

THE IMPACT OF INTERCHANGE FEE REGULATION IN EUROPE

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Abstract: The present article analyses two relevant issues for the payment card market in the light of recent changes in the regulation of interchange fees throughout Europe (EU-27). In particular, we study the degree of intensive and extensive margins (mainly from the perspective of network effects) between merchants and cardholders, and test the extent to which cards have replaced cash transactions. Controlling for the social, economic and financial environment, crime and tourism, our results suggest that recent actions concerning interchange fees (mandatory reductions and investigations) have had a positive effect on the adoption and usage of payment cards. Interestingly, mandatory cross-border reductions (initiated by the European Commission) have encouraged cash replacement in Europe.

JEL code: G20, D12, E41.

Keywords: payment cards, interchange fees, merchants, cardholders.

1. Introduction

Payment instruments play an important role in the economy and financial systems. According to the Blue Book describing payment systems (European Central Bank, 2008), there are more than 350 million payment cards¹ in Europe; these are used to perform more than 12,000 million transactions and 6,000 million cash withdrawals per year. Electronic payments have substantially increased their share in the retail sector (small value payments). The greater acceptance and use of payment cards suggests that a growing number of consumers and merchants prefer payment cards to cash and cheques (Humphrey, 2004; Gerdes *et al.*, 2005; Garcia-Swartz *et al.*, 2006a; Klee, 2006a). Moreover, some studies have suggested that less frequent cash usage would improve social welfare (Van Hove, 2004). Transactions which were once solely conducted in cash are increasingly made using cards, and Humphrey *et al.* (2006) find that the complete replacement of paper-based payment instruments by electronic ones (payment cards) would produce a cost saving of approximately 1% of the total GDP in 12 European countries.

Payment cards constitute one example of two-sided markets, which exist when payment platforms (one or more) seek to attract end-users by setting appropriate charges for each type of end user (the balancing effect). In a four-party card system², the merchant typically contracts with an external company, which acquires the transaction. Via a terminal, the merchant communicates the amount of the transaction and the payment card information to the acquirer. The acquirer then consults the payment platform, which in turn, requests the issuer bank (the cardholder's bank) to verify that sufficient funds are available to the customer for the transaction. Assuming the funds are available, the transaction may either be authorised immediately or the issuer may require a phone call to be made to confirm the transaction, prior to issuing an authorisation.

Payment cards satisfy the definition of bilateral markets because payment platforms seek to ensure that both types of end-users, consumers and merchants, agree to use the system. Thus, so-

¹ Payment cards can be used to pay for goods and services at point-of-sale (POS) terminals or remotely (mail order, telephone order or via the Internet), and for making cash withdrawals at automated teller machines (ATMs); both functions are usually combined on a single card.

² The four parties are the consumer, merchant, issuer and acquirer.

called “network externalities” certainly exist in the area of payment cards and include adoption and usage externalities. Adoption externalities (intensive margins) are related to the fact that a payment platform with a higher number of cards issued is relatively more attractive to merchants than one with few cards issued. Similarly, a payment system with many merchants registered may be more attractive to consumers than one incorporating fewer merchants. Attaining a viable business level may require years of investment. However, there is no guarantee of success; payment systems may incur losses despite attaining sufficient scale, for exogenous reasons. Usage externalities (intensive margins) exist because consumers and merchants must decide, on an ongoing basis, how intensively to use a given card. Rochet (2003) considers this to be the primary externality for payment platforms. Insofar as usage externalities are important, network effects may continue to play a role in increasing the size of the network even after adoption has occurred.

The two-sided nature of the payment card market makes its analysis complex³, particularly so in the case of interchange fee regulation (the fees that acquirer banks pay to issuer banks when a sale is carried out using a payment card). This market has been characterised by its rapid growth and dynamism (Evans and Schmalensee, 1999 and Kahn, 2006), and several class actions have been initiated by governments and national or supra-national competition authorities regarding interchange fees (Bradford and Hayashi, 2008). Interchange fees and related practices have also been or are currently being reviewed by regulatory authorities and/or central banks in a number of jurisdictions (Annex I), including the European Union, Australia, Brazil, Colombia, Germany, Honduras, Hungary, Mexico, New Zealand, Norway, Poland, Portugal, Romania, Singapore, South Africa, Spain, Sweden, Switzerland, the United States and the United Kingdom. In certain countries, such as Australia and Mexico, interchange rates have been adjusted in anticipation of or response to government regulation. Recently, the European Commission ruled that the cross-border multilateral interchange fees applied by MasterCard in Europe violated EC Treaty

³ It is subject to substantial economies of scale and strong externalities. For surveys of the extensive literature on the Industrial Organization of card payments, see Chakravorti (2003), Hunt (2003), Rochet and Tirole (2004), Evans and Schmalensee (2005), and Rochet and Tirole (2006).

regulations. The Commission stated that MasterCard's fee structure restricted competition among acquiring banks and inflated the cost of card acceptance by retailers, without leading to proven efficiencies.

Since Baxter (1983) onwards, the literature has defended interchange fees as necessary incentives to guarantee participation by all parties (buyers, sellers, and their associated payment service providers) in an account-based transaction⁴. Today, however, there is little consensus among economists regarding the assessment of current pricing structures in the industry (Evans and Schmalensee, 2005; Rochet and Tirole, 2006a). The challenge to policymakers, on the other hand, is to use the information available to decide whether a network's pricing strategy and rules are likely to encourage or restrict economic efficiency (Hunt 2003).

The analysis of the effects of regulation is usually based on counterfactual experiments and not upon actual changes in interchange fees. Our approach is somewhat deeper, exploring the impact on both cardholders and merchants and addressing the effect of specific regulations. Using a dataset from three different sources (the ECB, the World Bank and Eurostat) for the period 1995-2007, we examine whether interchange fee regulation (national or cross-border) in the EU-27 can improve social welfare in a competitive environment. In addition, we obtain some new evidence of cash replacement associated with interchange fee regulation. Merchant and consumer welfare will be measured by increased intensive and extensive card margins. If more merchants (or consumers) adopt (or use) electronic payment cards, we conclude that social welfare has improved.

This paper seeks *a)* to test to what extent recent interchange fee regulation in European countries has influenced card margins and *b)* to quantify their total impact. Following this introduction, Section 2 offers an overview of the card payment industry in Europe and outlines important policy questions related to interchange fees, network effects and cash replacement. Section 3 discusses the sample used and introduces two empirical models to test whether both

⁴ For an up-to-date theoretical treatment, see Wright (2003).

intensive and extensive margins and cash replacement have been influenced by recent interchange fee regulation throughout Europe and whether network effects exist (controlling for cross-country variation in financial structure, social indicators, tourism and crime⁵). Section 4 interprets the results of the panel data estimations of the previous section. Finally, Section 5 presents our principal conclusions and indicates some directions for further research.

2. An overview of the payment card industry in Europe

2.1 The SEPA project and interchange fee regulation

The SEPA project

The payment card industry today involves thousands of banks and other financial service providers. As intermediaries, these process payments between millions of merchants and more than a billion cardholders. Over the last fifteen years, global financial market integration has gained momentum (especially in Europe because of the EMU), and the pressure to achieve compatible global payment systems has clearly increased. However, there is an appreciable fragmentation in payment markets and in card payment markets in particular. Fragmentation is due to the way in which payment systems were created and developed in the EU member states, through coordination and cooperation between banks at national level. However, more work is necessary for a Single Euro Payments Area (SEPA⁶) to be fully achieved.

The SEPA project represents the next major step towards closer European payment system integration (Annex II provides a chronology of important payment card-related events). It will have a major impact upon all stakeholders⁷, creating opportunities as well as challenges. The European Commission estimates that the completion of SEPA could result in cost savings of between 50 and 100 billion euros every year, with 1,250 billion euros exchanging hands in over-

⁵ For example, Humphrey et al. (1996) find that differences in the prices of payment instruments fail to fully account for differences in their use across countries and time. They suggest that other variables, such as the crime rate, probably explain a large part of the differences.

⁶ There are 31 members of SEPA. It comprises the 27 EU member states, the three European Economic Area countries (Iceland, Liechtenstein and Norway) and Switzerland.

⁷ Cardholders, consumers, merchants, banks, etc.

the-counter card payments in Europe annually. SEPA payment instruments⁸ will be available throughout the Euro area, with the advantages that: *i*) for consumers, the use of payment cards will be more efficient and this will reduce their need to carry cash. They will be able to use the same card for all retail payments in euros, which will thereby become “domestic” i.e. there will no longer be any differentiation between national and cross-border payments within the euro area. The use of cards is thus expected to grow in the future; *ii*) merchants will be able to choose any acquirer in the euro area to process their card payments; this will increase competition and reduce costs (Annex II presents a detailed chronology of the SEPA process).

Interchange fee regulation

As the card industry has grown and matured, competition law or policy has increasingly been applied in this area. Both competition authorities and financial regulators have investigated and taken action with regard to issues of competition.

Interchange fee equilibrium conditions on each side of the market not only allow payment card schemes to operate flexibly, but are also necessary to induce both parties to participate (Baxter, 1983 and Rochet and Tirole, 2002). Let us consider a simple case in which the per unit costs for issuer and acquirer of providing payment services to cardholders and merchants are fixed, although at different levels (Harper *et al.*, 2006). The demand curve for cardholders and merchants is downward sloping. Without a transfer between acquirers and issuers, the volume of transactions is determined by the issuer/cardholder side of the market, as depicted by $Q_I < Q_A$ ⁹. However, merchants have an unsatisfied demand at that level and would be prepared, in effect, to pay cardholders to use the cards.

This situation provides an opportunity for mutually advantageous trade. Equilibrium is achieved via merchants being charged an extra amount for transactions ($C_A + a$), where a is the

⁸ In addition to cards, credit transfers and direct debits will also be part of the single market for payments in the future.

⁹ Note that issuer banks charge annual fees and that cardholder demand determines the size of the market.

interchange fee. This amount is transferred from acquirers to issuers¹⁰. As the resulting network size is larger, both merchants and cardholders benefit from the balancing effect, due to $Q_I < Q^* < Q_A$ (Figure 1). This explains why if the interchange fee is too high, merchants will not adopt the cards, resulting in low usage and consumer adoption. If the interchange fee is too low, consumers may not have sufficient incentives to participate in payment networks. Therefore, interchange fee regulation may have a critical impact on platform size, especially when there is competition between platforms. Low usage volumes and lack of participation may undermine platform viability and thereby deter innovation.

