
Regulating Two-Sided Markets: An Empirical Investigation

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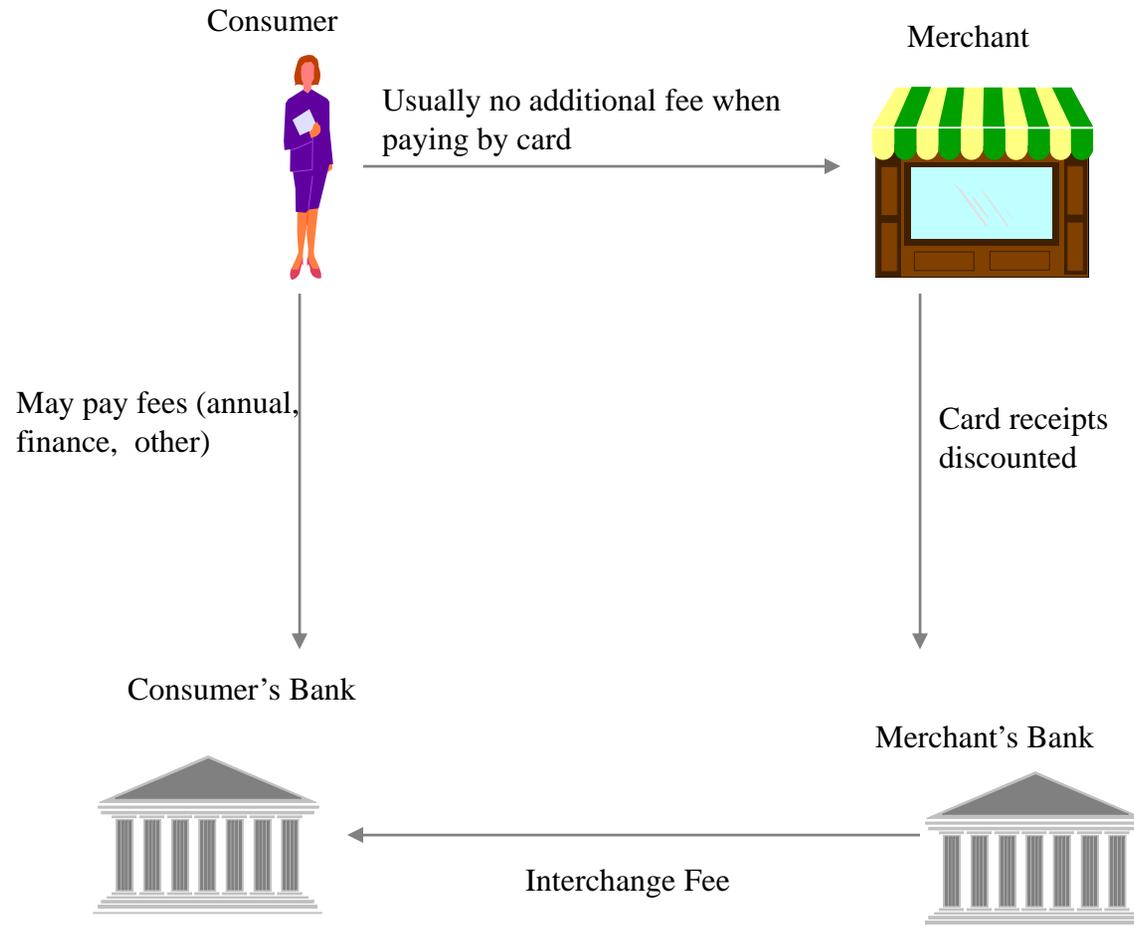
Summary

1. Introduction
2. Spanish regulatory developments
3. Our dataset
4. Empirical strategy
5. Main results
6. Robustness tests
7. Conclusion

1. Introduction

- The recent financial crisis has increased the calls for regulation of financial services, including payment services.
- One of the key issues is the regulation of interchange fees by public authorities. This type of regulation has occurred in several other countries during the past decade.
- In our study we use a unique Spanish proprietary bank-level dataset and we are able to study the impact of different interventions by the public authorities during 1997 to 2007 on merchant acceptance, consumer adoption, transaction volumes, and issuer and acquirer revenues.

Diagram 1. Payment Card Network Transfers



A consumer makes a purchase from a merchant.

