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MARKET POWER AND WILLINGNESS TO PAY IN NETWORK INDUSTRIES: EVIDENCE FROM PAYMENT CARDS WITHIN MULTIPRODUCT BANKING

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Abstract

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Theoretical contributions on network industries have been numerous. However, there is a lack of sufficient empirical evidence which would assist related policymaking. This is the case of payment cards markets. This paper employs a unique database to analyze changes in market power and consumers' willingness to pay resulting from the introduction of payment cards in a multiproduct banking technology. Our findings indicate that any rise in bank market power from payment cards is associated to a greater increase in consumers' willingness to pay. Any antitrust intervention which does not take into account such welfare effects could be misguided.
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1. Introduction

The literature of network economics and platform industries has expanded significantly in recent years[1]. In this context, theoretical contributions on these areas have been numerous. However, there seems to be a paucity of related empirical research, mainly as a consequence of the lack of reliable data. It has been very often been argued that more empirical evidence on network industries is needed to test a number of theoretical predictions and to assist regulators and antitrust authorities in the supervision and monitoring of competitive and strategic trends in these markets[2].

One of the main developments has taken place in payment cards services, which have typified industries with such interactions and network externalities, for both the firms and consumers involved. As payment cards have represented one of the main driving forces behind the development of modern retail financial services, competition authorities have paid increasing attention to them, both as an individual case and as a part of the entire range of financial services. Several antitrust authorities have argued that payment cards issuers have significantly increased their market power in recent years[3]. This has also been the case of well-known controversial antitrust resolutions and class action lawsuits against card associations worldwide. These resolutions have involved substantial changes in cards' pricing schemes in several European countries and Australia. In the US, many card associations have been forced to pay enormous compensations to merchants and cardholders for damages[4]. Unlike other platform

[1] Two-sided platforms serve two groups of agents, so that the participation of, at least, one group raises the value (the 'indirect' network effect) of participating for the other group. Some examples are software, Internet search engines, dating and employment agencies, some telecommunication systems or videogames.

[2] See Rochet and Tirole (2003, 2004 and 2005) for an extensive description of these markets and research guidelines.

[3] This is the case, for example, of surcharges on ATM transactions in the US (Hannan *et al.*, 2003). Similarly, the European Commission (2007) has suggested that some of the charges for consumers and merchants in several EU countries are abusive and need to be regulated.

[4] In Europe, the European Commission cleared Visa's European cross-border interchange fees and found that merchants were restricted to accept cards by a 'lock-in' effect since they were somehow forced to

industries (e.g. telecommunication systems or software), however, the competitive analysis of cards has been frequently undertaken using a standard, vertically organized, concept of the market, and antitrust agencies have often issued resolutions based upon this perception.

Although a wide range of non-banking financial and non-financial competitors are also card issuers, the role of cards is particularly relevant in the banking industry for various reasons. Firstly, banks are the main card issuers in most financial markets. Secondly, card services are usually offered as part of a set of banking products which, in turn, are frequently interrelated, in terms of costs, revenues and prices. Finally, the majority of transactions take place at ATMs and POS (Point of Sale) machines which are principally provided by banks and determine a significant proportion of card network externalities (Stavins and Gowrisankaran, 2004).

The vertical organization of 'traditional' bank markets may often shape the regulatory treatment of cards i.e. as if they were balance sheet assets. However, compared to other banking services, the market structure of cards has two main distinctive characteristics: (i) card markets are organized as network systems where consumers use cards at the ATMs or POS terminals of their own banks or those of their competitors. The value one user receives from ATM or POS terminals increases in line with the number of other users of that services; (ii) as payment instruments at the point

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offer the credit card payment service. The European Commission (2006) has also taken the preliminary view that MasterCard restricts competition between member banks by pre-determining a minimum price retailers must pay for accepting MasterCard and Maestro branded payment cards and an investigation is being carried out in that sense. This type of antitrust resolutions have been particularly relevant in Australia, where an Act of Parliament in 2005 lead the Reserve Bank of Australia to reform the interchange fees schemes and to drastically reduce interchange fees. In the US, most resolutions have taken place in courts as a consequence of class action lawsuits. One of the most controversial was the 'tie-in' arrangement imposed by Visa and MasterCard that forced any merchant accepting their credit cards to also accept their debit cards. Merchants took the credit card schemes to court –in what became known as the Wal-Mart case– arguing that the rule breached anti-trust laws. In April 2003, the case was finally settled, with Visa and MasterCard agreeing to abolish the rule, reduce the interchange fee, and pay damages of $3 billion to merchants. There have also been several class actions against American Express in the US concerning non only card fees but also for providing financial plans incurring in conflicts of interest and poor disclosure which affects 2.4 million investors. The damage claims by the plaintiffs have reached $100 million dollars by 2007.

of sale, card services are organized as a two-sided market, and thus banks offering POS services may satisfy two different groups of customers, namely consumers paying by card and merchants offering the POS terminal service. Bank networks have, therefore, to coordinate the activities of financial institutions that issue cards and provide ATMs, together with retail outlets that accept cards from consumers at POS terminals. On the one hand, this may increase (at least theoretically) consumers' and merchants' willingness to pay[5]. On the other hand, the inclusion of cards widens the range of the bank's product bundle, which may increase the bank's ability to differentiate this product mix (Calem and Mester, 1995). Importantly, this requires a diffusion-related trend which guarantees a significant level of adoption by consumers (Molyneux and Shamrouk, 1996). Additionally, bank customer's switching costs also augment as they contract a wider product range (Stango, 2002). Whether the shift in consumers' willingness to pay exceeds the potential increase in market power or vice versa remains an unresolved empirical question.

The contribution of this study is twofold. Firstly, we provide evidence regarding changes in market power related to the supply of card payment services at multiproduct banks and the willingness of bank customers to pay for those services. Secondly, we estimate the welfare effects of incorporating such payment services to the bank multi-output set. Of particular importance, the specific pricing structure and network effects of payment cards are estimated and incorporated into the estimations of market power and willingness to pay. We employ a unique database of Spanish banks that contains quarterly bank-level information regarding card transactions and revenue sources at ATMs and POS terminals from 1997:1 to 2003:3. The focus of this paper is on the

[5] Such coordination, however, has often produced outcomes such as the collective setting of certain prices. It is not surprising, therefore, that the payment card industry (and other two-sided markets and industries with network effects) has been closely scrutinized by antitrust authorities in many countries.

overall effect of (debit and credit) card payments on bank market power and on bank customers' willingness to pay[6].

The paper is divided into six sections, apart from this introduction. Section 2 reviews the theoretical and empirical background of studies on market structure, demand characteristics and antitrust policies in card markets. Section 3 presents the theoretical framework and the main hypotheses. Section 4 explains the data and empirical methodologies employed. The main results are presented in Section 5, while Section 6 provides a summary of conclusions and policy implications.

2. Card services, industry structure and willingness to pay

2.1. Cards, network effects and two-sided markets

Payment cards function differently from most financial services, partly due to network effects. The more merchants (and ATMs) which accept a payment card, the more valuable it is to consumers. At the same time, merchants are more willing to accept a card if they know that many consumers use it[7]. Together with network effects, a second distinctive characteristic of the market structure of cards is that they are generally organized as two-sided markets. In these markets, two (or more) parties interact on a "platform", and the interaction involves network externalities. In the two-sided card market, the value of a network increases with every new consumer who uses

[6] The database contains information on both sides of the card markets: the number of total (debit and credit) cards is the proxy for the cardholders' side while POS terminals are the proxy for the merchants' side. In this paper no distinction can be made between debit and credit card operations due to lack of data by individual bank.

[7] See Economides and Himmelberg (1995) and Economides (1996) for a comprehensive study of network effects in card markets.

cards, every merchant that accepts them at their point of sale and any other bank that accepts them at their ATMs[8].

Card markets also generate adoption and usage externalities. When a network is introduced on a small scale, consumers and merchants have no incentives to join. Therefore, banks launch large-scale ATM and POS networks which, in turn, implies the existence of significant barriers to entry in payment cards (Hunt, 2003). Similarly, usage externalities are related to consumers' decisions regarding card use frequency. It is not surprising, therefore, that banks typically offer additional advantages (e.g. "reward points") for card use. Merchants also enjoy additional incentives for accepting cards. In particular, cards increase consumers' willingness to pay and, as a result, merchants who accept them increase their sales and make greater profits than merchants who do not (Wright, 2005).

All the abovementioned incentives for bank customers (either consumers or merchants) also depend on the acceptance of two common rules: the 'honor-all-cards' rule and the 'no-surcharge' rule, which reduces the uncertainty that banks, consumers and merchants would otherwise face. By applying the 'honor-all-cards' rule all the networks agree to accept transactions made using cards from any other network at their ATM and POS terminals. The 'no-surcharge' rule applies to POS transactions and prevents merchants from imposing surcharges on customers paying by card. The combination of these two rules is presumed to increase the value of card networks and convenience for card users[9]. However, two points should be borne in mind regarding the 'honor-all-cards' and 'no-surcharging' rules. Firstly, Katz (2001) questions whether network effects are relevant for mature payment systems, particularly when consumers

[8] For banks, there are also advantages in deploying and sharing ATMs. Matutes and Padilla (1994) show that such banks' customers will tend to accept a lower return on their deposits, since such sharing lowers customers' expected transportation costs.
[9] These positive externalities of card networks (expanded use/acceptance) imply a negative externality to other payment networks based on cash or checks.

must pay a fixed cost to employ an alternative payment method. However, as Hunt (2003) notes, the use of cards in most markets is not yet mature and the relevant question is thus whether usage externalities remain significant under 'no-surcharge' and 'honor-all-cards' rules. Secondly, the 'honor-all-cards' rule seems reasonable for card transactions when debit and credit cards or ATMs and POS terminals compete as substitutes, a question which empirical research has not so far answered.

