 periods than in the other two periods. These results are summarized in table A1. These differences are statistically significant according to Wald tests of differences in the estimated coefficients and

suggest that the dynamics of prices, adoption, and use particularly increased in the periods when interchange fees were reduced to a larger extent due to government interventions. In the case of credit cards, related differences in the magnitude of the coefficients for the above mentioned subperiods are a bit lower (from 1 to 1.5 times higher), although also statistically significant according to Wald tests (not shown).

Alternative Control Variables

The results also seemed robust to alternative specifications of the control variables, particularly in the time trend. A potential weakness of the proposed specification is that the trend is not appropriately capturing over time changes that may overlap with the identified impact of regulatory dummies. In particular, factors such as nonlinear trends, business cycle influences, or technological changes may affect our results. In order to control for these potential influences, we also tried other types of variables to pick them up, such as a quadratic time trend and Internet penetration. It may also be the case that the dynamics of adoption and use may be different in territories with different levels due to idiosyncratic features such as differences in the presence of tourists that may make adoption and use potentially heterogeneous across regions, thereby affecting to a larger extent banks, merchants, and consumers in more touristic regions. We have considered these influences by estimating our main equations for two subsamples separating regions over the median value of tourism revenues over GDP and below that median value. The results for all these alternative specifications (not shown but available on request) suggest that none of these alternative specifications significantly change our baseline results and conclusions since our main variables exhibit the same signs and similar coefficient magnitudes.