Generally, the merchant charges the same price regardless of the type of payment instrument used to make the purchase.

Consumers often pay annual membership fees to their financial institutions for credit cards and may pay service charges for a bundle of services associated with transactions accounts.

Merchants pay fees known as merchant discounts. Acquirers pay interchange fees to issuers.

Two-sided markets and antitrust Scrutiny of Interchange Fees

- Payment cards are generally characterized as a two-sided market. Rochet and Tirole (2003) define a two-sided market when the price structure, or the share that each type of agent pays the platform, affects the total volume of transactions. The key aspect of these markets is the presence of indirect network externalities and how fee structures are able to internalize these externalities. Interchange fees are the key pricing mechanism and they are the subject of antitrust scrutiny in most cases:
 - U.S. merchant interchange fee lawsuit
 - Interchange fee regulation in Australia
 - European Union interchange fee decision
 - Bank of Mexico used moral suasion to lower interchange fees

Motivation to Regulate

- Price fixing among competitors
- Distortion of incentives to use efficient payment instruments
- Limit tax evasion

Key Questions

- What is the socially optimal interchange fee?
- Does competition among payment providers, networks, or instruments improve consumer and merchant welfare?
- Is there a network externality that justifies government intervention?

The empirical evidence on the role of interchange fees is almost non-existent

- Hayes (2007) uses structural break analysis to study the impact of interchange fee regulation in Australia. He finds that while the change in interchange fees may not have affected long run trend of credit card usage, the sharing of economic surplus among agents may have shifted.
- There are some empirical investigations of other two-sided markets (Argentesi and Filistucchi, 2007; Dubois, Hernandez-Perez, and Ivaldi, 2007; Kaiser and Wright, 2006; and Rysman, 2004). Our approach is similar to Rysman (2004) who uses a simultaneous equation estimation technique study the tradeoffs between consumers and advertisers in the market for yellow pages.
- He estimates the consumer demand for yellow page usage as a function of advertising and the inverse demand for advertising as a function of consumer usage. He is able to identify a positive network effect.

2. Spanish regulatory developments

- Spain represents a unique laboratory to study the effects of encouraged or mandated interchange fee ceilings on consumer and merchant payment card adoption and usage:
 - ▶ Very few countries have had repeated interventions to reduce interchange fees.
 - ▶ Many central banks and regulatory bodies have encouraged the migration to electronic payment instruments to increase the efficiency of payment. Spain has been one of the main examples.
 - ▶ One strategy to increase usage of payment cards is to reduce merchant acceptance cost. A key determinant of merchant fees is the interchange fee. As in other countries, Spain also experienced antitrust scrutiny on interchange fees (See Table 1).

Table 1: 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	Maximum interchange fees were gradually reduced from around 3.5 percent in 1999 to 2.75 percent in July 2002.
2002	INVESTIGATION ON THE SETTING OF INTERCHANGE FEES (MORAL SUASION)	SPAIN'S ANTITRUST AUTHORITY	Maximum interchange fees were reduced from 2.75 percent in July 2002 to 1.85 percent in January 2003.
2003	PROPOSALS FROM THE NETWORKS ON THE SETTING OF INTERCHANGE FEES ARE REFUSED (MORAL SUASION)	SPAIN'S ANTITRUST AUTHORITY	Maximum interchange fees were reduced from 1,85 in 2003 to 1.75 in 2005
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. The fees decreased from 1.75 percent in 2005 to 0.88 percent in 2009.

- **TABLE 2: Main trends in Spanish payment card market**

- During 1997-2007, debit card transactions increased from 156 million to 863 million and credit card transactions increased from 138 million to 1.037 billion.
- From 1997 to 2007, the number of debit cards has increased by 40.9 percent while the number of credit cards has increased by 207.1 percent. During the same period, the number of transactions increased substantially with debit card transactions being five times larger in 2007 than in 1997 while credit card transactions increased by seven times. Furthermore, the average number of POS transactions per card per year has increased from 7.1 to 27.8 during the same period.
- As for interchange fees, although the Bank of Spain only offers data from 2002 onwards, combining this information with our sample data for 1997, we observe that interchange fees decreased on average from 3.42 percent in 1997 to 0.90 percent.