2.2. Pricing schemes and market power in card markets

The prices card issuers and network users face from the two sides (consumers and merchants) significantly affect market participation and overall demand volume in the payment cards market, especially as financial intermediaries generally bundle their services, offering their customers a choice of 'packages'. In the case of cards, there are several prices which may be charged to or collected by the three main parties involved in the transaction: the cardholder, the cardholder's bank, and the ATM (POS terminal) owner. Cardholders typically pay an annual fee for cards, principally credit cards. Card issuers also impose surcharges upon non-account holders for using the ATMs they own. The issuers also charge foreign fees when one of their customers uses another's ATM. Similarly, in payment transactions at POS terminals, network associations usually demand that an interchange fee must be paid to the issuing bank by the bank acting as the acquirer for the merchant. Acquiring banks also charge a discount or service fee to merchants, partly to compensate for the interchange fee they pay to issuers. The complexity of this pricing scheme means that there may exist different and (at least partially) contradictory findings regarding the link between network effects and pricing decisions in ATM and POS networks.

The main rationale for surcharges and foreign fees is that cardholders face a trade-off between the cost of a transaction if they travel to an ATM belonging to their own bank and the total price, which is the sum of the charges they face if they travel to a closer ATM (Chakravorti and Emmons, 2001). McAndrews (1996) finds that both demand-side network effects and economies of scale influence such pricing decisions. Similarly, Hannan *et al.* (2003) find that the probability of surcharging is an increasing function of size and of market share (of ATMs) and that depositors' affiliation incentives lead to higher surcharges. Knittel and Stango (2006) show that surcharges and foreign fees strengthen compatibility between deposit account pricing and own ATMs, and weaken the relationship between deposit account pricing and competitors' ATMs and related factors[10]. The factor which has a considerable impact upon card prices is switching costs (i.e. those that cardholders pay when changing their card provider). As card fees increase, banks' market share of ATMs also increases, due to the existence of such costs for customers with high outstanding debt balances (Stango, 2002). Similarly, product differentiation may also explain why card prices are frequently so sticky, as it has been found for credit cards (Calem and Mester, 1995).

The case of interchange and service fees is even more complex. Networks usually set interchange fees collectively, and establishing the fee at the network association level eliminates costs related to bargaining between individual card issuers and acquirers and uncertainty about the true costs of a card transaction (Baxter, 1983; Small and Wright, 2001).[11] In a seminal study, Baxter (1983) maintains that collective determination of interchange fees cannot be labeled as anticompetitive behavior, since

[10] Massoud and Berndhart (2002) also consider these compatibility effects and show that prohibiting banks from surcharging -by forcing banks to charge their own customers and the foreign customers the same ATM price- leads to higher ATM prices, greater bank profits, and possibly reduced consumer welfare.

[11] See, for example, European Commission (2007). See also Weiner and Wright (2006), for a comprehensive survey of antitrust intervention in card markets.

under perfect competition among issuers (and among acquirers) the socially optimal interchange fee is non-zero. By contrast, Carlton and Frankel, (1995), Frankel (1998), Chang and Evans (2000) and Balto (2002), indicate that the collective determination of interchange fees by payment card associations have potentially anticompetitive results. Recent studies, however, maintain that collective determination should not be banned, since it is unclear whether negotiations between issuers and acquirers would lead to lower or higher interchange fees (Gans and King, 2003). Schmalensee (2002) and Rochet and Tirole (2002) develop models of an imperfectly competitive payment card industry -accepting a comparison between privately optimal and socially optimal interchange fees- and show that the proposal for cost-based regulation of interchange fees relies on an erroneous, vertically organized, model of the payment card industry, while collective determination offers no incentives to achieve socially non-optimal interchange fees. In a similar vein, Wright (2004) shows that when merchants compete and consumers are fully informed whether merchants accept particular cards, the profit and welfare maximizing fee coincide for a non-trivial set of cases.

2.3. Payment cards: willingness to pay, costs and product differentiation

Card users' willingness to pay for debit and credit cards essentially depends on the cost savings and the differentiation gains that cards may offer with respect to competing payment instruments, such as cash or checks. Regarding cost, studies by Humphrey and Berger (1990) or Humphrey *et al.* (1997) have shown that efficient payment instrument pricing induces greater use of electronic payment, as it is cheaper than paper-based payment. Nevertheless, the cost advantages of cards are highly dependent on the type of card employed[12]; Humphrey and Berger (1990) show that while debit cards are significantly cheaper than cash, credit cards are relatively expensive payment instruments. The latter deserve specific attention because their characteristics are not identical to those of debit cards. Hancock and Humphrey (1997) argue that the substitutability of credit cards for cash is dependent on both pricing and on national cultural attitudes towards credit. It has also been observed that credit cards help to shift illiquid customer consumption forward in time (Chakravorti and To, 2000). Since credit card fees are largely borne by retailers, consumers perceive credit cards as a low-cost delayed payment substitute for cash settlements. The willingness to pay for credit cards is, therefore, based principally upon perceptions and liquidity restrictions. Furthermore, Brito and Hartley (1995) demonstrate that although borrowing on credit cards may appear irrational, due to the higher prices usually paid[13], such cards also provide liquidity services by allowing customers to avoid some of the opportunity costs of holding money.

In addition to cost savings and liquidity advantages, product differentiation is fundamental in explaining consumer willingness to pay for card services. Banks providing cards and ATMs may extend their deposit services outside their branch network, thereby enabling depositors to withdraw cash at more convenient times and places (McAndrews, 2003). ATMs can also reduce the costs of servicing various depositor demands, such as transfers among deposit accounts and bill payments. In the case of POS transactions, banks may act both as 'issuers' (of consumer cards) and as 'acquirers' (i.e. providing merchants with POS terminals); in both cases, they offer

[12] Saunders *et al.* (2007) survey the literature of debit cards, credit cards, ATMs and POS and offer some empirical evidence on consumers' decisions on the different payment devices. They show that a certain degree of substitution exists between the use of cards at ATM and POS terminals.

[13] Ausubel (1991), Calem and Mester (1995) or Knittel and Stango (2003) have shown the inflexibility of credit card interest rates, relative to the cost of funds, as evidence of the rigidity of relatively high prices in credit card markets.

convenience. As a consequence of the wide range of interactions among acquirers and issuers, banks tend to coordinate these activities by constructing open payment networks[14], allowing many banks to participate and facilitating transactions between merchants and cardholders.

3. A theoretical framework

Consider n banks and a set of an arbitrary number of identical consumers. Let $N = \{1,2,\ldots,n\}$ be the set of banks. Let us assume that each bank i produces a set of outputs (y) with a given vector of inputs (x), so that a vector of netputs could be defined for each bank as $Q_i = (y, -x) = (Q_1,\ldots, Q_m, -x_1, \ldots, -x_n)$. Let us further suppose that the set of outputs y of each bank is a vector that contains m outputs, so that $y \in M = (1,2,\ldots,m)$, including m-1 balance sheet banking outputs plus one additional output consisting of card payment services (Q_c), and thus the multiproduct set for each bank is composed of any given but positive demanded quantity of the different outputs $y=(Q_1,\ldots, Q_{m-1}, Q_c)$, $Q_i > 0$. Let $p = (p_1,\ldots, p_{n-1}, p_c)$ be the price set of bank i corresponding to the output set y. We assume that banks compete in a Bertrand oligopoly fashion; that is to say, they select their prices independently and simultaneously. In the second stage, consumers observe the price vector p of each bank and select their consumption set $S = \underset{\sim}{S}(p)$, where $S \subseteq M$. Consumer payoff corresponds to the consumer surplus ($cs(p, \underset{\sim}{S}(p))$), defined as the difference between the willingness to pay for the set of outputs ($v(\underset{\sim}{S}(p))$) and the sum of the prices paid for these outputs ($\sum_{j \in \underset{\sim}{S}(p)} (p_j)$):

$$cs(p, \underset{\sim}{S}(p)) = v(\underset{\sim}{S}(p)) - \sum_{j \in \underset{\sim}{S}(p)} (p_j) \qquad (1)$$

[14] In a close network the card issuer also acts as the acquirer.

Bank payoff (π_j) corresponds to the mark-up of price (p_j) over marginal costs ($c_j^{'}$):

$$\pi_j(p, S(p)) = \sum_{j \in S(p) \cap M_j} (p_j - c_j^{'}) \qquad (2)$$

In this model, it is possible that consumers access different bank products as a choice of packages. In banking markets, consumers usually shop at one bank where they have a loan, a deposit account and different payment services, including debit and credit cards ('one-stop' banking)[15]. It is possible to interpret the model allowing for strategies such as price bundling. This will require different assumptions regarding the effect of such bundling strategies upon price competition. For the sake of simplicity, we initially assume that the choice of packages does not imply that the bundle is offered at a discount. Instead, we assume that the bundle allows consumers to access different products within the same bank and that the main rationale for this type of choice is convenience[16].