Frankel (2005) lists three principal economic arguments offered in support of claims that interchange fees¹¹ (IFs) have important pro-competition or efficiency-enhancing economic effects. These are: *i*) IFs “balance” a “two-sided” payment system market to correct an indirect “network externality” and solve a “chicken and egg”¹² entry barrier problem; *ii*) IFs resolve a “usage externality” in which consumers would otherwise have insufficient incentive to use cards which are assumed to impose lower costs on merchants; *iii*) IFs are needed to reimburse card issuers for specific services they provide for the benefit of merchants and their banks (e.g. the interest-free grace period, the “payment guarantee,” and “processing”).

IFs are intended to equitably distribute payment system costs¹³, but concerns have been voiced that this is not always the case and that fees may be excessive. In some countries, reduced interchange fees have resulted from pressure from regulatory and competition authorities who have investigated or charged four-party payment systems with violations of competition law or

¹⁰ Usually, the interchange fee is transferred from acquirers to issuers.

¹¹ There may be a problem of competition policy with both interchange fee setting and merchant fees, although the latter are less frequently discussed. These fees are often called merchant service charges (MSC). However, given that the fee is most typically a reduction in funds received by a merchant, and that interchange fees are called fees, we will use the term “merchant fee” hereafter.

¹² Merchants are reluctant to devote resources to accepting cards until there is a large volume of cardholders, while consumers are not interested in holding cards until a large volume of merchants accept them (Evans and Schmalensee, 2005).

¹³ Given that merchants are constrained from setting prices based on payment instruments costs in many jurisdictions, and merchants often do not differentiate prices even in jurisdictions allowing them to do so, the level of the interchange fee affects the adoption and usage of payment cards.

with behaviour harmful to welfare. The interim report¹⁴ conducted by the European Commission during the second half of 2005 is a summary of the Commission's findings on competition concerning payment cards. Their analysis is based on an extensive market survey and, interestingly, the evidence suggests that merely issuing cards would generate positive profits in 20 out of 25 countries, even without interchange fee income. Moreover, the report shows that interchange fees vary considerably across the EU, which may indicate that the market for card payment services is not working efficiently in some member states.

The structure of national interchange fees is also very heterogeneous, as some systems establish flat interchange rates while others charge a percentage per card transaction or a combination of flat rates and a percentage (European Commission – Interim Report, 2006). While the percentages may seem trivial, aggregate merchant service fees (which include interchange fees) are non-trivial: total sales volumes from point-of-sale card transactions in the EU in 2005 amounted to over 1,350 billion euros, while it is estimated that EU merchants paid more than 25 billion euros in fees in 2005¹⁵. Whatever the exact figure, the scope of interchange fee regulation across European countries has not been fully studied until now. Annex I includes a complete list of regulatory events related to interchange fees, divided into three groups: reductions of interchange fees, investigations and wide-ranging cross-border reductions (mandated by the European Commission).

2.2 Extensive and intensive margins

An important aspect of card schemes that is essential to understanding their past (and possibly future) success is the presence of network externalities¹⁶. Externalities arise from the fact that decisions whether to adopt a card or install a POS affect other users' utility (extensive

¹⁴ The Interim Report and further information on the inquiry into the sector are available on the European Commission Internet pages on competition policy:

http://europa.eu.int/comm/competition/antitrust/others/sector_inquiries/financial_services/

¹⁵ Estimate derived from Payment Cards Report, RBR, 2005, London.

¹⁶ Network externalities have certainly existed in the area of payment cards; these may include adoption and usage externalities.

margins)¹⁷. Osterberg and Thomson (1998) found that the benefits for consumers of having a new payment instrument depend on how many businesses will accept it in payment. On the other hand, merchants and service providers will refuse to invest in the systems needed to accept the new payment instrument until they are sure that there will be enough consumer demand to justify the expense. The gains from a larger network include reduced search time and increased convenience, while more cardholders make it easier for merchants to defray fixed costs.

Clearly, success in establishing a payments network requires reaching a critical mass, so that each side of the market can benefit from a minimum level of development on the other side¹⁸ (Economides, 1996). Card networks solved this ‘chicken and egg’ problem by making investments on both sides of the market or by employing other strategies to gain the commitment of both sides to the scheme. Katz (2001) questions the relevance of network effects related to adoption externalities for mature payment systems. He argues that when consumers and merchants have high switching costs, the mechanisms that may have been important for broadening acceptance by consumers and merchants (such as the honour-all-cards rule and the no-surcharge rule) are no longer as relevant. In other words, merchant acceptance will remain broad and consumers will maintain their cards once the network has been established.

Table 2 shows a group of extensive margin indicators across European countries, in addition to GDP per capita from 1996-2006. It also presents data on the number of point-of-sale (POS) terminals per merchant. Differences can be observed in the adoption of POS terminals, particularly in the growth rates of countries such as Bulgaria (719%) or the Czech Republic (2,700%)¹⁹. This is because they have not reached a critical mass (which reflects low levels of

¹⁷ In network industries, consumers’ expectations about the future size of the network play an important role in determining the actual size the network achieves.

¹⁸ For example, unless there are a sufficient number of merchants who accept the cards there will be fewer benefits to cardholders in terms of convenience. Similarly, without a sufficient number of cardholders, investment in the ability to accept a card will also appear less attractive from the merchant’s perspective.

¹⁹ Access to POS devices (in term of units per capita) appears to be easier in EU-15 countries compared to the “new” European countries.

extensive margins as of 2006), as other EU countries have done²⁰. It is clear that in many EU-15 countries POS terminals are growing at a faster rate than ATMs, which may be related to different institutional frameworks, regulation and other factors. The statistical data for the total number of cards per head shows that in practically all EU-15 countries there is one or more payment card per head, while the Table shows higher growth rates for the number of cards per head in the “new” European countries during the period 1996-2006.

A consumption externality can be defined as the increasing utility that a user derives from the consumption of a product as the number of other users who consume the same product increases (some authors have labelled this ‘demand-side economies of scale’). Consequently, usage externalities exist because consumers and merchants must decide how intensively to use a given card. Rochet (2003) considers this the primary externality for payment platforms. To the extent that usage externalities are important, network effects may continue to play an important role in increasing the network size even after adoption has occurred. Recent evidence regarding the strength of payment network effects shows that merchant acceptance of a system and consumer usage are correlated i.e. low merchant adoption restricts consumer use (Rysman, 2007).

Table 3 presents indicators of intensive margins across European countries from 1996 to 2006. During this period, the number and value of cashless payment transactions per card and POS have increased. We found heterogeneity when comparing EU accession countries i.e. while in most of the EU-15 consumers make 20 or more transactions per card per year (as is 2006), in many new EU countries this figure is under 20 (Bulgaria (3.76), Hungary (13.8), etc.). Whatever the details, in most economies the number of transactions per card was greater in 2006 than in 2000. The number of transactions per POS has followed a similar trend. Table 2 also shows that the average value of transactions per card and POS has increased in general, except in countries

²⁰ Nevertheless, the payment card industry continues to grow across countries.

where the adoption of POS or cards displays higher than average growth in the total value of transactions²¹.

2.3 Cash replacement

Paper-based instruments, especially cheques, have been rapidly replaced by electronic instruments since the mid-1990s. Early attempts to estimate the direct benefits from a move to e-payments focused on transaction cost reductions. Recently, these effects have been shown to be sizeable. For example, Humphrey *et al.* (2003), using European data, estimate that switching from paper to a totally electronic system can boost annual country GDP by 1%, merely in cost savings. Furthermore, the associated dynamic efficiency gains from such a change are likely to be substantially greater. Debit and credit cards have increasingly replaced cheques and cash as retail payment instruments. In 2002, general purpose payment cards were used to pay for goods and services to the value of 2.7 trillion USD throughout the world (Evans and Schmalensee, 2009).

The widespread use of cards is one of the most notable features of consumer retail payment systems in the EU-27²², but the pattern of cash replacement is heterogeneous. Moreover, the intensity of the adoption of POS terminals, the principal driving force behind the replacement of cash by electronic payment nowadays, has not yet been specifically explored, while its relations with recent interchange fee regulation remain largely unknown. In many developed countries during the 1980s, consumers adopted cards to withdraw cash from ATMs (Carbó and Rodriguez, 2008). Humphrey *et al.* (2006) suggest that the use of debit cards for ATM withdrawals and POS transactions may impose some restrictions on the replacement of cash by cards. Amromin and Chakravorti (2007) study changes in transactional demand for cash in 13 OECD countries from 1988 to 2003 and show that ATM withdrawals decrease as POS debit card usage increases.

²¹ For example, Romania and the Netherlands, among others.

²² However, the payment cards industry shows evidence of continuing fragmentation and the inquiry has found striking differences in the levels of prices and profitability across member states (OECD, 2006).

Following Jones and Jones (2005), we compute the following formula in order to calculate an intensive margin substitution ratio (*IMSR*):

$$IMSR = \frac{\text{Value of debit POS expenditure per head per year}}{\text{Value of ATM withdrawals} + \text{Value of debit POS expenditure per head per year}} \quad (1)$$

Computation of the above equation (1) is based on the following assumptions: *i*) the use of cheques has fallen across European countries, and thus it has been removed; *ii*) following Jones and Jones (2005), data for credit cards have been deliberately removed (since debit has been used rather than credit, due to the European propensity to use debit for domestic transactions); *iii*) ATM transaction value is an appropriate proxy for cash in circulation, since this figure is not consistently and accurately available in all European countries; *iv*) the value of debit card transactions will also include a small proportion of cardholder not present and e-commerce payments. Furthermore, we consider an extensive margin substitution ratio (*EMSR*) i.e the transactions made by payment card as a percentage of the total number of transactions per country. These data were obtained from the Blue Book regarding payment cards (ECB, 2009).

Table 4 shows the average values for *IMSR* and *EMSR* indicators for 1996-2006, when both ratios increased substantially. Cash remains a very important way to pay in Europe, with ATM withdrawals per capita per annum ranging from 438 euros (Romania) to 5,926 euros (Ireland). Although cash and cheques are not likely to disappear in the near future, it is probable that the positive trend in the replacement of paper-based instruments across European countries will continue.

3. The data and empirical models

3.1 The dataset

We use annual payment card data from 27 European countries from 1995 to 2007 and employ four different data sources. In total, there are 351 panel observations (see Annex III). Table 1 provides a summary and descriptive statistics of the main variables.