**Table 2: Recent Trends in Card Payments
in Spain (1997-2007)**

All the monetary magnitudes are expressed in real terms

Source: Bank of Spain and authors' own calculations

	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 ^(*) (percent)	3.42 ^(a)	0.90
Average Debit Card Interchange Fee ^(**) (€transaction)	3.61 ^(a)	0.40
Average Credit Card Interchange Fee ^(**) (percent)	3.19 ^(a)	0.93
<p>(a) As the earliest public data available for the average interchange fees for the entire Spanish market is 2002, we compute the 1997 values from our sample data.</p> <p>(*) Average percentage value of total debit and credit, on-us and intersystem interchange fees.</p> <p>(**) As a consequence of the intervention of the Spanish Ministry of Industry, Tourism and Trade in 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.</p>		

3. Our dataset

- We use proprietary quarterly payment card data from 45 Spanish banks from 1997:1 to 2007:4. In total, there are 1,980 panel observations.
- The database contains quarterly bank-level (acquirer and issuer) information on payment cards, ATMs and POS terminals as well as prices for debit (interchange and merchant fees) and credit card transactions (interchange fees, merchant fees and annual credit card fees).
- Our data also includes 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.
- Our sample banks represented 56.7 percent of total card payment transactions in 1997 and 64.8 percent in 2007 when compared to the aggregate data provided by the Bank of Spain.

Table 3: Variable Definitions (1/3)

VARIABLE	DEFINITION	SCOPE
$MACCD_{it}$: Debit card merchant acceptance by acquirer	Computed as (branch-weighted) average merchants accepting debit cards for purchase in those regions where the bank operates over time in those regions.	Bank-level
$MACCC_{it}$: Credit card merchant acceptance by acquirer	Computed as (branch-weighted) average merchants accepting credit cards for purchase in those regions where the bank operates over time in those regions.	Bank-level
$MACCDN_t$: Debit card merchant acceptance in the network	The percentage of merchants in the network that accept debit cards.	Network-level
$MACCCN_t$: Credit card merchant acceptance in the network	The percentage of merchants in the network that accept credit cards.	Network-level
$MFEED_{it}$: Merchant debit card discount fee	Average (transaction-weighted) discount fee charged by the bank computed as the average discount fee charged to the merchant.	Bank-level
$MFEEC_{it}$: Merchant credit card discount fee	Average (transaction-weighted) discount fee charged by the bank computed as the average discount fee charged to the merchant.	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

The distinction between bank-level and market-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 card in all the three networks. Similarly, a merchant's acceptance of debit cards is dependent on the number of cardholders that have debit cards.

Table 3: Variable Definitions (2/3)

$CCARDSN_t$: 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
$BRDS_{it}$: Branch density	Number of an issuer's branches 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 charged by the bank.	Bank-level
$BSIZE_{it}$: Bank size (in the card network)	Number of bank card transactions over the total number of card transactions in the network in which the bank operates.	Network-level
$CRIME_{it}$: Crime rate	The (asset-weighted) ratio of robbery & assaults per 1000 inhabitants in the regions where the acquirer or issuer operates.	Bank-level

Table 3: Variable Definitions (3/3)

<i>BANKDACR_{it}</i> : Bank (debit card) acquiring revenues	Acquirer income from debit card merchant discount fees	Bank-level
<i>BANKDISR_{it}</i> : Bank (debit card) issuing revenues	Issuer income from debit card interchange fees	Bank-level
<i>BANKCACR_{it}</i> : Bank (credit card) acquiring revenues	Acquirer income from credit card merchant discount fees	Bank-level
<i>BANKCISR_{it}</i> : Bank (credit card) issuing revenues	Issuer income from credit card interchange fees and credit card annual fees	Bank-level
<i>REG99</i> : Regulation dummy 1999	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.	Time dummy
<i>REG02</i> : Regulation dummy 2002	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.	Time dummy
<i>REG03</i> : Regulation dummy 2003	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.	Time dummy
<i>REG05</i> : Regulation dummy 2005	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.	Time dummy