If consumers access these different products at one single bank, then the sum of the prices paid by the consumer and the sum of the prices offered by the bank will coincide. In this situation, the welfare effects of incorporating cards into the output bundle will then depend solely on the difference between changes in consumer willingness to pay and changes in the bank's marginal costs. Several scenarios may result from static comparisons of consumers' surpluses and banks' mark-up of prices over marginal costs when cards are excluded or included in the multiproduct set. Among these, two are particularly relevant when analyzing the effects of the introduction of cards as a bank output upon changes in bank market power and in consumers' willingness to pay; the first is displayed in Figure 1. For the sake of

[15] This 'one-stop' banking assumption is generally accepted in the academic literature (Berger *et al.*, 1996) as a test on the value for consumers of universal banking (jointly provided or bundled) services. Recently, 'one-stop' banking services have also been subject to the scrutiny of Antitrust Authorities (European Commission, 2007, p.6)

[16] A more complete analysis of the effect of bundling within this theoretical framework is given by Liao and Tauman (2002).

simplicity, the scenario reflects linear demands of output bundles and the behavior of a representative bank. In Scenario 1, the bank maximizes its profits by equaling marginal revenues (*R'*) to marginal costs (*c'*), so that the introduction of cards in the output bundle increases consumers' surpluses and the bank's mark-up of price over marginal costs. These effects are reflected in the change from y_1 (when Q_c=0) to y_2 (when Q_c>0) and related changes in demand (y_{D1} and y_{D2}). In Scenario 1, there is a transfer of consumers' surpluses to the bank's profits, although the net change in consumers' surpluses is positive, due to the higher positive variation in consumers' willingness to pay, as a consequence of the introduction of cards that shifts the demand for bank services upwards. In Scenario 2 (Figure 2) there is also a transfer of consumers' surpluses to the bank's profits. In this case, however, the net change in consumers' surpluses is negative, since the variation in consumer willingness to pay is lower than the increase in bank market power due to the introduction of cards in the bank multiproduct set.

In order to assess the changes in bank market power and consumer willingness to pay, two other premises should be considered, in order to provide an adequate understanding of market power and market definition in this framework: i) cards should correspond to the same retail market where banks sell the rest of the bundled products. Therefore, it should be demonstrated that cards correspond to the same market as loans, deposits and other retail services; ii) due to the particular characteristics of cards as payment services and, in particular, their two-sided nature, the relevant prices of these card payments must be calculated, so that the influences of market power can be correctly identified.

With regard to the initial hypothesis, cards (or any other bank output) are considered as part of banks' multi-output setting when demand for the output bundle is sufficiently inelastic for a hypothetical bank monopolist to impose a significant and non-transitory increase in card prices. The second hypothesis assumes that cards will belong to a two-sided market when the volume of transactions of all users (cardholders and merchants) depends not only on the structure (the prices paid by both cardholders and merchants) but also on the overall level of the fees charged by the bank (Rochet and Tirole, 2005; Evans and Noel, 2005). The latter premise does not imply, however, that if cards belong to a two-sided market, the correct prices to assess market power from card supply should be divided between cardholders' and merchants' prices. As Emch and Thomson (2005) note, the "two-sidedness" of the markets does not refute the basic logic of the hypothetical monopolist test of the traditional measurement of market power, and thus the total price of cards (for both cardholders and merchants) should be employed to calculate market power.

4. Data and empirical methodology

4.1. Empirical objectives and data

Mainly due to the lack of available data, few empirical studies deal simultaneously with both willingness to pay and the competitive issues in network industries. Our paper attempts to separate willingness to pay for cards from any source of market power in this context. There are three main empirical objectives:

(i) To assess the changes in market power from the introduction of card payments into banking services, as well as the appropriate pricing and market definition for such banking services.

(ii) To estimate consumer willingness to pay for cards. Such willingness is analyzed both from a qualitative perspective (employing hedonic regressions) and a quantitative perspective (estimating changes in the willingness to pay for a bundle of bank services that alternatively includes and excludes card services).

(iii) To distinguish changes in willingness to pay as a result of the inclusion of cards in banks' multiproduct set from any source of market power derived from this inclusion. This empirical goal involves the simultaneous estimation of a system of demand and supply relationships, in order to perform a 'mark-up test' that permits the quantification of the percentage deviation of prices, quantities (and, therefore, revenues) from perfect competition levels.

We employ a unique database that contains quarterly bank-level information regarding total card transactions –the sum of debit and credit card transactions-, and revenue sources at ATMs and POS terminals, as well as other bank information. Importantly, the database contains information on both the number of cards –as a proxy of the cardholders' side- and the number of POS –as a proxy of the merchants' side- so that both dimensions of the two-sided card market are captured. No distinction can be made between debit and credit card transactions due to lack of data by individual bank. The sample consists of all savings banks operating in Spain from 1997:1 to 2003:3, constituting 1,242 panel observations. These savings banks belong to two of the three competing networks in Spain[17] and are involved in approximately 60% of total card payment transactions. The Spanish case is representative, since Spain is the world's second largest ATM and POS industry[18] (55,399 ATMs and 1,055,103 POS machines at the end of 2004)[19].

[17] These networks are Euro6000 and Servired. Euro6000 is organized solely as a network for savings banks, while all commercial banks, other savings banks and credit cooperatives belong to Servired.

[18] According to the figures contained in the Blue Book on Payment and Securities Settlement Systems (European Central Bank) and the Red Book on Payment and Settlement Systems (Bank for International Settlements), only the United States shows a higher absolute number of ATMs and POS terminals.

[19] The recent evolution of the Spanish card market is also interesting. The number of cards has almost doubled from 1996 (33,189,000) to 2004 (63,027,000). However, the number of transactions per ATM has declined during the same period (from 19,121 in 1996 to 16,336 in 2004), although the absolute volume of transactions rose from 582 million euros to 905 million euros (a net increase of 55.5%).

The definition and summary statistics of the variables employed in this empirical section are shown in Table 1.

4.2. Market power, market definition and mark-ups

As an initial empirical step, it is critical to measure market power. According to the theoretical framework described in Section 3, changes in market power are reflected in the mark-up of prices over marginal costs. This involves the estimation of the marginal costs of bank outputs, including card services. Furthermore, the cost function employed needs to be sufficiently flexible to reflect the non-linear shape of the different marginal costs estimated. Following Pulley and Braunstein (1992), we employ the fairly flexible composite cost function, a full description of which is provided in Appendix A. To estimate the composite function, three inputs ($k = 1, \ldots, 3$) are used: the price of deposits, labor and physical capital. The output bundle consists of five outputs including loans, deposits, other earning assets, the value of card transactions at ATMs and the value of card transactions at POS. Prices are computed directly from balance sheet, income statement and card reports information described in Table 1. In order to reflect both absolute and relative margins we also compute the ratio of the mark-up of price over marginal costs (Lerner index).

According to the premises of the theoretical framework, an initial and necessary condition to compute the effect upon market power of incorporating cards into bank services is to effectively demonstrate that such cards do in fact form part of the same market as the other products offered together with them. The standard test employed is

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Interestingly, the number of bank tellers increased even further, from 30,437 to 55,399 during the same period (a net increase of 81.8%). In contrast, the number of transactions per POS terminal has increased from 511 in 1996 to 1,204 in 2004, while the absolute change in the volume of POS transactions has risen from 294 million to 1,271 million euros (a net increase of 332.3%). The number of POS terminals has also increased, in the same period, from 575,325 to 1,055,103 (a net increase of 83.39%). It is important to note that the 'no-surcharge' and the 'honor-all-card' rules apply in Spain and, as in many other countries, there has been an intense debate regarding the fees banks charge for cardholder and merchant transactions.

the SSNIP test.[20] It assumes that a profit-maximizing bank offers a set of products (*M*), which, in our case, alternatively corresponds to a three-output or a five-output (including card transactions at ATMs and POS) definition of the multiproduct composite function. The SSNIP test estimates whether a hypothetical profit-maximizing monopoly supplier could impose a significant and non-transitory increase in prices for a particular product (payment cards, in this case). Adopting this definition, the SSNIP is implemented as a variation in profits for a product *J* in the bundle of *M* outputs ($\Delta\pi_{M,J}$). The standard 5% and 10% variation in prices are taken into account and the prices are set constant at their means for purposes of comparison ($\overline{p}_j$):

$$\Delta\pi_{M,J} = \left(\frac{\sum_{i=1}^{n} [\pi_i(p_j^{SSNIP}) - \pi_i(\overline{p}_j)]}{\sum_{i=1}^{n} \pi_i(\overline{p}_j)} \right) \tag{3}$$

The second premise, when studying changes in market power resulting from the introduction of payment cards by banks, is that card prices are correctly chosen. In order to study the two-sided nature of card payments, we therefore include both the prices paid by cardholders (p_c), computed as the ratio of "cardholder fees/cardholder transactions" and the prices paid by merchants (p_m), computed as the ratio of "merchant fees/transactions at POS". We will assume that card markets are two-sided if total prices ($p=p_c+p_m$) significantly affect not only total card transactions, but also each of the two prices separately. This test is performed as a log-linear approximation of demand curves, employing fixed-effects panel data techniques which relate these prices to the

[20] The SSNIP test was initially proposed by the US Department of Justice's Merger Guidelines. The SSNIP test is defined as the *Small, but Significant, Non-transitory Increase in Price* that causes profits to vary significantly. Approaches to market definitions in banking using the SSNIP test are rare. There is only, to our knowledge, one study dealing with such market definitions using this approach and residual deposit supply equations (Amel and Hannan, 1999).

total card transactions. The log of both GDP and population density are also included as control variables in these equations.