For payment data (number of POS terminals, cash infrastructure (ATMs), debit cards, credit cards, transactions and the total value²³ of these items) and banking infrastructure (branches), we use the European Central Bank's Payment and Securities Systems in the European Union (Blue Book) for the years 1995–2007. We also use the World Bank, the BIS (Red Book) and OECD Bank Profitability (2008) to substitute for some of the missing data. These books provide information on not only the total number of processed payment card transactions, but also the share of cash payments (in terms of the number of transactions). We also incorporate the infrastructure for cash availability (such as ATMs per branch) into our analysis as a proxy of the relative ease of withdrawing cash compared to paying at a POS.

For population, GDP, the number of companies, turnover, crimes recorded by police per km², the number of tourists visiting relatives and/or on holiday and the annual percentage rate of charge (variables that may have an influence on card transactions) we use the Eurostat Database. Financial structure data across countries are taken from the Financial Structure dataset of the World Bank. Finally, we control for the main regulatory changes across countries (see Annex I).

3.2 The empirical models

Intensive and extensive margins

We develop an empirical model of intensive and extensive margins of electronic payment; this illustrates how recent changes in interchange regulation become testable, taking into account network effects and financial and social control variables. Although our base model is restrictive, it allows us to study whether consumer and merchant welfare have improved. We model the

²³ Exchange rates for accession countries are included in Annex IV. All variables are expressed in euros.

country-level decision to adopt and use payment cards or POS in terms of the number (extensive margins) and volume or value of transactions (intensive margins)²⁴.

If we consider compatibility among POS terminals in European countries (World Bank, 2008), regulation concerning interchange fees (and, indirectly, merchant service fees) may have altered the natural pattern of adoption and usage of both cards and POS devices, due to changes in costs (annual fees and merchant service charges)²⁵. We will test the following hypotheses:

H1. Interchange fee regulation (i.e. a mandatory reduction) can have effects which government policymakers do not predict. In other words, it is likely to have an unintended impact on intensive and extensive margins.

H2. There are differences in the impact of intra-EU interchange fee regulation (mandated by the European Commission) and specific country regulation.

H3. Interchange fee investigations have affected intensive and extensive margins in the European payment card industry.

As discussed below, our payment data come from 27 European countries which participate in the SEPA project today. For both consumers and merchants, we employ country-level data on the adoption of payment cards and the value and number of transactions made using them. In our empirical specification, we use a data panel to simultaneously estimate equations²⁶ which identify intensive and extensive margins for merchants and consumers:

$$\text{Cardholder extensive margin equation} = f(X_{CEM}, C, R) \quad (2)$$

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

²⁴ There may be potential for further exploitation of network effects and interchange may therefore strongly stimulate these markets (Guibourg and Segendorff, 2007).

²⁵ In Europe, merchants follow a “no-surcharge rule” to attract customers; thus, there are no heterogeneous prices for the same product in the same country.

²⁶ Taking into account the simultaneity and endogeneity problems affecting simultaneous equations, we employ lagged variables as independent variables, due to a possible contemporaneous relationship between card volume and transactions. Moreover, the specification takes into account the fact that merchants or consumers observe previous market behaviour in order to take an adoption decision.

where X_{CEM} and X_{MEM} are the exclusion restrictions that respectively identify the consumer extensive margin and merchant extensive margin equations, C and R are the vectors of control and regulatory dummies (regulatory changes related to interchange fees for all European countries) and are common to all equations. We also simultaneously estimate the equations which identify the intensive margins for consumers and merchants:

$$\text{Cardholder intensive margin equation} = f(X_{CIM}, C, R) \quad (4)$$

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

where X_{CIM} and X_{MIM} are the exclusion restrictions that identify the consumer intensive margin equations and merchant extensive margin equations, respectively. The simultaneous estimation is performed separately for the value and number of payment card transactions.

Using this framework, we estimate the impact of regulatory actions concerning interchange fees. We estimate simultaneous equations using a General Methods of Moments (GMM) routine with fixed effects. All variables (except for the regulatory and dummy variables) are expressed in logarithms. The GMM estimation relies on a set of orthogonality conditions which are the products of equations and instruments. The initial conditions for estimation are obtained using three-stage least squares (3SLS), which is a restricted version of the simultaneous equation GMM model²⁷. Endogeneity bias is controlled for using the lagged values of the explanatory variables in the different equations (as instruments). We also include market-specific measures which control for those otherwise immeasurable aspects of change in markets over time, such as GDP per capita. Finally, we apply a Sargan test of over identifying restrictions in order to validate the set of instruments under the null hypothesis of correct identifying restrictions.

Note that vector C includes a rich set of variables which identify financial structure and social indicators, such as the number of crimes per capita and the number of tourists throughout countries (see Annex III). Given that payment processing is a scale business, we employ liquid

²⁷ This kind of GMM estimator allows for heteroskedasticity and cross-equation correlation where some variables (network effect variables) may appear as both exogenous and (lagged) endogenous variables in the different equations (Hansen, 1982).

liabilities/GDP (an indicator of the size of the financial intermediary sector) to control for any increases in the size of the financial sector during the sample period. To control for changes in the business environment, we use a country-based indicator of turnover per merchant as another control variable. Country-specific GDP per capita also controls for time trends, given that the former generally increases during our sample period²⁸.

Some theoretical models suggest that crime may deter cash usage (He *et al.*, 2005). To capture the effect of crime on the intensive and extensive margins of payment cards, we use time-series crime data from EU-27 countries. We would expect intensive and extensive margins to increase as crime increases.

With regard to vector R , we also include three regulatory dummies to measure the impact of different regulations on interchange fees: i) investigations of IFs, ii) reductions of IFs and iii) intra-EU IF regulation. These regulatory dummies represent the year when the regulatory intervention was introduced, and their implementation is listed in Annex I.

Cardholder Extensive Margin

We consider two key factors for payment card adoption. Firstly, increased merchant acceptance (number of POS/number of merchants) would increase the value of payment cards and may encourage greater adoption. A merchant acceptance indicator appears as the dependent variable in the merchant extensive margin equation and is included in the cardholder extensive margin as an explanatory factor, lagged by one year. The logic of this specification is that cardholders' adoption decisions depend on observed merchant acceptance during the previous year. Secondly, payment/withdrawal cards became more attractive to consumers as ATM cash withdrawal costs become lower. Our indicator of increased cash acquisition is the interoperability of ATMs²⁹.

²⁸ We have also considered other trend variables, such as a linear time trend. Our results were qualitatively identical. For this reason, we only present GDP per capita.

²⁹ "High interoperability of ATMs" means that all payment and cash withdrawal cards can be used seamlessly (though probably at a cost) at all ATMs in the country.

Reductions in interchange fees may affect the annual fee cardholders pay. Our empirical model allows us to study the impact of three types of IF regulation on cardholder adoption. If cardholders do not relinquish their cards, we can conclude that they are either inelastic to changes in card fees or are willing to pay higher fees if they can use their cards at more merchant locations. In the cardholder extensive margin regressions, we include our control and regulatory variables discussed above.

Merchant Extensive Margin

Theoretical models predict that merchants will increase their acceptance of payment cards when the IF decreases, if the number of payment cards (per head) increases in line with the expected usage of these cards (the network effects hypothesis). If cardholders decrease their participation in card schemes because their benefits fall, merchants may decrease their adoption even if their fees are reduced. Therefore, IFs and the adoption of payment cards per head are the first exclusion restrictions which identify the merchant extensive margins.

Cardholder Intensive Margin

In the cardholder intensive margin regression, we analyse which factors encourage greater usage of payment cards by consumers. The dependent variable is both the value and number of transactions per card. The key explanatory variable is the merchant acceptance ratio (number of POS/number of merchants). We include the same control and regulatory dummies as in the other regressions.

Merchant Intensive Margin

In addition to adoption, we test for factors which contribute to greater payment card usage at POS. For the merchant intensive margin, we use the value and number of transactions as our dependent variable. The exclusion restriction that identifies the merchant intensive margin is the total number and value of transactions per card. This variable, together with regulatory dummies, will determine the intensive margin from the merchant side.

Card substitution in Europe: a dynamic panel data approach

As a first approach to assessing the relationship between cash replacement, intensive and extensive margins and wide cross-border interchange fee regulation, we use a set of dynamic panel estimations, employing our two cash substitution ratios, “IMSR” and “EMSR”, as alternative dependent variables (see Section 2.3). The dynamic panel methodology relies on the generalised method of moments (GMM) estimator developed by Arellano and Bond (1991), and is employed since the lagged values of the cash share variables are likely to determine, at least partially, the current levels of card share. Consider the following regression equation,

$$y_{i,t} - y_{i,t-1} - y_{i,t-2} = (\alpha - 1)y_{i,t-1} + (\phi - 1)y_{i,t-2} + \beta'X_{i,t} + \eta_i + \varepsilon_{i,t} \quad (6)$$

where y corresponds to both the “IMSR” and “EMSR variables, X is a set of explanatory variables representing technology variables, interchange fee dummies and financial and social control factors, η_i is an unobserved company-specific effect and ε is the error term. The subscripts i and t represent the company and time period, respectively. Equation (6) can be rewritten as:

$$y_{i,t} = \alpha y_{i,t-1} + \phi y_{i,t-2} + \beta'X_{i,t} + \eta_i + \varepsilon_{i,t} \quad (7)$$

The firm-specific effect is eliminated by taking second-differences in equation (7) so that:

$$y_{i,t} - y_{i,t-1} - y_{i,t-2} = \alpha(y_{i,t-1} - y_{i,t-2}) + \phi(y_{i,t-2} - y_{i,t-3}) + \beta'(X_{i,t} - X_{i,t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) \quad (8)$$

All variables are expressed in logs so that the differences can be interpreted as growth rates. The use of appropriate instruments is necessary to deal with the likely endogeneity of the explanatory variables, and also to deal with the fact that the new error term $(\varepsilon_{i,t} - \varepsilon_{i,t-1})$ is correlated with the lagged dependent variables $(y_{i,t-1} - y_{i,t-2})$ and $(y_{i,t-2} - y_{i,t-3})$. To reduce the potential biases and inaccuracy associated with the usual difference estimator, we use a new estimator that combines, in a single system, the regression in differences with the regression in levels (Arellano and Bover, 1995; Blundell *et al.* 2000)³⁰. We use the same variables as

³⁰ In dynamic panel data models where the observations are highly autoregressive and the number of time series is small, the standard GMM estimator has been found to have large finite sample bias and low precision in simulation studies. The Standard GMM panel data estimator also frequently performs poorly in relatively small panels with highly persistent data. The GMM system estimator improves the performance

instruments for the regression in differences. The instruments for the regression in levels are the lagged differences of the corresponding variables. These are appropriate instruments under the following additional assumption: although there may exist correlation between the levels of the right-hand side variables and the firm-specific effect in equation (7), there is no correlation between the differences of these variables and the firm-specific effect.