Table 4: Summary Statistics

	Mean	Std. dev.	Min	Max
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
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
Branch density by issuer ($BRDS_{it}$) (Branches/km ²)	1.1	0.6	0.4	1.9
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) ($BFSIZE_{it}$) (percent)	1.16	4.02	0.01	11.28
Crime rate ($CRIME_{it}$)	0.37	0.21	0.10	0.68
Bank (debit card) acquiring revenues ($BANKDACR$) (€millions)	4.31	2.19	0.08	45.23
Bank (debit card) issuing revenues ($BANKDISR$) (€millions)	25.43	13.84	0.32	114.15
Bank (credit card) acquiring revenues ($BANKCACR$) (€millions)	6.17	3.12	0.11	54.89
Bank (credit card) issuing revenues ($BANKCISR$) (€millions)	28.06	14.16	0.23	131.12

4. Empirical strategy

- Our empirical analysis will focus on how decreasing interchange fees affected merchant and consumer adoption of payment cards as well as issuer and acquirer transaction volume and revenue.
- We will 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 will 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.

Merchant acceptance and consumer adoption

- In addition to the level of fees, merchants also consider consumer adoption (number of cardholders) in their acceptance decisions. We estimate equations (1) and (2) that identify merchant acceptance and consumer adoption decisions:
- Merchant acceptance = $f (Xma , C, R)$ (1)
- Consumer adoption = $f (Xca , C, R)$ (2)

where Xma and Xca are the exclusion restrictions that identify the merchant acceptance and consumer adoption decisions, respectively, and C and R are vectors of control variables and regulatory dummies.

NOTE: All variables (except for the regulatory dummies) are expressed as the difference between the logarithms of current quarter and the quarter before. These differences can be interpreted as quarterly growth rates.

Acquirer and issuer transaction volume

- Unfortunately, our data does not allow us to study transaction per card or per merchant. Our dependent variables for usage are average quarterly transactions per POS terminal by acquirers and average quarterly transactions by card by issuers separated into debit and credit card transactions:
- Acquirer transaction volume = $f(X_{atv} , C, R)$ (3)
- Issuer transaction volume = $f(X_{itv} , C, R)$ (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 vectors C and R are the same as in equations (1) and (2).

Identifying issuer and acquirer revenues

- We are unable to measure acquirer and issuer profits directly, but we are able to study the impact of changes in interchange fees on bank 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 and total annual fees collected (only for credit cards). For debit cards, we only use 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.

Estimation procedures

- EQUATIONS 1 AND 2: Since our model specification allows acceptance and adoption variables to interact with variables related to number of transactions this may create non-linear 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.
- EQUATIONS 3 AND 4: Unlike adoption and acceptance decisions, we estimate acquirer and issuer transaction volumes separately. Given that our unit of study is acquirers and issuers, estimating the volumes separately is appropriate for transaction volumes. The estimation method is three-stage least squares (3SLS) with fixed effects.
- ISSUER AND ACQUIRER REVENUES: Also estimated separately using three-stage least squares (3SLS) with fixed effects.

5. Main results

- Table 5 shows the results corresponding to consumers and merchant adoption of debit cards.
- We find that a 10 percent reduction in the rate of decline per quarter in the average merchant discount fee by an acquirer resulted in a .48 percent rate of increase in merchant acceptance per quarter.
- The signs of all the regulatory dummies except for 1999 suggest that lower interchange fees strongly impacted the rate of merchant acceptance. However, the impact of each intervention was different suggesting that not all interventions were equal in convincing merchants to adopt debit cards.
- We also find strong evidence to support our hypothesis that consumers value greater merchant acceptance and react to increases in the price of the main alternative payment instrument—cash. Specifically, a 10 percent increase in the rate of merchant adoption per quarter resulted in a 4.6 percent increase in the quarterly adoption rate of debit cards by consumers.

Table 5: Consumers and Merchants Adoption (debit cards)
Simultaneous Equation estimation (GMM with fixed effects)
(Clustered standard errors by bank in parentheses)