4.3. Willingness to pay for card services: hedonic regressions methodology

We estimate a series of hedonic regressions of various output prices on the characteristics of banks' own and their competitors' services, in an initial attempt to analyze consumer willingness to pay for cards. This involves examining the relationship between the pricing of card payments and various bank characteristics and strategies. There are, at least, two advantages of employing hedonic regressions. Firstly, given certain assumptions, hedonic regressions will show the marginal effect of these characteristics on customers' willingness to pay. Secondly, they help to identify the cross-effects of card use at ATMs and POS terminals as possible substitutes.

The seminal contribution of Rosen (1974) explains the interpretation of hedonic regressions as 'willingness to pay'. However, hedonic regressions cannot always be strictly interpreted as utility parameters, since they reflect other influences, such as changes in costs and related variations in market power. Pakes (2003) shows that hedonic valuation is the expectation of marginal costs plus that of the mark-up conditional upon 'own product characteristics'. The hedonic approach views products as bundles of characteristics that are valuable to consumers, displaying the marginal values of these characteristics to the typical consumer. In our approach, we identify various characteristics of the price of card use at ATMs as well as the price of card use at POS terminals, since these are the two main relevant delivery channels. The specification of the hedonic regression is in line with Knittel and Stango (2006) for ATMs[21], as follows:

[21] In particular, Stango (2006) analyses the effects of surcharges on the compatibility between deposits and ATMs and demonstrates the effects of compatibility upon depositors' evaluations of various bank services.

$$\log(p_{it}) = \beta \log(X_{it}) + \mu_i + \chi M_{it} + \log(B_{it}) + \varepsilon_{it} \quad (4)$$

where $\log(p_{it})$ is the logarithm of the price of card use at ATMs and the price of card use at POS of bank *i* and time *t*. X_{it} is a vector of the characteristics of own and competitors' bank services, including own ATM density; competitors' ATM density; own POS terminal density; competitors' POS terminal density. It also contains interactions terms to capture indirect network effects, namely: logarithm of [(card growth) x (own ATMs)]; logarithm of [(competitors' ATMs) x (own card issuance)]; logarithm of [(card growth) x (own POS terminals)]; logarithm of [(competitors' POS terminals) x (own card issuance)]; and the logarithm of own branches. These variables reflect own and indirect network effects from offering ATMs and POS terminals as well as the effects of each device upon the other. Branches are also included as a measure of convenience for traditional bank services. All these variables are taken in logs in order to reflect marginal effects. μ_i is a vector of individual bank persistent heterogeneity. M_{it} is an individual measure of market power that also varies over time. B_{it} is a set of bank-specific environmental control variables, including the growth rate of cards (reflecting bank investment in the card market) and regional[22] values of GDP, population density and salary levels.

4.4. Complementarities in consumption: willingness to pay, joint production and network effects

The use of hedonic regressions provides an initial qualitative approach to the use of cards at ATM and POS and the related bank strategies that may affect consumers' convenience and their willingness to pay for such services. However, we

[22] The regional variable is obtained as a weighted average of the values of the variable in the different regions where the bank operates, using the regional distribution of branches as the weighting factor.

also aim to offer a quantitative approach that provides a point estimate of changes in consumers' willingness to pay and market power when cards are included in the output bundle.

The empirical approach we employ to assess consumers' willingness to pay for a combined set of bank products is similar to that utilized by Berger *et al.* (1996). Under certain conditions, revenue scope economies will illustrate synergies in the joint consumption of financial services. For banks to obtain greater revenues in the joint production of financial services, output prices must vary according to different output mixes. Nonetheless, revenue economies of scope would exist in a competitive environment only if: (i) consumers are willing to pay a premium for jointly provided financial services; and (ii) there are cost diseconomies of scope. If there were no cost justification for charging higher prices for jointly provided services, competition among banks would eliminate revenue synergies, even if consumers valued jointness. Therefore, the coexistence of cost and revenue scope economies will only be possible in a less than perfectly competitive environment. Potential reductions in transaction and searching costs for customers may encourage banks to supply a wide range of services.

The specification of the revenue function is also affected by competitive assumptions. A standard revenue function approach would assume perfect competition in bank markets, where banks are price-takers in both input and output markets. In a competitive environment, prices are exogenous. However, the perfect competition hypothesis does not seem to be plausible in most banking markets, where a certain degree of market power is observed (Berger *et al.*, 1996; Berger and Mester, 1997; Humphrey and Pulley, 1997). Banks have a degree of control over the level of output prices charged, and thus output price exogeneity does not apply to many banking products. Therefore, it is necessary to specify an alternative revenue function that permits the use of a more accurately measured metric-output quantity (y) to improve the local identification of revenues, and thus profits. There will be a given vector of on and off-balance sheet outputs (y), a vector of inputs (x) and also a vector of netputs $Q = (y, -x) = (Q_1,\ldots, Q_m, -x_1, \ldots, -x_n)$. An indirect revenue function (R) is defined to analyze revenue scope economies. The revenue problem seeks to maximize the revenue function:

$$\underset{p}{Max}\ R = p'y \quad \text{s.t.} \quad g(p,y,r)=0 \qquad (5)$$

where p and r are vectors of output prices and input prices, respectively. The Lagrangian yields the revenue maximizing prices as functions of y and r:

$$R = p'y = p(y,r)'y = R\ (y,r) \qquad (6)$$

The definition of global scope revenue economies compares complete specialization with joint production of financial services. However, as Pulley and Braunstein (1992) and Berger et al. (1996) note, complete specialization is not a realistic view of bank production; it may be more appropriate to consider banks as 'quasi-specialized' institutions. Quasi-specialization does not necessarily mean that a bank produces the same proportion of all outputs jointly (which would be the standard definition of scope economies), but also includes banks having different specialization levels. Revenue scope economies are estimated using a composite function, and the specification of the quasi-specialization scope economies and the composite function are given in Appendix A.

To estimate the composite function, three inputs ($k = 1, \ldots,3$) are used: the price of deposits, labor and physical capital. In parallel, two definitions of the output mix are considered to estimate changes in consumer willingness to pay with regard to card services[23]:

- Three-output vector: loans, deposits and other earning assets.
- Five-output vector: loans, deposits, other earning assets, value of card transactions at ATMs and value of card transactions at POS.

The revenues considered include all sources of income from loans, deposits, other earning assets for the three-output definition plus the revenues from card services in the case of the five-output definition. Since our database permits us to separate card transactions and revenues from own and competitors' customers (both cardholders and merchants) the revenue from cards only includes income flows for own customers, who are those that evaluate bank services[24]. However, considering card revenues as a whole allows us to identify whether indirect network effects exist. Specifically, the difference between revenue scope economies from all sources of card income and revenue scope economies from own customers will be an accurate proxy of 'indirect' network effects.

Equation (6) was estimated using iterative non-linear least squares routines with fixed effects[25]. Importantly, differences between revenue scope economies from the five-output vector composite function and revenue scope economies from the three-output vector composite function will demonstrate the net contribution of cards to the joint valuation of bank services. Similarly, the specific contribution of card services at

[23] The difference between the estimated intercepts of the three-output and the five-output definitions of the revenue functions may represent a change in the scale economies (Lau, 2000). Recall that subadditivity is a combination of scope and scale effects and, therefore, a change in scale would affect the scope results. In our case, the differences between the intercepts of both output mix definitions were not found to be statistically significant (not shown). Hence, our scope economies estimations are robust to changes in scale.

[24] Additionally, various control factors were included, namely: own and competitors' ATMs; own and competitors' POS terminals; and own branches. These controls reflect various non-price characteristics that may reflect different investments in the card markets. These variables improve the goodness of fit of the regressions.

[25] We use non-linear methods in which concavity conditions for costs and convexity conditions for revenues were always fulfilled.

ATMs (alternatively, at POS terminals) can also be assessed by setting output quantities and revenues from card use at POS terminals (alternatively, at ATMs) to zero.

4.5. Changes in the willingness to pay and market power: the effects of payment cards

Since the basic structure of our revenue function model may introduce a certain bias into our estimations of consumer willingness to pay, due to market power, we aim to distinguish between the two effects by employing the so-called ‘mark-up’ model proposed by Bresnahan (1982) and Lau (1982). This procedure has been already applied to the US (Shaffer, 1989) and Canada (1993) using aggregate national data. The ‘mark-up’ test estimates the extent to which the average firm's perceived marginal revenue deviates from demand, and thus demonstrates the degree of market power exercised by banks. Profit-maximizing firms will establish a marginal cost equal to their perceived marginal revenue. This marginal revenue will coincide with the demand price in a situation of competitive equilibrium, but with the industry's marginal revenue in the collusive extreme.