Considering the IMSR and EMSR variables (Table 4), we test the follow hypothesis:

H3. Regulatory action concerning interchange fees is likely to have the unplanned impact of moving payment systems towards card-based systems (in terms of the value and number of card transactions).

4. Empirical results

We report our regression results in Tables 5-7, firstly discussing intensive and extensive margins and then commenting on our cash replacement results. We find that cardholders and merchants benefit in general from different types of interchange fee regulation (national and cross-border reduction) and investigations, together with the strong network effects that result in greater adoption and usage of payment cards.

Identifying intensive and extensive margins: the role of interchange fee regulation

The extensive margin regressions show that mandatory reductions of interchange fees have had a positive impact on the number of POS per merchant but a negative one on the number of cards per capita. Interestingly, investigations into interchange fees have a positive and significant effect on cardholder and merchant adoption.

Furthermore, we are able to identify the presence of a strong network effect (i.e. an increase in customer adoption of payment cards results in greater merchant adoption), as predicted by the theoretical literature on two-sided markets. Among the control variables, the size of the

of the GMM estimator in the dynamic panel data context. Additionally, the GMM system estimator produces substantial asymptotic efficiency gains compared to to this nonlinear GMM estimator, and these are reflected in their finite sample properties (Blundell *et al.*, 2000).

financial sector (card processing may have scale benefits) and number of ATMs per branch are positive and statistically significant for cardholder extensive margins. GDP per capita displays a negative and statistically significant coefficient for cardholder adoption, resulting in consumers holding fewer cards per head.³¹ Moreover, the ROE, turnover (per merchant), tourism and crime variables are positive and statistically significant for merchant extensive margins.

Regarding intensive margin regressions (see Tables 6 and 7), in which the dependent variables are the value and the number of transactions, the signs of the regulatory dummies suggest that: *i*) mandatory reductions (at national level) have had a positive and significant effect on the number of transactions per card and the value of transactions per POS; *ii*) interchange fee investigations have had a positive and significant effect on transactions per POS and *iii*) cross-border reductions (mandated by the European Commission) have had a negative and significant impact on the value of transactions per card.

We found positive network effects in all regressions. The two sets of control variables (financial and social variables) display statistically significant coefficients. Both the size of the financial sector and GDP per capita increase the number of transactions per card, but decrease the value of transactions per card. However, GDP per capita displays a negative relationship with the number and value of transactions per POS. The number of tourists decreases the number of transactions per POS but increases the average value of transactions at POS. Finally, crimes recorded by police decrease both the value of transactions per card and the number of transactions per POS. This negative effect is in contrast to the increase in extensive margins (in accordance with diversification intended to minimise risk behaviour).

Our empirical analysis strongly suggests that mandated reductions and investigations of interchange fees result in higher merchant and cardholder extensive margins (see Table 5). However, the impact of each of the former is different, suggesting that not all actions are equally capable of convincing merchants and consumer to adopt cards. Econometric tests performed on

³¹ In future research, it could be useful to run quartile-income regressions in order to test adoption across different income levels.

equations (2) – (5) confirm the previously advanced hypotheses 2 and 3 (H2 and H3) and reject hypothesis 1 (H1). This suggests that welfare has benefited from the recent changes in interchange fees, in terms of payment card adoption and usage levels.

Cash replacement result: wide cross-border interchange fee reduction

We now analyse the results from the cash replacement equations, using dynamic panel estimations (Table 8 and 9). We have employed our two cash substitution ratios (“IMSR” and “EMSR”) as alternative dependent variables (see Section 2.3). The results confirm that the cross-border interchange fee reduction mandated by the European Commission has had a positive and significant effect on payment card usage (i.e. a higher number and value of card transactions compared to paper-based instruments). Our results allow us to reject hypothesis 4.

As in the last section, we include control variables in our regressions by using a set of financial and social indicators. For the dependent variable “IMSR”, we find a positive effect upon the number of POS per merchants, ATMs per branch and tourism. The “EMSR” regression displays a strong positive effect on the number of cards per head, the number of ATMs per branch and the number of tourists. Interestingly, the year of entry into the euro area, the year of implementation of the SEPA and turnover per merchant display a negative and statistically significant coefficient for payment card transactions as a percentage of the total number of transactions per country.

5. Summary and conclusions

A wide range of regulations has affected the development of payment systems. Specifically, our results suggest that recent actions related to interchange fees (mandatory reductions and investigations) have had a positive effect upon consumer and merchant adoption and usage of payment cards. Notably, mandatory cross-border reductions have encouraged cash replacement in Europe. Furthermore, our analysis suggests that financial and social variables in Europe may have affected intensive and extensive margins, and not only cash replacement. In

conclusion, we have been able to make a contribution to the debate on interchange fees from a European perspective. Specifically, our results suggest that when cash replacement and the adoption and usage of cards are low, interchange fee actions may improve consumer and merchant welfare.

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Annex I: Public authority involvement in interchange fees and MSC³² in the EU-

27

Competition authorities in the European Union have been examining whether shoppers receive equitable treatment from payment card networks. Litigation designed to eliminate the anti-competitive activities of the payment card and their banks has taken place or is currently underway in several countries.

We distinguish between three types of actions:

A. Investigations commenced by public authorities related to IFs (IFinvest)

Sweden 1995^(d): The Swedish Competition Authority rejected applications for negative clearance for the Visa (Case No. 1341/93) and Europay (Case No. 1833/93) systems, in December 1994 and June 1995 respectively, on the grounds that their non-discrimination rules and multilateral interchange fees were anti-competitive.

Poland 2001^(d): In 2001 the association of Polish retailers filed a complaint against Visa and MasterCard card-issuing banks, accusing them of, *inter alia*, price-fixing and creating barriers to entry to the payment cards market.

Germany 2001^(d): In March 2001 the ZKA (an association of five central associations of German banks, comprising almost all German banks.) applied for an exemption from article 1 of the German Act against Restraints of Competition, in order to reach a collective agreement among German banks upon the introduction of interchange fees into the German debit card system.

Spain 2002⁽ⁱ⁾: The Spanish National Competition Commission requested domestic payment card networks to provide information on their method of determining interchange fees.

Spain 2003⁽ⁱ⁾: The Spanish National Competition Commission rejected several proposals from the networks for the setting of interchange fees.

Germany 2003^(d): Since payment system rules no longer have to be notified to and approved by the German Competition Authority due to the coming into force of Regulation 1/2003 EG and the new Act against Restraints of Competition (2005), there now exists no automatic examination of rules concerning fees and their compatibility with applicable German competition law (see 1, 29 Act against Restraints of Competition).

UK 2003^(b): The Office of Fair Trading found that an agreement between MasterCard's UK members on a common fee for credit and charge card transactions made in the UK by infringed the Competition Act 1998.

France 2004^(b): The Commission issued an Statement of Objections on 8 July 2004, stating that the interchange fees constituted an agreement among nine of the largest French banks which were members of the 'Groupement des Cartes Bancaires'.

Netherlands 2004^{(b) (d)}: In April 2004 the Dutch Competition Authority concluded that Interpay Nederland, which operates the debit card system, infringed competition laws by charging excessive fees for PIN transactions during a certain period.

³² The Merchant Service Charge (MSC) is the fee that an acquiring bank charges to merchants. This fee covers a charge for the acquiring service (which is a revenue stream for the acquirer) plus the interchange fee (which the acquirer has to transfer to the issuer). This is important, since the interchange fee typically represents a large part - reportedly between 65% and 80% - of the MSC (Jones, 2005)

Denmark 2005^{(a) (b) (d) (e)}: The MSC charged by Dankort was replaced by an annual fee per retailer of between €67 and €363, depending on the size of the merchant.

Netherlands 2005^{(c) (d)}: A decision by the Competition Authority led to thousands of retailers requesting reimbursement for lost income. Subsequent discussions led to an agreement beginning from January 2005, whereby all retailers accepting PIN-based debit cards were refunded €0.01 per transaction. In December 2005, following the administrative appeal procedure, the Authority confirmed that the eight banks which established the Interpay system had infringed the prohibition on cartels.

UK 2005^(a): The Office of Fair Trading (OFT) found that MasterCard's interchange fee arrangements were illegal (September). The OFT issued a Statement of Objections regarding the Visa agreement (October).

France 2006^(b): A second Statement of Objections was addressed to the 'Groupement des Cartes Bancaires' alone, as the Commission believed that tariffs were set by a decision of the 'Groupement des Cartes Bancaires' acting as an association of undertakings, and not by an agreement among the banks themselves. The Commission therefore closed the case against the nine banks to which the preceding Statement of Objections was sent.

Hungary 2006^(a): The Competition Authority of Hungary considered intervening in the payment card market. Interchange fees were regarded as too high compared to costs, especially in the case of debit cards. Price discrimination between "on-us" (acquirer=issuer) and "foreign" (acquirer≠issuer) transactions was considered to have adverse effects upon issuer competition. Until that date, there had been no supervisory activity of interchange fees competition in Hungary^(d).

Italy 2006^(d): The Bank of Italy (which was responsible for the application of competition law regarding banking until 12 January 2006) and the Italian Competition Authority have opened a number of antitrust proceedings affecting the Italian card markets in recent years, regarding: 1) the cost of credit card purchases of gasoline; 2) the pricing decision of CartaSì acting as an acquirer; 3) the joint venture between CartaSì and American Express; 4) PagoBancomat services; 5) merchant fees in debit card transactions.

UK 2006^(a): The MasterCard finding was appealed, and since MasterCard had changed its method of setting interchange fees, the OFT consented to its decision being set aside by the Competition Appeal Tribunal (June).

Hungary and Romania 2007^(h): Visa's 10-K statement listed 19 countries around the world in which central banks and regulatory authorities are investigating interchange fee issues and acting to resolve them. This list includes both Romania and Hungary.

UK 2007^(a): The OFT launched a new MasterCard investigation in February.

B. Actions taken by public authorities related to IF reductions (IFreduc)

Spain 1999: The Spanish Ministry of the Economy ordered a reduction of interchange fees, from 3.5% in 1999 to 2.75% in July 2002.

Denmark 2003^(a): The Competition Authority established a positive MSC for Dankort transactions and reduced the fees for using Maestro and Visa Electron from 0.75% to 0.4%, with a maximum of 4 DKK.