	<i>Merchant adoption (debit cards)</i>	<i>Consumer adoption (debit cards)</i>
	<i>Merchant acceptance by acquirer(MACCD_{it})</i>	<i>Number of debit cards by issuer (DCARDS_{it})</i>
<i>Constant</i>	0.26E-11 (0.001)	0.21E-12 (0.001)
<i>Merchant acceptance in the network (MACCDN_{t-1})</i>	-	0.4630** (0.054)
<i>Merchant debit card discount fee (MFEED_{it})</i>	-0.0481** (0.015)	-
<i>Number of debit cards in the network (DCARDSN_t)</i>	0.0017** (0.013)	-
<i>Branch density (BRDS_{it})</i>	-	-0.0054** (0.043)
<i>Bank size (in the card network) (BSIZE_{it})</i>	0.0108 (0.018)	0.0443** (0.018)
<i>Crime rate (CRIME_{it})</i>	-0.0293 (0.184)	-0.0123 (0.852)
<i>Linear time trend</i>	0.0205** (0.024)	0.1951** (0.078)
<i>Regulation dummy 1999 (REG99)</i>	-0.0254* (0.025)	0.0926** (0.061)
<i>Regulation dummy 2002 (REG02)</i>	0.0119** (0.014)	-0.1425* (0.086)
<i>Regulation dummy 2003 (REG03)</i>	0.0163** (0.006)	-0.1007 (0.053)
<i>Regulation dummy 2005 (REG05)</i>	0.0129** (0.013)	-0.1852** (0.095)
Adjusted R ²	0.84	0.71
Number of observations	1935	1935

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- The underlying dynamics of credit card adoption is significantly different from debit card adoption (Table 6). Reductions in credit card merchant discount fees increased merchant acceptance of credit cards. Specifically, a 10 percent increase in the rate of decline of the average merchant discount of an acquirer increased the growth rate of merchant acceptance of credit cards by 1.6 percent.
 - As for the number of credit cards in the network, a 10 percent quarterly growth rate in this variable resulted in a 1.63 percent quarterly growth in the acceptance of credit cards by merchants. Note that only the last two regulatory dummies are significant—with coefficients .11 and .20—suggesting that the initial regulatory interventions were not as effective in increasing merchant acceptance as the last two. In particular, credit card merchant acceptance increased by 1.1 percent quarterly after the 2003 regulation and 2 percent quarterly after the 2005 regulation.
 - The number of cards issued is positively impacted by the number of merchants that accept credit cards. Specifically, a 10 percent increase in the quarterly growth rate in merchant acceptance increases the quarterly growth of credit card issuance by 3.0 percent.

Table 6: Consumers and Merchants Adoption (credit cards)
Simultaneous Equation Estimation (GMM with fixed effects)
(Clustered standard errors by bank in parentheses)

	<i>Merchant extensive margin (credit cards)</i>	<i>Consumer extensive margin (credit cards)</i>
	<i>Merchant acceptance by acquirer (MACCC_{it})</i>	<i>Number of credit cards by issuer (CCARDS_{it})</i>
<i>Constant</i>	-0.30E-06 (0.001)	0.53E-06 (0.001)
<i>Merchant acceptance in the network (MACCCN_{t-1})</i>	-	0.2985** (0.084)
<i>Merchant credit card discount fee (MFEEC_{it})</i>	-0.1585** (0.073)	-
<i>Number of credit cards in the network (CCARDSN_t)</i>	0.1630** (0.078)	-
<i>Annual credit card fee (AFEECRED_{it})</i>	-	0.6023 (0.430)
<i>Bank size (in the card network) (BSIZE_{it})</i>	0.0045* (0.004)	-0.0013 (0.012)
<i>Crime rate (CRIME_{it})</i>	0.0696* (0.082)	0.0651** (0.079)
<i>Linear time trend</i>	0.1694** (0.001)	0.1388** (0.042)
<i>Regulation dummy 1999 (REG99)</i>	-0.0950 (0.073)	0.0372** (0.016)
<i>Regulation dummy 2002 (REG02)</i>	0.0633 (0.084)	-0.0231 (0.032)
<i>Regulation dummy 2003 (REG03)</i>	0.1124** (0.096)	0.2651** (0.077)
<i>Regulation dummy 2005 (REG05)</i>	0.2023** (0.072)	0.2955** (0.098)
Adjusted R ²	0.87	0.93
Number of observations	1935	1935