Following Bresnahan (1982), the *true* marginal revenue function may be represented as $p + h(y,S,d)$, where p is the industry price, y is the vector of outputs ($y=(Q_1,\ldots, Q_m)$), S is a vector of exogenous variables and d is a vector of demand system parameters to be estimated. The bank’s *perceived* marginal revenue function may be expressed as $P+\lambda h(y,S,d)$, where $h(y,S,d)$ equals the semi-elasticity of market demand for bank products ($y/(\partial y/\partial p)$) and λ is the market structure parameter to be estimated; this represents the extent to which banks recognize the distinction between demand and marginal revenue functions, ranging from λ=0, (perfectly competitive behavior and marginal cost pricing) to λ=1 (joint monopoly or perfect collusion).

As Shaffer states (1993), -λ constitutes a local estimate of the percentage deviation of aggregate output from the competitive equilibrium level, so that the actual price deviates locally from the competitive price (marginal cost) by -λ $y/(\partial y/\partial p)$ and the actual quantity deviates locally from the competitive output level by -λ*y*. Dividing by *y* gives the percentage quantity deviation from the competitive level.

Shaffer (1989, 1993) proposes an empirical implementation in which the estimation of λ is based on a simultaneous estimation of an inverse demand function and a supply relation. Our model is constructed using a similar procedure, although our equations are derived from bank-level data using panel data techniques and fixed effects. The demand function is specified as:

$$y_{it} = a_0 + a_1 p_{it} + a_2 S_t + a_3 p_{it} Z_t + a_4 Z_t + a_5 p_{it} S_t + a_6 S_t Z_t + \mu_i + e_{it} \qquad (7)$$

The y_{it} in equation (7) represents the total output quantity that the bank *i* offers at time *t*, and p_{it} is the price of such services. Equation (7) may thus be expressed as an equation for either the three-output or the five-output specification of *y*. In our model for panel data, y_{it} is then either the sum of the quantities of our three-output specification (loans, deposits and other earning assets) or the sum of the quantities of the five-output vector specification (loan, deposits, other earning assets, value of card transactions at ATMs and value of card transactions at POS). Similarly, p_{it} is a weighted average price for these services, using the relative weight of each output in total assets as a weighting factor. In our model the exogenous variable *S* is *GDP*. Z is another exogenous variable which represents the price of a substitute for banking services. The stock exchange index of prices would seem to be a reasonable proxy of this substitute[26]. Equation (7) also includes a vector of bank fixed-effects (μ_i) and an error term (ε_{it})[27].

In order to obtain a supply relationship, a marginal cost function must first be derived. Our multiproduct composite specification permits us to define a cost function whose form essentially resembles that of the revenue equation shown in Appendix A. The reduced-form composite cost (*C*) equation would be:

$$C^{(\phi)} = \{F(q, \ln r) \cong \exp[G(\ln r)]\}^{(\phi)} + \varepsilon \qquad (8)$$

and therefore the supply relation derived from the marginal cost function, under the assumptions that banks are input price-takers and profit-maximizers, is:

$$p_{it} = -\lambda y_{it} / (a_1 + a_3 Z_t + a_5 S_t) + \delta_1 \sum \partial C^{\theta} / \partial Q_{\delta i} + \mu_t + \varepsilon_{it} \qquad (9)$$

where $-\lambda y_{it} / (a_1 + a_3 Z_t + a_5 S_t)$ is the deviation of prices from marginal costs. The empirical procedure involves the simultaneous estimation of (7) and (9). Once more, non-linear least squares routines with fixed effects are employed to estimate these equations.

Since the estimation of λ is a tool to estimate quantity and price percentage deviations from competitive equilibrium models, it is also possible to compute the percentage deviation in revenues as the product of deviations in quantities and prices. Equations (7) and (9) are estimated using both the three-output and the five-output mix definitions. Differences in estimated deviation in revenues between the two specifications will show the contribution of cards to bank market power. Finally, this percentage deviation in revenues can be deducted from the scope economies estimation to obtain a net valuation of card services provided jointly with other bank outputs.

[26] As an alternative, we also employed a 10-year government bond; the econometric outcomes were very similar.
[27] The interaction terms *p* times *Z*, *p* times *S*, and *S* times *Z* allow for demand curve rotation.

5. Results

5.1. Market power and multiproduct setting definitions

The prices, estimated marginal costs (from the supply relation) and mark-ups (of price over marginal costs) of the different products of the posited bank output bundle are shown in Table 2. These results reveal the existence of higher mark-ups (and therefore, market power) for loans and other earning assets, compared to card transactions at ATMs or POS. Deposits apparently act as loss leaders (i.e. they have negative mark-ups) to attract customers to use the entire bundle of products.

The estimation of the different mark-ups and Lerner indices is based on the estimated marginal costs from the five-output composite function. However, these results are only reliable if cards can be effectively considered as part of the output bundle i.e. if they belong to the same relevant bank retail market. The results of the SSNIP test (Table 3) reveal that there is a significant and non-transitory change in profits for both a 5% and a 10% increase in prices. This change in profits is 3.84% in the case of the three-output definitions but may rise to 5.70% when cards are added. Therefore, we conclude that the definition of the multi-output setting is consistent with the market definition.

Finally, the two-sided nature of the card services is also tested, using a series of log-linear demand functions (Table 4). The panel data results reveal that both the prices charged to cardholders and merchants affect total card transactions and, therefore, the market for payment cards seem to be two-sided. Total price (as the sum of cardholders' and merchants' prices) is also significant and, according to theoretical assumptions, this is the relevant price to measure changes in market power related to banks' supply of card services.

5.2. Hedonic regressions: results

The contribution of own and competitors' network characteristics to consumers' valuation are explained in a series of hedonic regressions given in Table 5. The panel data model is estimated using a random effects routine which, according to Hausman tests, is preferable here to fixed-effects estimation. The results reveal that customers tend to value competitors' ATMs density. Similarly, they appear to value the POS terminals density positively and significantly, no matter if these belong to their own banks or to others banks. Thus, no-surcharging rules seemingly imply a valuation of POS, no matter which bank is the acquirer. Additionally, the interaction terms show that competitors' ATMs (column I) and POS terminals (column II) seem to generate a positive externality on the own card issuance, as own bank customers benefit from other bank ATM and POS devices. However, the interaction between own ATMs and card growth only seems to affect negatively and significantly the willingness to pay for POS services. The interaction between card growth and the deployment of own POS terminals has a positive and significant effect on the willingness to pay for POS services and a negative and significant effect on the willingness to pay for ATM services. The hedonic regressions also reveal the existence of certain substitution relationships between ATMs and POS. In particular, the density of own bank POS terminals (ATMs) is negatively related to the price of card use at ATMs (POS). Furthermore, the development of bank branches appears to be positively related to card service prices, suggesting the existence of complementarities between traditional and non-traditional non-price characteristics of banking.

In this hedonic approach, and for the sake of consistency, the market power variable employed is the λ coefficient from the 'mark-up' test, which is estimated individually and over time by evaluating the estimated parameters of equations (7) and

(9) at the bank level. Importantly, this estimation involves the identification of the total price of cards as the relevant price for card markets (according to our test of the two-sided nature of cards). As expected, the effect of market power on card transaction prices at both ATMs and POS is positive and significant. With regard to control variables, growth in card numbers is apparently negatively related to the willingness to pay for card services at ATMs, a result which indicates that consumers diversify the use of cards as card markets become more mature. Regional population density and GDP are negatively and significantly related to prices, as a reflection of higher competition in more developed and urban territories. Finally, regional salary levels, as an important source of differences in costs, have a positive impact on prices.

5.3. Multiproduct banking and the willingness to pay: results for cards

The estimations of consumers' willingness to pay are initially obtained as complementarities in consumption from the three-output (loans, deposits and other earning assets) composite revenue function[28]. The scope economies are found to be negative and significant (-2.6%) for the joint consumption of traditional bank products, a result that is in line with Berger *et al.* (1996) for the U.S[29]. Furthermore, these diseconomies are found to diminish and to reach virtually zero when moving from complete diversification ($\in = 0$) to complete specialization ($\in = 0.3$). As expected, fixed-scope economies are zero in the case of revenues, meaning that diseconomies result from negative complementarities among the three outputs[30]. However, the results change with the five-output bundle definition (loans, deposits, other earning assets, card transactions at ATMs and card transactions at POS terminals). Interestingly, these

[28] The long-list of estimated composite function parameters is not shown here, for the sake of simplicity.
[29] See also Carbó and Rodríguez (2005), who provide similar evidence for Spain.
[30] Berger *et al.* (1996) find positive values for revenue fixed-scope economies, although they consider these results as spurious since, unlike costs, revenues do not have a fixed component for zero output values.

results show that the expected economies of scope among bank products only come to light when a broad definition of the output mix, including card services, is considered. Revenue complementarities in consumption then become positive and significant (2.3%). This result implies that by including card services in the output mix, scope economies increase by 4.9%; this is unsurprising, since modern banking services cannot be fully understood without considering payment and related card services and defining the different sources of interest and fee income (Rogers and Sinkey, 1999; Wheelock and Wilson, 2001; Stiroh, 2004). Thus, our results reinforce this view of cards as one of the main influences of customers' willingness to pay for the bundle of bank services. However, according to the definition of the revenue function in (6), these complementarities may be somewhat biased, as they might be also a result of market power.

5.4. Willingness to pay and market power: results

5.4.1. Changes in market power related to card services

To distinguish consumers' "willingness to pay" from market power influences, a simultaneous estimation of the demand and supply relations in (7) and (9) is performed, to obtain the deviation of actual quantities (-λ), prices $((-\lambda\, y/(\partial y/\partial p))$ and, consequently, revenues from competitive equilibrium levels.