Spain 2005^(a): The Spanish National Competition Commission refused to authorise the interchange fee arrangements of domestic card schemes. In December, agreement was

reached between Spanish card networks and merchants for interchange fees to be reduced from a maximum of 2.32% to 1.1% by 2008.

Austria 2006^(a): Following the European Commission's Interim Reports on the retail banking industry, Austrian banks agreed to review arrangements for setting interchange fees and announced that a reduction could be expected.

Portugal 2006^(a): The above-mentioned Interim Reports led Portuguese issuers and acquirers to satisfy some of the Commission's concerns, via a slight reduction of domestic interchange fees and the elimination of preferential bilateral domestic interchange fees.

Poland 2007^(a): In January 2007 the banks behind Poland's Visa and MasterCard interchange fee scheme were found to be flouting Poland's competition laws. The Polish Office of Competition and Consumer Protection ordered banks to discontinue their multilateral interchange fee agreements.

C. Actions taken by public authorities related to cross-border IFs (IFcross)

European Commission 2002^{(a),(f)}: The European Commission reached agreement with Visa to reduce its cross-border interchange fees by December 2007, to meet the objections from EU merchants (and specifically Eurocommerce), who claimed that Visa's Multilateral Interchange Fees (MIFs) were too high. The agreement reached required Visa's MIFs on credit cards to be gradually reduced over a five-year period, to reach a weighted average MIF of 0.7% by 2007.

European Commission 2003^{(c),(f)}: In 2003 the Commission initiated an investigation of MasterCard and issued a preliminary Statement of Objections, challenging the cost of MasterCard's cross-border MIFs for credit card transactions, similar to its investigation of Visa.

European Commission 2007^(a): The European Commission ruled that MasterCard's interchange fees were illegal³³ in December 2007. MasterCard filed an appeal against the decision in March 2008.

Source:

^(a) Bradford, T., and Hayashi, F., (2008), "*Developments in Interchange Fees in the United States and Abroad*". Payment System Research Briefing - April. Federal Reserve Bank of Kansas City.

^(b) Tumpel-Gugerell, G., (2005), "*Interchange in a changing market: Observations from the euro area perspective*". Speech for conference organised by the Federal Reserve Bank of Kansas City, Santa Fe, 6 May 2005.

^(c) EuroCommerce (<http://www.eurocommerce.be/>),

^(d) OECD, (2006), "*Competition and Efficient Usage of Payment Cards*". Policy Round Tables (published in October, 2007),

^(e) Study on the impact of regulation 2560/2001 on bank charges for national payments. RBR, London September 2005,

³³ On April 1 2009 the European Commission (EC) released a statement saying that MasterCard had agreed to three conditions (to be met by July), in response to a December 2007 decision by the Commission that MasterCard fees were in breach of EU antitrust laws. MasterCard would cap the weighted average cross-border interchange fee at 0.3% for credit card transactions (compared to between 0.8% and 1.9% previously) and 0.2% for debit card transactions. MasterCard also agreed to repeal related price increases it made in October 2008, and the network plans to make its rules more transparent,

^(f) Ordover, J., Guerin-Calvert, M. and Jones, P., (2005), “*Credit Card Multilateral Interchange Fee Regulation: The Wrong Strategy*”

([http://ema.com.ua/ema/ema.nsf/id/8B69E923DF73C1B8C2257389006C5F52/\\$FILE/interchange.pdf](http://ema.com.ua/ema/ema.nsf/id/8B69E923DF73C1B8C2257389006C5F52/$FILE/interchange.pdf)),

^(g) DG Internal Market & Services Newsletter on Financial Services, Fin-Focus, May 2007, No. 3,

^(h) A link to Visa’s 10-K³⁴ filing is posted at

<http://investor.visa.com/phoenix.zhtml?c=215693&p=irol-sec>

⁽ⁱ⁾ Spanish National Competition Commission <http://www.cncompetencia.es/>

³⁴ Interchange fees and related practices have also been or are currently being reviewed by regulatory authorities and/or central banks in a number of jurisdictions, including Australia, Brazil, Colombia, Honduras, Mexico, New Zealand, Norway, Singapore, South Africa, Switzerland and the United States. In certain countries, such as Australia and Mexico, interchange rates have been adjusted in anticipation of, or in response to, government regulation.

Annex II: Chronology of important events related to payment cards in the EU

	Dummy variable	Events
European Union	EU-27	Member states as of 1 January 2007 (EU-27): EU 25, Bulgaria and Romania.
	EU-25	Member states as of the end of 2006 (EU-25): EU15 plus Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia.
	EU-15	Member states as of the end of 2003 (EU-15): Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom.
Euro area	Since 1999: EA-1 Since 2001: EA-2 Since 2007: EA-3	Members as of 1 January 2007 (since 1999): Austria, Belgium, Finland, France, Germany, Greece (since 2001), Ireland, Italy, Luxembourg, Netherlands, Portugal, Slovenia (since 2007), Spain.
		Membership scheduled for 2008: Cyprus, Malta.
		Membership scheduled for 2009: Slovakia.
		Membership date not yet fixed: Bulgaria, Estonia, Czech Republic, Hungary, Latvia, Lithuania, Poland, Romania, and Sweden. Membership not in foreseeable future: Denmark, United Kingdom.
SEPA	SEPA-1	Design phase (2004-2005): The first phase began in 2004 and is now complete.
	SEPA-2	Implementation phase (06/2006): The second phase, the implementation phase, started in mid-2006 and continued until the end of 2007. This phase of the project was concentrated on preparation for the roll-out of the new SEPA instruments, standards and infrastructures. National implementation/migration bodies that have now been established in each euro area country will assist by monitoring the different stakeholders' preparations for SEPA roll-out. These stakeholders are very diverse, consisting of banks, infrastructure operators, public administrations, companies and other users.
		Migration phase (01/2008 – 12/2012+): The final phase will be a migration period, in which national payment schemes will coexist with the new SEPA schemes. National migration is the period of time over which the new SEPA payment products will gradually replace the existing domestic products. The goal is to achieve a gradual market-driven migration to SEPA, so that by 2010-2012 a critical mass of transactions will have migrated (i.e. SEPA instruments will be in general use). On 1st January 2008 the SEPA Cards Framework was launched.

Annex III. Variable definitions

Code	Variable	
A1	Gross domestic product at market prices (GDP): Current prices (millions of ECUs/euros)	Total economy including Rest of the World (all sectors)
A2	Total population: (thousands)	Total economy including Rest of the World (all sectors)
A3	Number of branches: Outstanding amounts at the end of the period (stocks)	Total credit institutions and payment institutions
A5	Number of card transactions (thousands) (2000-2007)	For cards issued in the reporting country, all cards except those with an e-money function
A6	Number of card transactions (thousands)	For cards issued in the reporting country, cards with a debit function
A11	Value of card transactions (thousands) (2000-2007)	For cards issued in the reporting country, all cards except those with an e-money function
A12	Value of card transactions (thousands)	For cards issued in the reporting country, cards with a debit function
A191	Number of cards	For cards issued in the reporting country, cards with a cash function
A23	Number of ATM terminals	All types of payment instruments in the reporting country
A24	Number of POS terminals	All types of payment instruments in the reporting country
A25	Number of cash withdrawals (thousands)	For cards issued in the reporting country
A26	Value of cash withdrawals (thousands)	For cards issued in the reporting country
A27	Number of POS transactions (thousands)	For cards issued in the reporting country
A28	Value of POS transactions (thousands)	For cards issued in the reporting country
A251	Value of cash withdrawals (thousands)	For cards <u>issued outside</u> the reporting country
A261	Number of cash withdrawals (thousands)	For cards <u>issued outside</u> the reporting country
A271	Value of POS transactions (thousands)	For cards <u>issued outside</u> the reporting country
A281	Number of POS transactions (thousands)	For cards <u>issued outside</u> the reporting country
LLGDP	Liquid liabilities (currency plus demand and interest-bearing liabilities of banks and non-bank financial intermediaries)/GDP (i.e. the size of the	

	financial intermediary sector)
ROE	Bank ROE
ENTERPRISES	Number of enterprises (Retail trade, except for motor vehicles, motorcycles; repair of personal and household goods, Hotels and restaurants, Transport, storage and communication)
TURNOVER	Turnover (Retail trade, except for motor vehicles, motorcycles; repair of personal and household goods, Hotels and restaurants, Transport, storage and communication) (millions of euros)
CRIME	Crimes recorded by the police
TOUR	Number of tourists visiting relatives and/or on holiday
IFREDUC	Dummy variable for IF reduction
IFINVEST	Dummy variable for IF investigation
IFCROSS	Dummy variable for inter-EU IF reduction
INTER_ATM	interoperability of ATMs (1: high 2: medium and 3:low)
CARD_SHARE	The data refer to payments made by transaction cards as a percentage of the total number of transactions per country
KM2	Country area (km2)

Source: ECB Blue book (June 2001), ECB Blue book in accession countries (August 2002), ECB Blue book Addendum incorporating 2000 figures (July 2002), ECB Blue book Addendum incorporating 2003 figures (August 2005), ECB Payment Statistics December 2008, Jones and Jones (2005), World Bank Financial Structure Indicators (2008), Eurostat, and World Bank (2008) "Payment Systems Worldwide: a Snapshot. Outcomes of the Global Payment Systems Survey 2008", Bank Profitability (2008): FINANCIAL STATEMENTS OF BANKS (1996-2005) OECD.

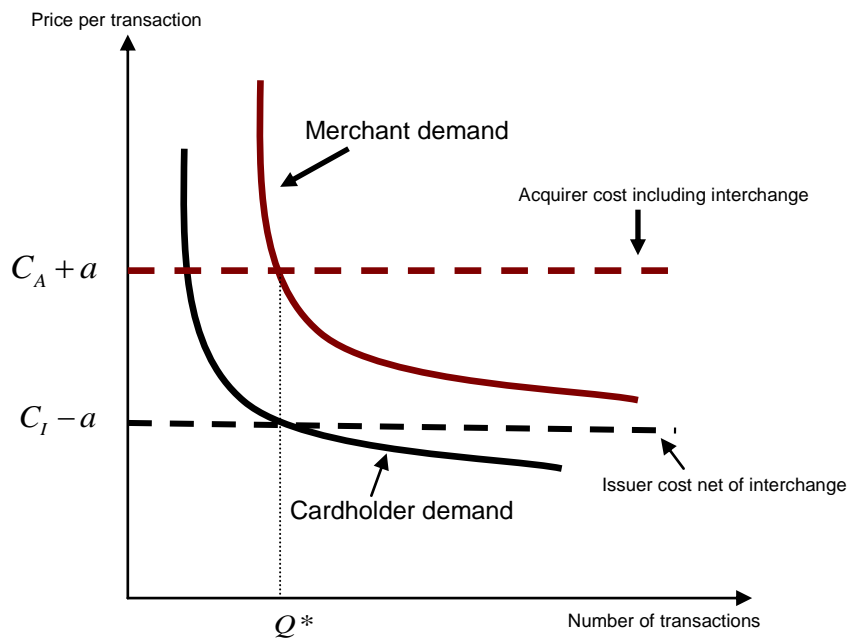
Note: All payment data are on an annual basis. Monetary magnitudes are expressed in real terms.