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- As for payment card transaction volume, the results for debit cards (Table 7) show that the interaction of merchant acceptance at an acquirer and the total number of cards—showing network effects—is significant and positive. Specifically, a 10 percent quarterly growth rate in this interaction resulted in a debit card transaction quarterly growth rate of .27 percent. Additionally, a 10 percent increase in the quarterly growth rate of rival ATM density—which proxies for the cost of cash withdrawal—resulted in a .22 percent increase in the quarterly growth rate of debit card transactions at POS terminals.
 - All the regulatory dummies are positive and significant suggesting that regulatory intervention increased the quarterly usage at merchant locations.
 - The increase in issuer transactions proxies for the increase in consumer usage. Specifically, a 10 percent increase in the quarterly rate of growth of the interaction of network merchant acceptance and debit cards issued by an issuer resulted in a .47 percent quarterly growth rate in an issuer's debit card transactions per card. Furthermore, a 10 percent increase in the quarterly growth of rival ATM density resulted in a .63 percent increase in the quarterly growth rate of issuer debit card transactions per card. In other words, an increase in cash acquisition costs strongly encourages usage of debit cards.

Table 7: Debit Card Transaction Volume for Consumers and Merchants. Each equation estimated by 3SLS with fixed effects
(Clustered standard errors by bank in parentheses)

	<i>Acquirer transaction volume (debit cards)</i>	<i>Issuer transaction volume (debit cards)</i>
	<i>Debit card transactions per POS terminal (DEBPOSTR_{it})</i>	<i>Debit card transactions per card (issuer perspective) (DEBISS_{it})</i>
<i>Constant</i>	0.04E-13 (0.001)	-0.04E-10 (0.001)
<i>Merchant acceptance by acquirer (MACCD_{it-1})X Number of debit cards in the network (DCARDSN_t)</i>	0.0271** (0.015)	-
<i>Merchant acceptance in the network (MACCDN_{t-1})X Number of debit cards by issuer (DCARDS_{it})</i>	-	0.0467** (0.013)
<i>Rival ATM density (RATMD_{it})</i>	0.0217* (0.018)	0.0628* (0.029)
<i>Bank size (in the card network) (BSIZE_{it})</i>	0.0429* (0.029)	0.0120 (0.018)
<i>Crime rate (CRIME_{it})</i>	0.1488 (0.156)	0.1157 (0.961)
<i>Linear time trend</i>	0.1866** (0.017)	0.1158** (0.037)
<i>Regulation dummy 1999 (REG99)</i>	0.0201* (0.023)	0.0963** (0.025)
<i>Regulation dummy 2002 (REG02)</i>	0.1402** (0.018)	0.0669* (0.024)
<i>Regulation dummy 2003 (REG03)</i>	0.0925* (0.026)	0.1108* (0.071)
<i>Regulation dummy 2005 (REG05)</i>	0.2451** (0.015)	0.2201** (0.084)
Adjusted R ²	0.90	0.76
Number of observations	1935	1935

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- We report credit card acquirer and issuer transaction volume regressions in table 8. A 10 percent increase in the quarterly growth of the interaction term of acceptance by merchants using the same acquirer and total credit cards in the network results in a 2.09 percent increase in the growth of acquirer transactions at the point of sale. 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 8, column 3. We find that a 10 percent 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 1.63 percent increase in issuer transaction volume. The coefficient on the crime rate is also significant and positive.
 - Importantly, all the regulatory dummies are significant and positive and the impact of the 2003 and 2005 dummies on the increase in quarterly growth rate of credit card transaction volume are particularly high (.11 and .29, respectively).

Table 8: Credit Card Transaction Volume for Consumers and Merchants
Each equation estimated by 3SLS with fixed effects
(Clustered standard errors by bank in parentheses)