The estimated parameters of equations (7) and (9) are shown in Appendix B. Interestingly, the intercept of the estimated demand equation increases when cards are included in the output bundle, thereby suggesting that reservation prices (and consumers' willingness to pay) also increase when cards are included. Table 6 shows the deviation from competitive equilibrium for the 'traditional' three-output definition ('balance sheet assets') and the five-output definition, which includes card services at

ATMs and POS. The estimates of $-\lambda$ are also reported yearly and as bootstrapped confidence intervals[31]. Both the point estimates and the confidence intervals reveal a certain degree of market power in the traditional output mix specification (0.147). The deviation from competitive equilibrium is even higher in the five-output mix specification (0.263) which, in turn, suggests that card services provide a degree of additional market power. The two estimates significantly differed, according to standard mean-difference tests. The deviation from competitive equilibrium in the three-output specification implies a reduction in prices of 9.9% and an increase in revenues of 1.15%. The introduction of card services produces an additional negative deviation of prices of 9.7% and an additional increase in revenues of 1.29%.

5.4.2. Estimated indirect network effects and total change in willingness to pay

The estimated increase in market power must be deducted from the revenue provided by consumers' willingness to pay (complementarities in consumption), in order to obtain an estimation of the net change in willingness to pay when providing card services jointly with other bank outputs. However, this calculation must also include the indirect revenue effect which may arise from customers of other banks using ATMs or POS terminals of the bank in question and, vice versa, from own customers using ATMs and POS terminals of other banks. These indirect network effects are estimated as the difference between scope economies from a total revenue function and scope economies from the baseline revenue function (which only includes revenues from own bank customers). The outcomes of these consumer valuation and market power sources are summarized in Table 7. Indirect revenue effects were found to be both positive (0.35% on average) and significant. Adding these effects to the standard

[31] We follow the specification of Eakin et al. (1990) to compute bootstrapped confidence intervals for multi-output technologies.

valuation produces a total revenue complementarities value of 2.98%. Since the estimated revenue deviation from competitive levels is 2.24%, there is a net positive effect on willingness to pay of 0.52% for payment card services jointly provided with loans, deposits and other earning assets.

The revenue function specification also permits the analysis of the specific contribution of ATM or POS card transactions to willingness to pay and market power influences (not shown). Revenue complementarities from POS transactions were found to be larger (1.83%) than those from ATMs (0.71%). Similarly, indirect network effects were also larger for POS (0.22%) than for ATM transactions (0.15%). Furthermore, the revenue deviation from competitive equilibrium in ATM transactions (0.87%) was double that produced by POS transactions (0.42%).

5.4.3. An additional robustness check for several levels of bank investments

Overall, the results in Tables 6 and 7 suggest that, although banks increase market power by offering card services, their customers are willing to pay for such services and the net effect on willingness to pay turns out to be positive. In order to combine the former inference, obtained from the hedonic regressions, with the welfare effects of the demand and supply relationships estimated, we undertake an additional robustness check. In particular, we examine whether bank investments are conditioned by pricing policies, and if banks with larger investments (in both ATMs and POS terminals) are rewarded by a greater increase in consumers' willingness to pay, indirect network effects and/or market power. To this end, the principal empirical procedures are repeated for three sub-samples. These sub-samples distinguish between banks which are over and below the median values of three measures: the 'cards/deposits' ratio, the growth rate of ATMs and the growth rate of POS. The breakdown of results is presented in Table 8. Employing any of the three indicators showing the relative investments in the card industry, there appears to be a higher willingness to pay for those services supplied by banks making larger investments. Although both willingness to pay and the market power effects are higher for such banks, the net welfare effect is highly positive and significant. The differences between high-investment and low-investment banks are lower in terms of indirect network effects, since the customers of banks with lower ATM or POS investment may reap relatively higher benefits from network effects.

6. Conclusions and policy implications

This paper aims to contribute to the literature of network industries in two ways. First, we provide evidence on changes in market power related to the supply of card payment services at multiproduct banks and the willingness of bank customers to pay for those services. Secondly, we estimate the welfare effects of incorporating such payment services to the bank multi-output set. In accordance to industry structure, the specific pricing structure and network effects of payment cards are estimated and incorporated into the estimations of market power and willingness to pay.

To our knowledge, the literature to date has offered limited empirical evidence regarding the willingness to pay in network industries. This paper offers empirical evidence on this issue, using a typical network industry such as payment cards. Using a unique database of Spanish banks, we design an empirical strategy to separate the willingness to pay for the sum of debit and credit card services (jointly provided with other bank products) from the market power effect of including card payment services in the bank output bundle. A hedonic approach is initially applied, in order to analyze the effects of various characteristics of own bank and competitors' strategies upon customer evaluation of card services. The measurement of consumers' willingness to pay also comprises the estimation of revenue scope economies, using composite revenue functions. The effect of market power is subsequently estimated, employing a so-called 'mark-up' model that allows us to estimate the deviation of revenues from perfect competition.

The empirical results reveal that there is a net positive welfare effect of card services provided jointly with other bank products, even when market power influences are controlled. The positive change in consumers' willingness to pay extends to both ATM and POS transactions separately. Furthermore, indirect network effects appear to be a significant component of this joint valuation. Interestingly, banks making the greatest investments in cards, ATMs and POS seem to enjoy these revenue advantages and valuation to a significantly larger extent, although a certain degree of substitution between ATMs and POS also appears to exist.

Card markets are peculiar in that their market structure is two-sided and their competitive features should not be treated as a standard, vertically organized, market. In addition, the estimated market power indicators in this study reveal that the deviation from fully competitive standards of card prices is similar to that of other bank products. Consequently, any antitrust policy which ignores the full welfare effects of cards and, in particular, of changes in consumers' willingness to pay may be misdirected.

APPENDIX A: REVENUE SCOPE ECONOMIES AND THE SPECIFICATION OF THE COMPOSITE FUNCTION

The 'quasi-specialized' revenue economies of scope (*QRSE*) are defined as:

$$\begin{aligned} QRSE \ = \ & [\{R(\ Q_1,\ Q_2,...,Q_{n+m};\bar{r}) - R(1\text{-}(m\text{-}1)\in\}Q_1,\in Q_2,...,\in Q_{n+m};\bar{r}) \\ & \text{-}\ R(\in Q_1,\ \{1\text{-}(m\text{-}1)\in\}Q_2,...,\in Q_{n+m};\bar{r}) \ -... \\ & -R(\in Q_1,\in Q_2,\ ...,\{1\text{-}(m\text{-}1)\in\}Q_{n+m};\ \bar{r})]\ /\ R(\ Q_1,\ Q_2,...,Q_{n+m};\bar{r}) \end{aligned} \qquad \text{(A1)}$$

where m is the number of outputs (Q_i, $i=1,\dots,m$) and $\in$ is the proportion of non-specialized outputs produced; thus, when $\in=0$, expression (A1) becomes the standard measure of global scope economies[32].

A composite function is employed to model the behavior of revenues in a multiproduct framework. Compared with other commonly used (e.g. translog or quadratic) functional forms, the composite function produces more robust and efficient results when modeling multiproduct technologies[33]; it admits zero values for output, does not impose separability between output and input prices and allows for zero or negative values of the dependent variables, which is likely to occur in the case of revenues. A generalized composite cost revenue function is, then, defined as a Box-Cox transformation of total revenues *(R*), outputs (Q_i) and natural logs of input prices (ln r_k):

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[32] Note that when $\in>0$ we obtain different measures of subadditivity, capturing scope economies for a given output mix ranging from complete diversification ($\in = 0$) to different levels of specialization (higher values of $\in$). Therefore, QCSE is an empirical subadditivity measure, since we are able to estimate scope economies with simultaneous changes in scale and product mix. Institutional size becomes very relevant at this point since specialization and subadditivity change with bank output level.

[33] The composite actually nests a standard translog, a generalized translog and quadratic functional forms. Multiplicative forms, such as the translog, usually impose separability between inputs and outputs, and input demand elasticities are defined equally and independently of changes in input prices. As Carroll and Ruppert (1984) and Snee (1986) state, the composite function offers an alternative specification by transforming both sides of the cost (profit or revenue equation) and permitting us to model empirically the dependent variable, both in logarithms and in levels, and contrasts the results.

$$f^{(\phi)}(Q_i, \ln r_k) =$$

$$R^{(\phi)} = \begin{pmatrix} \left[\alpha_0 + \Sigma\alpha_i Q_i + \frac{1}{2}\Sigma\Sigma\alpha_{ij}Q_iQ_j + \Sigma\Sigma\delta_{ik}Q_i \ln r_k\right] \\ .\exp\left[\beta_0 + \Sigma\beta_k \ln r_k + \frac{1}{2}\Sigma\Sigma\beta_{kl} \ln r_k \ln r_l + \Sigma\Sigma\mu_{ik} Q_i \ln r_k\right] \end{pmatrix}^{(\phi)} + \varepsilon \qquad \text{(A2)}$$

$$s.t. \quad \begin{aligned} R^{(\phi)} &= (R^{\phi} - 1)/\phi \quad when\ \phi \neq 0 \\ &= \ln R \qquad\qquad when\ \phi = 0 \end{aligned}$$

where Q_i are the output quantities ($i= 1,..., n+m$), and r_K is the vector of input prices ($k = 1,\ldots n$). Thus, the composite in (A2) will adopt a logarithmic form when $\phi = 0$, while it will correspond to a generalized form in unlogged output levels when $\phi = 1$[34].