- Exchange rates for accession countries from 1995 to 1999 correspond to 1999 (Annex IV).
- Completely homogeneous data correspond to the period 2000-2007.
- All variables (except for dummies) are in logarithms.

Annex IV: Exchange rates (local currency/EURO)

Date	USD	BGN	CYP	CZK	DKK	EEK	GBP	HUF	LTL	LVL	MTL	PLN	ROL	RON	SEK	SIT	SKK
1995	0.9383	0.5134	1.7276	0.0271	0.1345	0.0639	1.5181	0.0040	0.2345	1.5984	2.3487	0.2366	0.0001	-	0.1135	0.0051	0.0227
1996	0.9383	0.5134	1.7276	0.0271	0.1345	0.0639	1.5181	0.0040	0.2345	1.5984	2.3487	0.2366	0.0001	-	0.1135	0.0051	0.0227
1997	0.9383	0.5134	1.7276	0.0271	0.1345	0.0639	1.5181	0.0040	0.2345	1.5984	2.3487	0.2366	0.0001	-	0.1135	0.0051	0.0227
1998	0.9383	0.5134	1.7276	0.0271	0.1345	0.0639	1.5181	0.0040	0.2345	1.5984	2.3487	0.2366	0.0001	-	0.1135	0.0051	0.0227
1999	0.9383	0.5134	1.7276	0.0271	0.1345	0.0639	1.5181	0.0040	0.2345	1.5984	2.3487	0.2366	0.0001	-	0.1135	0.0051	0.0227
2000	1.0827	0.5134	1.7424	0.0281	0.1342	0.0639	1.6407	0.0038	0.2706	1.7881	2.4744	0.2495	0.0001	-	0.1184	0.0048	0.0235
2001	1.1164	0.5133	1.7365	0.0293	0.1342	0.0639	1.6080	0.0039	0.2791	1.7853	2.4812	0.2723	0.0000	-	0.1081	0.0046	0.0231
2002	1.0576	0.5130	1.7382	0.0325	0.1346	0.0639	1.5903	0.0041	0.2891	1.7210	2.4454	0.2592	0.0000	-	0.1092	0.0044	0.0234
2003	0.8840	0.5131	1.7121	0.0314	0.1346	0.0639	1.4451	0.0039	0.2896	1.5609	2.3470	0.2273	0.0000	-	0.1096	0.0043	0.0241
2004	0.8042	0.5120	1.7189	0.0314	0.1344	0.0639	1.4743	0.0040	0.2896	1.5035	2.3369	0.2210	0.0000	-	0.1096	0.0042	0.0250
2005	0.8043	0.5113	1.7337	0.0336	0.1342	0.0639	1.4628	0.0040	0.2896	1.4364	2.3262	0.2486	0.0000	0.2793	0.1077	0.0042	0.0259
2006	0.7964	0.5113	1.7368	0.0353	0.1341	0.0639	1.4669	0.0038	0.2896	1.4363	2.3294	0.2567	-	0.2836	0.1081	0.0042	0.0269
2007	0.7297	0.5113	1.7163	0.0360	0.1342	0.0639	1.4613	0.0040	0.2896	1.4284	2.3294	0.2643	-	0.2998	0.1081	-	0.0296

Figure 1. Balancing Role of Interchange



Source: Harper *et al.* (2006) and authors' elaboration.

Table 1. Summary and descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
a1	347	355353.9	565812	2754.3	2422900
a2	341	18027.65	22612.48	377.78	82520
a3	208	10866.24	15708.11	106	59827
a5	211	760560.6	1390014	821	7200000
a6	317	453436	970458.2	1.52	6144656
a11	211	4.53E+07	9.13E+07	27157	5.54E+08
a12	337	2.35E+07	5.17E+07	1.026829	3.39E+08
a191	346	1.81E+07	3.27E+07	20	1.65E+08
a23	351	10064.34	15944.65	0.01	68321
a24	349	184248.6	300352.5	0.01	1351774
a25	340	338661.6	556693.8	11	2834000
a26	341	3.43E+07	6.33E+07	107.3	3.82E+08
a27	341	543093.8	1134933	1.52	6894000
a28	341	2.99E+07	7.07E+07	0.5544874	5.17E+08
a251	121	1132039	3797902	36708	3.97E+07
a261	118	8752.11	34710.29	292	369595
a271	128	2478429	4544336	15210	2.32E+07
a281	125	38569.9	78353.95	130	327000
LLGDP	333	0.7583303	0.5543859	0.1599156	3.951936
ROE	348	0.1019005	0.1180128	-0.71126	1.060129
ENTERPRISES	284	227476.9	303404.5	507	1157627
TURNOVER	290	122559.7	193176.2	586.4	825929.4
CRIME	316	1075631	1647437	3910	6668717
TOUR	187	1.12E+07	1.42E+07	190000	6.28E+07
IFINVEST	351	0.0541311	0.2265991	0	1
IFREDUC	351	0.017094	0.1298068	0	1
IFCROSS	351	0.2307692	0.4219265	0	1
INTER_ATM	351	1.222222	0.4163332	1	2
CARD_SHARE	333	28.64417	19.23603	0	93.9
KM2	351	160405.8	160942.6	316	551500

Table 2. Extensive margin indicators across European countries

Country	1996			2000			2006		
	GDP per capita	POS/number of merchants	Cards per capita	GDP per capita	POS/number of merchants	Cards per capita	GDP per capita	POS/number of merchants	Cards per capita
Austria	23,184	0.06	0.61	25,904	0.47	0.90	31,067	0.95	1.12
Belgium	21,369	-	1.04	24,570	2.05	1.36	30,183	0.88	1.57
Bulgaria	946	0.00	0.00	1,682	0.01	0.07	3,278	0.76	0.78
Cyprus	11,138	-	0.70	14,523	0.33	0.63	18,992	1.57	1.11
Czech Republic	4,736	0.01	0.12	5,986	0.05	0.39	11,051	0.28	0.62
Denmark	27,618	1.41	0.57	32,521	1.43	0.65	40,158	2.03	0.96
Estonia	2,606	0.23	0.30	4,448	0.48	0.63	9,745	1.59	1.20
Finland	19,758	0.93	0.93	25,555	1.07	1.18	31,719	1.79	1.19
France	20,794	0.96	0.46	23,726	1.24	0.67	28,601	1.49	1.36
Germany	23,465	-	0.98	25,095	1.11	1.33	28,185	1.02	1.27
Greece	-	-	-	12,634	1.24	0.54	19,124	0.93	0.83
Hungary	3,451	-	0.16	5,096	2.71	0.44	8,937	0.27	0.79
Ireland	16,072	0.18	0.79	27,591	1.25	0.81	41,682	1.39	1.05
Italy	17,449	0.20	0.27	20,917	0.52	0.37	25,109	1.04	0.65
Latvia	1,820	-	0.01	3,583	0.32	0.27	7,014	0.77	0.90
Lithuania	1,790	0.01	0.01	3,537	0.26	0.14	7,065	0.43	1.04
Luxembourg	39,016	0.71	1.18	50,172	1.08	1.35	71,775	1.30	2.11
Malta	7,610	-	0.51	10,825	0.44	0.84	12,529	-	1.26
Netherlands	21,211	0.66	1.31	26,250	1.02	1.63	33,041	1.80	1.94
Poland	3,224	0.00	0.02	4,855	0.13	0.29	7,135	0.29	0.60
Portugal	9,216	0.25	0.70	11,957	0.40	1.07	14,686	0.58	1.45
Romania	-	-	-	1,797	0.01	0.05	4,521	0.26	0.42
Slovakia	3,099	0.63	0.14	4,080	1.68	0.32	8,267	2.04	0.80
Slovenia	8,212	0.13	0.65	10,775	0.65	0.92	15,446	1.42	1.48
Spain	12,424	-	0.84	15,653	0.79	1.16	22,291	1.24	1.61
Sweden	24,603	0.58	0.52	30,030	0.79	0.55	34,504	1.57	1.04
UK	16,515	1.74	1.53	27,209	1.79	2.05	32,003	2.47	2.71

Table 3. Intensive margin indicators across European countries

Country	1996				2000				2006			
	Number of transactions per card	Number of transactions per POS	Value of transactions per card	Value of transactions per POS	Number of transactions per card	Number of transactions per POS	Value of transactions per card	Value of transactions per POS	Number of transactions per card	Number of transactions per POS	Value of transactions per card	Value of transactions per POS
Austria	-	2,964	-	158,979	15.04	1,994	1,084.72	112,522	31.26	2,320	1,910.40	115,452
Belgium	-	2,604	-	136,233	31.99	3,574	1,854.27	197,070	48.02	6,486	2,706.38	350,027
Bulgaria	-	59	-	57	-	-	-	15,346	3.76	198	214.96	14,566
Cyprus	-	728	-	53,629	17.23	1,072	1,598.24	72,022	25.21	1,052	2,322.86	75,444
Czech Republic	-	818	-	59,153	3.65	1,011	190.73	46,908	14.74	1,514	575.48	59,087
Denmark	-	6,300	-	221,973	122.27	5,285	6,020.97	256,878	147.27	6,551	7,810.96	329,745
Estonia	-	275	-	4,261	13.70	2,805	272.72	81,820	66.04	7,051	1,185.01	118,351
Finland	-	3,451	-	117,647	52.05	5,129	2,291.61	225,806	130.17	7,897	4,487.92	271,097
France	-	3,172	-	152,349	80.41	3,924	3,736.72	182,353	65.56	4,787	3,302.42	237,280
Germany	-	1,364	-	106,323	13.14	2,477	1,001.93	185,587	23.37	4,284	1,565.57	282,259
Greece	-	-	-	1,493	8.63	140	532.24	9,217	7.75	186	806.51	14,469
Hungary	-	427	-	52,666	4.62	478	162.50	53,879	13.80	2,341	455.63	183,031
Ireland	-	227	-	8,636	26.55	1,952	1,877.63	138,095	45.82	3,863	4,312.18	363,528
Italy	-	335	-	32,603	27.88	531	2,290.43	38,623	32.21	660	3,116.79	61,069
Latvia	-	182	-	-	8.35	985	449.12	52,989	27.71	3,460	640.87	67,336
Lithuania	-	944	-	113,746	8.60	667	204.59	37,920	19.35	2,692	596.86	47,076
Luxembourg	-	1,447	-	96,890	-	3,435	-	242,694	40.91	3,927	3,241.08	261,888
Malta	-	417	-	27,705	7.38	446	449.91	25,780	12.52	618	788.13	33,441
Netherlands	-	3,862	-	166,590	32.63	5,514	1,631.73	286,664	48.43	6,188	2,263.99	255,974
Poland	-	643	-	45,843	4.83	359	215.75	15,336	15.56	1,958	476.27	57,454
Portugal	-	3,818	-	100,943	43.69	4,625	1,304.08	123,024	51.60	4,394	1,784.56	141,976
Romania	-	-	-	-	0.76	190	25.24	22,469	2.35	382	116.59	15,844
Slovakia	-	368	-	10,778	-	573	-	16,295	10.11	1,466	761.93	44,931
Slovenia	-	5,323	-	1,536	30.05	2,469	869.78	18,320	34.55	2,804	1,115.09	52,629
Spain	-	480	-	10,429	-	553	-	22,761	23.70	1,205	1,201.17	60,496
Sweden	-	1,433	-	92,834	66.23	2,938	5,099.67	194,332	126.42	5,301	5,225.68	200,620
UK	-	2,345	-	105,712	32.72	5,155	2,350.69	359,186	40.99	6,295	3,070.45	459,841