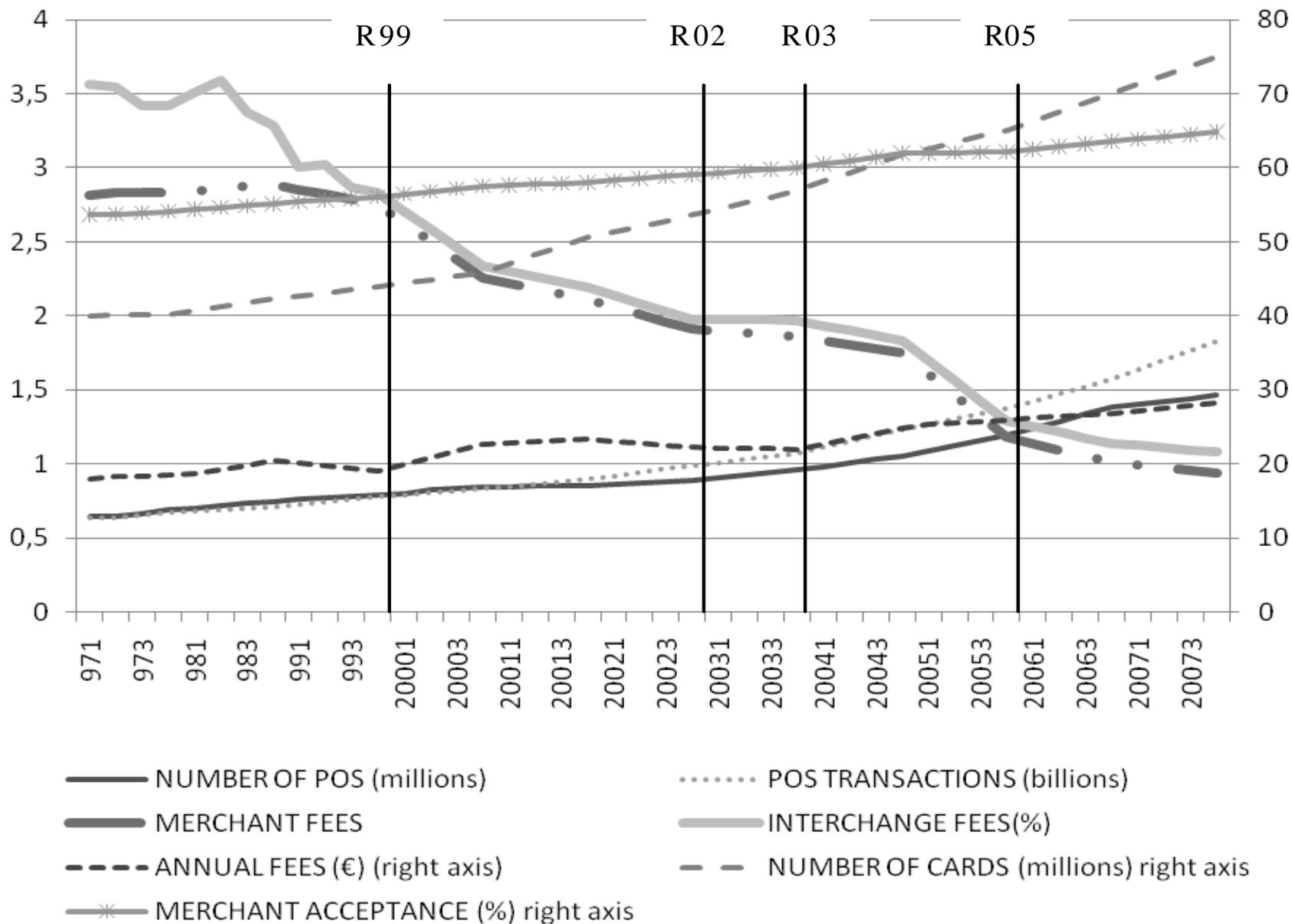
	<i>Merchant intensive margin (credit cards)</i>	<i>Consumer intensive margin (credit cards)</i>
	<i>Credit card transactions per POS terminal (CREDPOSTR_{it})</i>	<i>Credit card transactions per card (issuer perspective) (CREDISS_{it})</i>
<i>Constant</i>	0.11E-07 (0.001)	-0.10E-06 (0.001)
<i>Merchant acceptance by acquirer(MACCC_{it-1})X Number of credit cards in the network (CCARDSTN_t)</i>	0.2088** (0.094)	-
<i>Merchant acceptance in the network (MACCCN_{t-1})X Number of credit cards by issuer (CCARDS_{it})</i>	-	0.1631** (0.083)
<i>Bank size (in the card network) (BSIZE_{it})</i>	-0.1652 (0.345)	0.0152** (0.040)
<i>Crime rate (CRIME_{it})</i>	0.0963* (0.068)	0.0568* (0.027)
<i>Linear time trend</i>	0.2452** (0.013)	0.1996** (0.084)
<i>Regulation dummy 1999 (REG99)</i>	0.0657 (0.080)	0.0760* (0.034)
<i>Regulation dummy 2002 (REG02)</i>	0.2414** (0.073)	0.2168** (0.080)
<i>Regulation dummy 2003 (REG03)</i>	0.1652* (0.090)	0.1173* (0.071)
<i>Regulation dummy 2005 (REG05)</i>	0.3005** (0.074)	0.2952** (0.090)
Adjusted R ²	0.71	0.91
Number of observations	1935	1935