[34] ϕ is introduced as a parameter to be estimated so that the equation structure is itself a testable hypothesis. However, the composite is non-linear and must be estimated iteratively. Non-linear least squares routines are employed to estimate ϕ and all the other revenue function parameters in equation (4)[34]. In particular, equation (4) is estimated using a pseudo-model (Pulley and Braunstein, 1992) defining the geometric mean of total revenues as R^*.

APPENDIX B: ESTIMATED PARAMETERS OF THE SIMULTANEOUS ESTIMATION OF DEMAND AND SUPPLY RELATIONS FROM THE 'MARK-UP' MODEL

Non-linear least squares simultaneous estimation (with fixed effects) of the system of equations:

$$y_{it} = a_0 + a_1 p_{it} + a_2 S_t + a_3 p_{it} Z_t + a_4 Z_t + a_5 p_{it} S_t + a_6 S_t Z_t + \mu_i + e_{it}$$

$$p_{it} = -\lambda y_{it} / (a_1 + a_3 Z_t + a_5 S_t) + \delta_1 \sum \partial C^{\theta} / \partial Q_{\delta i} + \mu_t + \varepsilon_{it}$$

standard errors in parentheses

	Three-output definition (loans, deposits and other earning assets)	Five-output definition (loans, deposits, other earning assets, card transactions at ATMs and card transactions at POS)
a_0	0.111*** (0.02)	0.142*** (0.02)
a_1	-0.105** (0.04)	-0.114** (0.03)
a_2	0.232*** (0.12)	0.201*** (0.17)
a_3	-0.058 (0.03)	-0.183 (0.04)
a_4	0.030* (0.02)	0.102* (0.07)
a_5	-3.651** (1.21)	-2.459** (1.56)
a_6	0.062 (0.01)	0.054 (0.02)
λ	0.147*** (0.02)	0.263*** (0.03)
δ_1	0.0170** (0.04)	0.0214** (0.03)
R^2	0.71	0.79

* statistically significant at 10% level
** statistically significant at 5% level
*** statistically significant at 1% level

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TABLE 1. VARIABLE DEFINITION AND DESCRIPTIVE STATISTICS

	Definition	Mean	Std. dev.
Loans (millions of euros)	Outstanding value of customer loans at quarter-end.	3511.31	4403.11
Other earning assets (millions of euros)	Outstanding value of shares and securities at quarter-end.	1847.28	2942.96
Deposits (millions of euros)	Outstanding value of customer deposits at quarter-end.	3728.44	4980.08
Value of card transactions at ATM (millions of euros)	Outstanding value of card transactions at ATMs at quarter-end.	224.2	316.27
Value of card transactions at POS terminals (millions of euros)	Outstanding value of card transactions at POS terminals at quarter-end.	71.37	82.98
Total revenue (millions of euros)	Total bank revenue including interest and non-interest income.	342.27	256.88
Total revenue excluding indirect network effects (millions of euros)	Total bank revenue including interest and non-interest income, minus revenues from the use of cards at own ATMs and POS terminals by non-bank customers.	328.15	249.22
Total costs (millions of euros)	Total costs including interest and operating costs.	297.16	216.23
Price of deposits	Interest paid on deposits/outstanding value of deposits at quarter-end.	0.0224	0.0128
Price of labor (euros/worker)	Salaries/workers.	1636.1	2148.3
Price of physical capital	Interest paid on deposits/outstanding value of deposits at quarter-end.	0.1645	0.1252
Price of card use at ATM	Revenues from card transactions at ATMs/value of transactions at ATM	0.019	0.028
Price of card use at POS	Revenues from card transactions at POS/value of card transactions at POS	0.023	0.037
Average price of deposits, loans and other earning assets	Capital depreciation expenditures/value of physical capital at year-end.	0.0749	0.0660
Average price of deposits, loans, other earning assets and card services	Revenues from loan, other earning assets and deposits/outstanding value of loans, deposits and other earning assets at quarter-end.	0.0792	0.0688
Stock price index	The average quarterly growth of IBEX-35	0.0613	0.0568
Own ATM density	Number of own ATMs per square kilometer in the territories where the bank operates.	0.3522	0.2271
Competitors' ATM density	Number of competitors' ATMs per square kilometer in the territories where the bank operates.	0.8016	0.3593
Own POS terminals density	Number of own POS terminals per square kilometer in the territories where the bank operates.	0.6427	0.5508
Competitors' POS terminals density	Number of competitors' POS terminals per square kilometer in the territories where the bank operates.	1.1227	0.9244
Own branches	Number of own branches	0.0324	0.0320
Card growth	Quarterly growth rate of cards	0.0692	0.0497
Regional GDP (millions of euros)	Regional gross-domestic product (in real terms)	39246.4	22151.1
Regional population density	Inhabitants per square kilometer	63.27	25.56
Regional salary level (euros)	Salary per employee at the regional level	1274.15	587.22

Data sources: All the quantities and prices of bank assets, card services, ATMs and POS terminals have been provided by the Spanish Confederation of Savings Banks (CECA). Regional GDP, population density and salary levels have been obtained from the Spanish Statistical Office (INE).

TABLE 2. ESTIMATED MARKET POWER INDICATORS FOR THE POSITED BANK OUTPUTS

Marginal costs estimated from a multiproduct composite cost function				
	Price	**Marginal costs**	**Mark-up**	**Lerner index**
Loans	0.049	0.039	0.010	0.204
Deposits	0.018	0.019	-0.001	-0.056
Other earning assets	0.063	0.032	0.031	0.492
Card transactions at POS	0.063	0.059	0.004	0.063
Card transactions at ATMs	0.092	0.061	0.031	0.337
Total card transactions	0.082	0.06	0.022	0.268

TABLE 3. SSNIP TEST FOR CHANGES IN PROFITS (%) WITHIN A MULTIPRODUCT BANKING FRAMEWORK WITH PAYMENT CARDS

The SSNIP test is defined as the Small, but Significant, Non-transitory Increase in Price that results in a significant change in profits. In this table, the profit-maximizing bank offers a set of products (J) which alternatively corresponds to the three-output or five-output (including card transactions) definitions of the multi-output production function. The SSNIP is implemented for the standard 5% and 10% variation in prices. Prices are set constant at their means for comparison purposes ($\overline{p}_j$ *):*

$$\Delta\pi_{M,J} = \left(\frac{\sum_{i=1}^{n} [\pi_i(p_j^{SSNIP}) - \pi_i(\overline{p}_j)]}{\sum_{i=1}^{n} \pi_i(\overline{p}_j)} \right)$$

Change in prices	**Three-output definition** (loans, deposits and other earning assets)	**Five-output definition** (loans, deposits, other earning assets, card transactions at ATMs and card transactions at POS)
5%	-1.92	-2.85
10%	-3.84	-5.70

TABLE 4. PAYMENT CARDS AS TWO-SIDED MARKETS: TEST OF THE SIGNIFICANCE OF CHANGES IN THE PRICES CHARGED TO CARDHOLDERS (p_c), MERCHANTS (p_m) AND OF TOTAL PRICES ON THE QUANTITY OF CARD TRANSACTIONS

Fixed effects estimations of a linear approximation to demand curves *t-statistics in parenthesis*			
Log (cardholders price)	-0.3907*** (-11.32)	-	-
Log (merchants price)	-	-0.2118*** (-11.12)	-
Log (total price of cards)	-	-	-0.5166*** (-18.90)
Log (price of deposits)	-0.3542*** (-8.64)	-0.4086*** (-10.12)	-0.3345*** (-8.93)
Log(GDP)	0.15E-07*** (17.10)	0.12E-07*** (12.25)	0.11E-07*** (12.81)
Log (population density)	0.0521*** (3.32)	0.0623*** (3.96)	0.0447*** (3.09)
R^2	0.96	0.96	0.97
* statistically significant at 10% level ** statistically significant at 5% level *** statistically significant at 1% level			

TABLE 5. HEDONIC REGRESSIONS: PRICES AND SERVICE CHARACTERISTICS

Panel data regressions (random effects model)
Standard errors in parentheses

	(I) *log(Price of card use at ATM)*	*(II)* *log(Price of card use at POS)*
Constant	-1.701 (0.081)	1.269* (0.067)
log (own ATMs density)	0.055 (0.071)	-0.021** (0.031)
log (competitors' ATMs density)	0.061** (0.031)	-0.010 (0.011)
log (own POS terminals density)	-0.032** (0.061)	0.014* (0.029)
log (competitors' POS terminals density)	-0.015 (0.075)	0.018** (0.013)
log [(card growth) x (own ATMs)]	0.074 (0.081)	-0.031** (0.048)
log [(competitors' ATMs) x (own card issuance)]	0.057*** (0.021)	-0.013 (0.011)
log [(card growth) x (own POS terminals)]	-0.076** (0.031)	0.011** (0.023)
log [(competitors' POS terminals) x (own card issuance)]	-0.031* (0.052)	0.013** (0.011)
log (own branches)	0.012** (0.055)	0.026*** (0.029)
log (market power [λ])	0.049*** (0.018)	0.024*** (0.050)
log (card growth)	-0.026** (0.073)	0.035 (0.045)
log (regional population density)	-0.111*** (0.022)	-0.058*** (0.015)
log (regional GDP)	-0.026 (0.030)	-0.269*** (0.014)
log (regional salary level)	0.290*** (0.051)	0.240*** (0.041)
R^2	0.80	0.78