Note: Value of transactions in Euros and volume of transactions in units.

Table 4. Cash replacement indicators across European countries

Country	1996				2000				2006			
	Value of POS expenditure per capita	Value of ATM withdrawal per capita	IMSR (%)	EMSR (%)	Value of POS expenditure per capita	Value of ATM withdrawal per capita	IMSR (%)	EMSR (%)	Value of POS expenditure per capita	Value of ATM withdrawal per capita	IMSR (%)	EMSR (%)
Austria	304	1,390	0.18	0.05	564	1,685	0.25	0.12	1,382	2,032	0.40	0.15
Belgium	997	1,557	0.39	0.21	1,882	2,045	0.48	0.32	3,386	2,805	0.55	0.40
Bulgaria	0	0	0.03	0.03	3	35	0.09	0.00	81	455	0.15	0.30
Cyprus	201	212	0.49	0.10	674	260	0.72	0.20	2,041	1,179	0.63	0.31
Czech Republic	7	129	0.05	0.00	74	476	0.13	0.03	323	1,620	0.17	0.00
Denmark	2,556	-	1.00	0.46	3,644	598	0.86	0.52	6,715	515	0.93	0.63
Estonia	4	158	0.02	0.00	171	1,338	0.11	0.24	1,171	2,499	0.32	0.53
Finland	1,366	2,732	0.33	0.35	1,990	3,246	0.38	0.37	4,272	3,152	0.58	0.53
France	-	771	-	0.21	2,518	1,086	0.70	0.27	4,476	1,587	0.74	0.38
Germany	366	2,172	0.14	0.04	1,009	3,089	0.25	0.12	1,504	4,630	0.25	0.14
Greece	-	-	-	0.78	4	1,776	0.00	0.65	69	3,728	0.02	0.49
Hungary	133	117	0.53	0.02	884	763	0.54	0.11	2,403	1,351	0.64	0.14
Ireland	10	1,655	0.01	0.08	474	3,158	0.13	0.28	1,575	5,926	0.21	0.36
Italy	193	1,038	0.16	0.10	406	1,247	0.25	0.29	1,210	1,414	0.46	0.34
Latvia	7	2	0.81	0.01	253	289	0.47	0.13	1,570	1,601	0.50	0.34
Lithuania	6	2	0.76	0.04	26	78	0.25	0.16	542	1,452	0.27	0.44
Luxembourg	1,756	1,131	0.61	0.94	2,486	1,317	0.65	0.00	3,391	1,521	0.69	0.38
Malta	184	708	0.21	0.00	378	1,279	0.23	0.18	499	2,235	0.18	0.27
Netherlands	1,031	2,196	0.32	0.20	2,341	2,557	0.48	0.29	3,930	3,376	0.54	0.37
Poland	4	6	0.39	0.02	35	351	0.09	0.11	173	1,142	0.13	0.28
Portugal	457	1,064	0.30	0.34	1,275	1,496	0.46	0.50	2,385	2,454	0.49	0.64
Romania	-	-	-	0.00	1	17	0.06	0.02	37	438	0.08	0.09
Slovakia	1	125	0.01	0.00	30	359	0.08	0.04	558	1,140	0.33	0.17
Slovenia	4	379	0.01	0.42	200	917	0.18	0.66	877	2,051	0.30	0.32
Spain	204	1,216	0.14	0.21	337	1,540	0.18	0.25	1,075	2,310	0.32	0.36
Sweden	757	2,703	0.22	0.15	1,908	3,617	0.35	0.27	4,259	3,308	0.56	0.61
UK	809	1,375	0.37	0.27	2,206	3,149	0.41	0.38	4,971	4,353	0.53	0.47

Note: **IMSR (intensive margin substitution ratio)** = Value of POS expenditure per capita/(Value of POS expenditure per capita + Value of ATM withdrawal per capita) and **EMSR (extensive margin substitution ratio)** = payments made by transaction cards as a percentage of the total number of transactions per country

.Table 5. Extensive margins for consumers and merchants
Simultaneous equations estimation (GMM) with fixed effects
(Robust standard errors (Robust-White) in parenthesis)

	<i>Model 1⁺</i>		<i>Model 2⁺⁺</i>		<i>Model 3⁺</i>	
	<i>Cardholder extensive margin (CARDS)</i>	<i>Merchant extensive margin (POS)</i>	<i>Cardholder extensive margin (CARDS)</i>	<i>Merchant extensive margin (POS)</i>	<i>Cardholder extensive margin (CARDS)</i>	<i>Merchant extensive margin (POS)</i>
	<i>Number of payment cards per capita (LCARDPOP_{it})</i>	<i>Number of POS/number of merchants (LPOSLOCAL_{it})</i>	<i>Number of payment cards per capita (LCARDPOP_{it})</i>	<i>Number of POS/number of merchants (LPOSLOCAL_{it})</i>	<i>Number of payment cards per capita (LCARDPOP_{it})</i>	<i>Number of POS/number of merchants (LPOSLOCAL_{it})</i>
Constant	8.863*** (0.413)	-3.112*** (1.086)	7.99*** (0.34)	-	8.36*** (0.27)	-3.58*** (1.37)
Network effects						
Number of POS/merchant (LPOSLOCAL_{t-1})	0.502*** (0.079)	-	0.23*** (0.08)	-	0.53*** (0.08)	-
Number of payment cards per capita (LCARDPOP_{t-1})	-	0.486*** (0.173)	-	0.16*** (0.04)	-	0.64*** (0.18)
Interchange fees						
Dummy for IF reduction (IFreduc)	-0.429** (0.166)	0.549* (0.324)	-	-	-	-
Dummy for IF investigation (IFinvest)	-	-	0.53*** (0.11)	0.56* (0.32)	-	-
Dummy for inter-EU IF reduction (Ifcross)	-	-	-	-	-0.14 (0.1)	0.08 (0.14)
Financial variables						
Liquid liabilities/GDP (size of financial intermediary sector) (LLGDP)	0.773*** (0.085)	-	0.76*** (0.06)	-	0.6*** (0.08)	-
ROE (LROE_{t-1})	-	1.01*** (0.28)	-	0.48* (0.26)	-	0.64*** (0.16)
Number of ATMs/branch (LATMBR_{t-1})	0.368*** (0.058)	-	0.46*** (0.05)	-	0.25*** (0.06)	-
Interoperability of ATMs (inter_ATM)	-0.057 (0.199)	-	0.26* (0.13)	-	0.02 (0.18)	-
Turnover/number of merchants (LTURNENTER)	-	0.633*** (0.118)	-	0.75*** (0.09)	-	0.6*** (0.08)
Dummy for the implementation phase of SEPA (SEPA2)	0.032 (0.092)	-0.507** (0.224)	0.03 (0.08)	-0.16 (0.17)	-0.16* (0.08)	-0.14 (0.15)
Social variables						
GDP per capita (LGDPPOP_{t-1})	-0.519*** (0.099)	-0.155 (0.149)	-0.36*** (0.08)	-0.13 (0.1)	-0.38*** (0.07)	-0.23*** (0.08)
Number of tourists (LTOUR_{t-1})	-	0.203*** (0.043)	-	0.06 (0.05)	-	0.12*** (0.02)
Crimes recorded by police per km² (LCRIMEKM_t)	0.012 (0.022)	-0.092 (0.066)	-0.08** (0.04)	-0.15* (0.07)	0.05* (0.03)	-0.14** (0.06)
R²	0.77	0.65	0.71	0.67	0.67	0.67
Sargan test of over identifying restrictions (p-value in parenthesis)	11.2794 (0.186)		9.22523 (0.417)		10.3613 (0.241)	

Table 6. Intensive margins for consumers and merchants (number of transactions)
Simultaneous equations estimation (GMM) with fixed effects
(Robust standard errors (Robust-White) in parenthesis)