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- In table 9, we report our results for bank revenues. The table shows that 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 revenues from increased transactions volume offset the decrease in per-transaction revenues for the time period of our sample.
 - However, the impact of the regulatory interventions are more significant on the issuing side than the acquiring side as also evidenced by the magnitudes of the coefficients and the goodness of fit.
 - This result is consistent with the fact that the acquiring side of the business may be more competitive and any reductions in interchange fees would result in an equal magnitude decrease in the merchant discount.

Table 9: Impact on Bank Issuing and Acquiring Revenues
Each equation estimated by 3SLS with fixed effects
(Clustered standard errors by bank in parentheses)

	<i>Bank (debit card) acquiring revenues (BANKDACR)</i>	<i>Bank (debit card) issuing revenues (BANKDISR)</i>	<i>Bank (credit card) acquiring revenues (BANKCACR)</i>	<i>Bank (credit card) issuing revenues (BANKCISR)</i>
<i>Constant</i>	0.10E-07* (0.001)	0.09E-10* (0.001)	0.06E-08* (0.001)	0.09E-09 (0.001)
<i>Merchant acceptance by acquirer (MACCD_{it-1}) X Number of debit cards in the network (DCARDSN_t)</i>	0.0393* (0.017)	-	-	-
<i>Number of debit cards by issuer (DCARDS_{it}) X Merchant acceptance in the network (MACCDN_{t-1})</i>	-	0.1503** (0.012)	-	-
<i>Merchant acceptance by acquirer (MACCC_{it-1}) X Number of credit cards in the network (CCARDSN_t)</i>	-	-	0.0714** (0.009)	-
<i>Number of credit cards by issuer (CCARDS_{it}) X Merchant acceptance in the network (MACCDN_{t-1})</i>	-	-	-	0.1685** (0.012)
<i>Rival ATM density (RATMD_{it})</i>	0.0018 (0.007)	0.0069 (0.040)	-	-
<i>Bank size (in the card network) (BSIZE_{it})</i>	0.0694** (0.051)	0.1305** (0.081)	0.1805** (0.021)	0.0761** (0.013)
<i>Crime rate (CRIME_{it})</i>	0.0383 (0.079)	0.0206 (0.084)	0.0326 (0.046)	0.0300 (0.028)
<i>Liner time trend</i>	0.6499** (0.107)	0.6631** (0.113)	0.5612** (0.013)	0.8104** (0.093)
<i>Regulation dummy 1999 (REG99)</i>	0.0115 (0.077)	0.0209 (0.093)	0.01218 (0.037)	0.0314 (0.071)
<i>Regulation dummy 2002 (REG02)</i>	0.0191 (0.029)	0.0894** (0.013)	0.0324 (0.020)	0.0625** (0.010)
<i>Regulation dummy 2003 (REG03)</i>	0.04537* (0.023)	0.1432** (0.024)	0.0983* (0.018)	0.1841** (0.013)
<i>Regulation dummy 2005 (REG05)</i>	0.019 (0.024)	0.1673** (0.031)	0.1025 (0.016)	0.2633** (0.011)
<i>Adjusted R²</i>	0.53	0.88	0.58	0.87

Figure 1: Adoption, transaction volumes, fees and regulatory events



6. Robustness tests

- We have tried other specifications for the simultaneous equations estimations. In particular, we estimated the system using two-stage-least squares, three-stage least squares and seemingly-unrelated regressions.
- 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.
- We also tried several variations in regulatory dummy specification.
- Estimations for different sub-periods and related regulatory effects.
- The results also seemed robust to alternative specifications of the control variables and, in particular, the time trend.

7. Conclusion

- Our results suggest that reductions in interchange fees has had a positive effect on consumer and merchant adoption and usage
- Banks may be better off because the increase in volume of transactions offsets the decrease in per-transaction revenue
- However, once the network (adoption and usage) externality is eliminated, interchange fee regulation may not further improve social welfare