* statistically significant at 10% level
** statistically significant at 5% level
*** statistically significant at 1% level

TABLE 6. DEVIATION OF ACTUAL PRICES AND QUANTITIES FROM COMPETITIVE LEVELS

Bootstrapped confidence intervals in parentheses

	Three-output definition (loans, deposits and other earning assets)			Five-output definition (loans, deposits, other earning assets, card transactions at ATMs and card transactions at POS)		
	Deviation of actual quantities from the competitive output level (-λ)	***Local deviation of actual prices from competitive price levels*** $[-\lambda y/(\partial y/\partial P)]$	***% income deviation from competitive income levels***	***Deviation of actual quantities from the competitive output level (-λ)***	***Additional local deviation of actual prices from competitive price levels*** $[-\lambda y/(\partial y/\partial P)]$	***Additional % income deviation from competitive income levels***
1997	0.132 (0.109,0.150)	0.097	1.132	0.252 (0.227,0,297)	0.098	1.270
1998	0.136 (0.112,0.154)	0.098	1.143	0.256 (0.229,0.301)	0.098	1.282
1999	0.138 (0.110,0.159)	0.099	1.146	0.257 (0.231,0.302)	0.099	1.283
2000	0.139 (0.103,0.160)	0.099	1.150	0.265 (0.240,0.310)	0.099	1.296
2001	0.148 (0.120,0.195)	1.002	1.158	0.274 (0.250,0.304)	0.099	1.313
2002	0.153 (0.137,0.198)	1.003	1.160	0.269 (0.243,0.319)	0.097	1.302
2003	0.161 (0.142,0.213)	1.009	1.162	0.261 (0.240,0.316)	0.099	1.299
1997-2003	**0.147 (0.122,0.202)**	**0.099**	**1.158**	**0.263 (0.241,0.313)**	**0.098**	**1.298**

* All estimated λ values are statistically significant at the 5 per cent level (as a minimum). See also estimations in Appendix B.

TABLE 7. ESTIMATED CHANGE IN BANK CONSUMERS' WILLINGNESS TO PAY WHEN CARD SERVICES ARE INCLUDED IN THE MULTIPRODUCT SETTING

*Willingness to pay estimates obtained from yearly evaluated composite function parameters**
Revenues deviation from competitive equilibrium models obtained from a simultaneous estimation of demand and supply relationship functions

	Complementarities in consumption from card services supplied jointly with bank balance-sheet assets (% revenues)	***Indirect network effects (% revenues)***	***Total increase in consumers' willingness to pay (A)***	***% revenue deviation from competitive equilibrium (balance sheet plus card services) (B)***	***Estimated net change in willingness to pay (as a percentage of bank revenues) (A)-(B)***
1997	2.32	0.28	2.60	2.402	**0.20**
1998	2.51	0.29	2.80	2.425	**0.38**
1999	2.60	0.30	2.90	2.429	**0.47**
2000	2.71	0.32	3.03	2.446	**0.58**
2001	2.58	0.32	2.90	2.471	**0.43**
2002	2.80	0.38	3.18	2.462	**0.72**
2003	2.92	0.41	3.33	2.461	**0.87**
1997-2003	**2.63**	**0.35**	**2.98**	**2.456**	**0.52**

* All estimated values are statistically significant, at the 5 per cent level (as a minimum) ($\in = 0.0$)

TABLE 8. ESTIMATIONS OF THE WILLINGNESS TO PAY FOR CARD SERVICES. ROBUSTNESS CHECK FOR DIFFERENT LEVELS OF BANK INVESTMENT IN CARDS, ATMs AND POS TERMINALS

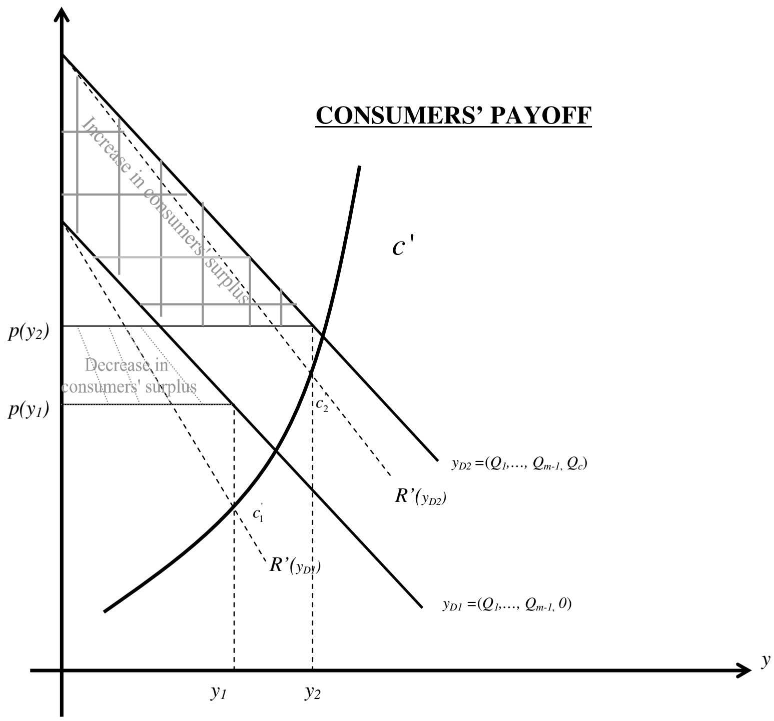
*Consumer valuation estimates obtained from yearly evaluated composite function parameters**
Revenues deviation from competitive equilibrium models obtained from a simultaneous estimation of demand and supply relationship functions

NOTE: LOW and HIGH refer to the estimates for those banks below or over the median value of the selected criterion, respectively. These values were found significantly different in all cases according to mean difference tests.

	CARDS/DEPOSITS		***ATMs GROWTH***		***POS GROWTH***	
	LOW	***HIGH***	***LOW***	***HIGH***	***LOW***	***HIGH***
Complementarities in consumption from card services supplied jointly with bank balance-sheet assets (% revenues)	2.16	2.88	2.47	2.68	2.12	2.93
Indirect network effects (% revenues)	0.37	0.35	0.39	0.32	0.42	0.3
Total increase in consumers' willingness to pay (A)	2.53	3.23	2.86	3.00	2.54	3.23
% revenue deviation from competitive equilibrium (balance sheet plus card services) (B)	2.36	2.57	2.42	2.53	2.38	2.48
Estimated net change in willingness to pay (as a percentage of bank revenues) (A)-(B)	0.17	0.66	0.44	0.47	0.16	0.75

* All estimated values are statistically significant, at least, at the 5 per cent level (as a minimum) ($\in = 0.0$)

FIGURE 1. THE INTRODUCTION OF CARDS IN THE OUTPUT BUNDLE, SCENARIO 1: INCREASES IN CONSUMERS' SURPLUS AND BANKS' MARK-UP OF PRICE OVER MARGINAL COSTS



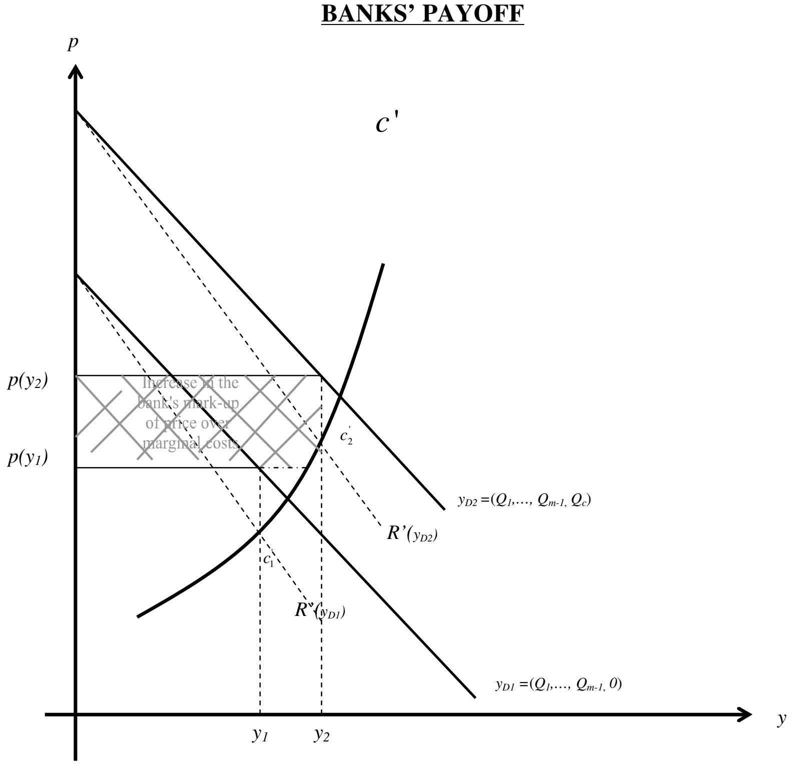


FIGURE 2. THE INTRODUCTION OF CARDS IN THE OUTPUT BUNDLE, SCENARIO 2: A DECREASE IN CONSUMERS' SURPLUS AND AN INCREASE IN BANKS' MARK-UP OF PRICE OVER MARGINAL COSTS