	<i>Model 1⁺</i>		<i>Model 2⁺</i>		<i>Model 3⁺</i>	
	<i>Cardholder intensive margin (transactions per card)</i>	<i>Merchant intensive margin (transactions per POS)</i>	<i>Cardholder intensive margin (transactions per card)</i>	<i>Merchant intensive margin (transactions per POS)</i>	<i>Cardholder intensive margin (transactions per card)</i>	<i>Merchant intensive margin (transactions per POS)</i>
	<i>Number of transactions per card (LVOLCARD_{it})</i>	<i>Number of transactions per POS (LVOLPOS_{it})</i>	<i>Number of transactions per card (LVOLCARD_{it})</i>	<i>Number of transactions per POS (LVOLPOS_{it})</i>	<i>Number of transactions per card (LVOLCARD_{it})</i>	<i>Number of transactions per POS (LVOLPOS_{it})</i>
Constant	-5.11*** (0.35)	14.02*** (1.74)	-5.47*** (0.53)	11.01*** (1.91)	-5.18*** (0.52)	13.74*** (2.27)
Network effects						
Number of transactions per POS (LVOLPOS _{t-1})	0.59*** (0.05)	-	0.6*** (0.08)	-	0.63*** (0.07)	-
Number of transactions per card (LVOLCARD _{t-1})	-	1.5*** (0.09)	-	1.6*** (0.1)	-	1.6*** (0.11)
Payment variables						
Number of POS/number of merchants (LPOSLOCAL _{t-1})	0.13* (0.07)	-	0.16 (0.12)	-	0.23*** (0.08)	-
Number of payment cards per capita (LCARDPOP _t)	-	-0.68*** (0.18)	-	-0.32 (0.26)	-	-0.75*** (0.27)
Number of transactions with cards issued outside of the country per POS (LVOUTPOS)	-	-0.14*** (0.04)	-	-0.13*** (0.04)	-	-0.15*** (0.05)
Interchange fees						
Dummy for IF reduction (IFreduc)	0.35* (0.19)	0.36 (0.33)	-	-	-	-
Dummy for IF investigation (IFinvest)	-	-	-0.59 (0.4)	1.19** (0.58)	-	-
Dummy for inter-EU IF reduction (Ifcross)	-	-	-	-	-0.27 (0.29)	0.24 (0.19)
Financial variables						
Liquid liabilities/GDP (size of the financial intermediary sector) (LLGDP)	0.11 (0.14)	-	0.52*** (0.18)	-	0.6*** (0.15)	-
Number of ATM cash withdrawals (LCASHATM)	0.19** (0.08)	-	0.44*** (0.15)	-	0.37*** (0.14)	-
Dummy for the implementation phase of SEPA (SEPA2)	-0.06 (0.13)	0.16 (0.15)	0.19* (0.09)	-0.14 (0.1)	0.15 (0.1)	0.01 (0.11)
Social variables						
GDP per capita (LGDPPOP _{t-1})	0.3*** (0.07)	-0.51*** (0.08)	0.15 (0.1)	-0.55*** (0.11)	0.15* (0.08)	-0.56*** (0.09)
Number of tourist (LTOUR _t)	-	-0.17*** (0.04)	-	-0.09** (0.03)	-	-0.08*** (0.03)
R ²	0.84	0.78	0.76	0.87	0.76	0.80
Sargan test of over identifying restrictions (p-value in parenthesis)	13.3151 (0.101)		11.5251 (0.174)		13.0262 (0.111)	

⁺ Also robust to autocorrelation: NMA= 0, Kernel=Bartlett. *, **, ***: statistically significant at 10%, 5% and 1% level, respectively. **Note:** correlation between variables LVOUTPOS and LTOUR was -0.44.

Table 7. Intensive margins for consumers and merchants (value of transactions)
Simultaneous equations estimation (GMM) with fixed effects
(Robust standard errors (Robust-White) in parenthesis)

	<i>Model 1⁺</i>		<i>Model 2⁺</i>	
	<i>Cardholder intensive margin (value of transactions per card)</i>	<i>Merchant intensive margin (value of transactions per POS)</i>	<i>Cardholder intensive margin (value of transactions per card)</i>	<i>Merchant intensive margin (value of transactions per POS)</i>
	<i>Value of transactions per card (LVALCARD_{it})</i>	<i>Value of transactions per POS (LVALPOS_{it})</i>	<i>Value of transactions per card (LVALCARD_{it})</i>	<i>Value of transactions per POS (LVALPOS_{it})</i>
Constant	1.66 (1.56)	-4.32*** (1.22)	1.8* (0.96)	-6.63*** (1.86)
Network effects				
Value of transactions per POS (LVALPOS_{t-1})	0.77*** (0.1)	-	0.73*** (0.05)	-
Value of transactions per card (LVALCARD_{t-1})	-	0.86*** (0.08)	-	0.81*** (0.1)
Payment variables				
Number of payment cards per capita (LCARDPOP_{t-1})	-0.21 (0.25)	0.97*** (0.15)	-0.21* (0.12)	1.21*** (0.2)
Number of POS/number of merchants (LPOSLOCAL_{t-1})	-0.15* (0.08)	-1.47*** (0.14)	-0.16** (0.08)	-1.47*** (0.22)
Value of transactions with cards issued outside of the country per POS (LVAOUTPOS_t)	-	0.24* (0.12)	-	0.27*** (0.09)
Interchange fees				
Dummy for IF reduction (IFreduce)	0.24 (0.4)	0.23** (0.08)	-	-
Dummy for inter-EU IF reduction (Ifcross)	-	-	-0.2*** (0.06)	0.11 (0.16)
Financial variables				
Liquid liabilities/GDP (size of financial intermediary sector) (LLLGDGP)	-0.17 (0.16)	-	-0.25*** (0.07)	-
Value of ATM cash withdrawals (LVCASHATM)	-0.65*** (0.03)	-	-0.64*** (0.06)	-
Turnover/number of merchants (LTURNENTER)	-	1.93*** (0.18)	-	1.94*** (0.23)
Dummy for the implementation phase of SEPA (SEPA2)	0.1* (0.06)	-0.2* (0.12)	-0.04 (0.06)	0.06 (0.11)
Social variables				
GDP per capita (LGDPOP_t)	0.68*** (0.1)	-1.07*** (0.08)	0.68*** (0.08)	-1.07*** (0.13)
Crimes recorded by police per km² (LCRIMEKM_t)	-0.38*** (0.04)	-0.31*** (0.09)	-0.31*** (0.03)	-0.38*** (0.1)
Number of tourists (LTOUR_{t-1})	-	0.39*** (0.1)	-	0.42*** (0.09)
R²	0.95	0.97	0.97	0.96
Sargan test of over identifying restrictions (p-value in parenthesis)	0.87 (0.647)		9.57 (0.296)	

⁺ Also robust to autocorrelation: NMA= 0, Kernel=Bartlett.

*, **, ***: statistically significant at 10%, 5% and 1% level, respectively.

Note: Correlation between the LVALPOS and LTOUR_{t-1} variables was only 0.08.

**Table 8. Inter-EU IF regulation and intensive margin substitution ratio (IMSR) in Europe
(EU-27)**

Number of observations: 41		
Dynamic Panel Data Analysis ⁺ (GMM system estimator)		
Standard errors in parenthesis		
Dependent variable: IMSR (intensive margin substitution ratio) = (Value of POS expenditure per capita)/(Value of debit (POS) expenditures per capita + Value of ATM withdrawal per capita)		
Variable	(I)	(II)
Constant	-10.64*** (0.05)	-10.57*** (0.09)
Lagged dependent variable		
IMSR_(t-1)	0.75** (0.3)	0.41*** (0.12)
IMSR_(t-2)	0.83** (0.31)	0.37*** (0.09)
Adoption variables		
Number of POS/number of merchants (LPOSLOCAL)	-0.07 (0.1)	0.11*** (0.03)
Number of payment cards per capita (LCARDPOP)	-0.54** (0.2)	0 (0.02)
Interchange fees		
Dummy for inter-EU IF reduction (Ifcross)	1.76*** (0.08)	1.67*** (0.08)
Financial Variables		
Liquid liabilities/GDP (size of financial intermediary sector) (LLGDP)	0.02 (0.46)	-0.12 (0.08)
Number of ATMs/branch(LATMBR)	0.04 (0.14)	0.08** (0.03)
Turnover/number of merchants (LTURNENTER_(t-1))	0.7*** (0.2)	-0.16*** (0.03)
Dummy for the implementation phase of SEPA (SEPA2)	-1.39*** (0.11)	-1.36*** (0.07)
Dummy for entry in the euro area (EA3)	-	-0.05 (0.05)
Social variables		
Crimes recorded by police per km² (LCRIMEKMC_(t-1))	-0.36** (0.18)	0.07** (0.03)
GDP per capita (LGDPOP_(t-1))	-1.12*** (0.38)	0.14** (0.06)
Number of tourists (LTOUR_(t-1))	0.57*** (0.12)	-0.05** (0.02)
F-test	-9.45*** (0.33)	-9.32*** (0.17)
Sargan test (p-value in parenthesis)	15.51 (0.905)	16.7167 (0.823)

⁺ Also robust to autocorrelation: NMA= 1, Kernel=Bartlett.

*, **, ***: statistically significant at 10%, 5% and 1% level, respectively.

All variables are in logs. The model includes a time dummy for technical change.

Table 9. Inter-EU IF regulation and extensive margin substitution ratio (EMSR) in Europe (EU-27)

Number of observations: 39		
Dynamic Panel Data Analysis ⁺ (GMM system estimator)		
Standard errors in parenthesis		
Dependent Variable: EMSR (extensive margin substitution ratio) = transactions using payment cards as a percentage of the total number of transactions per country.		
Variable	(I)	(II)
Constant	-10.64*** (0.06)	-10.53*** (0.06)
Lagged dependent variable		
EMSR _(t-1)	-1.11*** (0.18)	-0.67*** (0.16)
EMSR _(t-2)	2.0*** (0.18)	1.6*** (0.15)
Adoption variables		
Number of POS/number of merchants (LPOSLOCAL)	0.22*** (0.06)	0.03 (0.04)
Number of payment cards per capita (LCARDPOP)	-0.04 (0.06)	-0.03 (0.03)
Interchange fees		
Dummy for inter-EU IF reduction (Ifcross)	1.71*** (0.08)	1.66*** (0.08)
Financial variables		
Liquid liabilities/GDP (size of the financial intermediary sector) (LLGDP)	-0.03 (0.14)	-0.12 (0.1)
Number of ATMs/branch (LATMBR)	0.17*** (0.05)	0.09** (0.03)
Turnover/number of merchants (LTURNENTER _(t-1))	-0.19*** (0.05)	-0.08* (0.05)
Dummy for the implementation phase of SEPA (SEPA2)	-1.36*** (0.07)	-1.35*** (0.07)
Dummy for entry in the euro area (EA3)	-	-0.11*** (0.04)
Social variables		
Crimes recorded by police per km² (LCRIMEKMC _(t-1))	-0.01 (0.03)	0.01 (0.03)
GDP per capita (LGDPOP _(t-1))	-0.09 (0.06)	-0.03 (0.05)
Number of tourists (LTOUR _(t-1))	0.06** (0.03)	0.04* (0.02)
F-test	-9.37*** (0.15)	-9.48 *** (0.10)
Sargan test (p-value in parenthesis)	17.4088 (0.831)	14.4934 (0.912)
⁺ Also robust to autocorrelation: NMA= 1, Kernel=Bartlett.		
*, **, ***: statistically significant at 10%, 5% and 1% level, respectively.		
All variables are in logs. The model includes a time dummy for technical change.		